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هيئة التحرير

كلمة العدد..........

الحمد لله رب العالمين على توفيقه لنا لإصدار **العدد الثامن عشر** من **المجلة الدولية للعلوم والتقنية** و الذي أخترنا غلافه ليحمل صور من مدينتنا و عاصمتنا الحبيبة **طرابلس عروس البحر** و التي نسأل الله ان يحفظها و ويحفظ اهلها.

المجلة الدولية للعلوم والتقنية هي إحدى المجلاّت التي تصدر عن مركز العلوم والتقنية للبحوث والدراسات الذي تم تأسيسه على يد مجموعة من الاساتذة والفنيين ذوي الخبرة والنشاط العلمي المميز لإتاحة المجال للبحّاث و المهتمين في مجالات العلوم الهندسية والتطبيقية و التقنية نشر أبحاثهم على صفحاتها، والتي نسعى من خلالها لتقديم و توفير المعلومات و البيانات ونتائج الاختبارات العلمية الصحيحة لطلاب العلوم الهندسية و التطبيقية حتى يمكنهم استكمال دراساتهم و ابحاثهم على اسس علمية.

و من هذا المنطلق فإن هيئة تحرير المجلة تجدد حرصها الدائم على استمرارية صدور المجلة برصانة و منهجية في البحث العلمي وذلك بإتباع الأساليب العلمية المحكّمة في تقييم البحوث العلمية المقدمة من الأساتذة و البحّاث بإشراف أساتذة متخصصين في جميع فروع العلوم و التقنية، آخذين في الاعتبار الطرق المتبعة في المجلات العلمية العريقة في هذا المجال.

وبهذه المناسبة يسر هيئة التحرير بالمجلة أن تثمن عالياً جهود جميع البحّاث و الأساتذة المهتمين الذين اختاروا صفحات هذه المجلة لنشر أبحاثهم و أوراقهم العلمية، كما أنها تتقدم بجزيل الشكر و العرفان لكل من ساهم في تحرير و مراجعة البحوث المقدمة للمجلة وتقديم هذا الصرح العلمي للوجود

هيئة التحرير

جدول المحتويات

دراسة سرعة الخلط الميكانيكي بمفاعل خزان الخلط وتأثيرها في عمليات التخمر

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ABSTRACT

Citric acid is a naturally occurring organic acid, it is found in citrus and is a natural organic preservative, it is known as lemon acid, it is called in popular circles and consumer markets with food salt, which is a transparent crystals tend to light white, and its scientific names are hydrogen citrate, where are part of it consists of six carbon atoms and seven oxygen atoms and eight hydrogen atoms, it is chemical compound and it has a high circularity in water.

Chemical reactors are the space where interaction in limited and converting the reactive materials into products, it is reported that, the reactor in the images more complex as in laboratories and medical laboratories, Such as laboratories and booths in which various chemical processes and carried out.

The complexity of looking at large nuclear reactors, for example, and the medicine in which the drugs are produced and as bioreactors, which are the main heart of biochemical technologies.

In this paper, the mechanical mixing speed of STR reactor was studied and their effect on fermentation processes, biomass growth and the amount of citric acid production.

Our study and results showed that the high speed of mixing in stirred tank reactor is effect on the fermentation process and production of citric acid.

الخلاصة

حامض الستريك هو أحد الأحماض العضوية الموجودة طبيعياً، فهو موجود في الحمضيات، و هو مادة حافظة عضوية طبيعية، و من أسمائه المعروفة كذلك حامض الليمون، و يسمى في الأوساط الشعبية و الأسواق الاستهلاكية بملح الليمون، وهو عبارة عن بلورات شفافة مائلة للبياض الخفيف، و من أسمائه العلمية سترات الهيدروجين حيث يتكون الجزيء الواحد منه من ست ذرات كربون و سبع ذرات أوكسجين و ثماني ذرات هيدروجين، و هو مركب كيميائي ذو ذائبية عالية جدا في الماء.

المفاعلات الكيميائية هي الحيز الذي يحدث فيه تحويل المواد المتفاعلة الي نواتج. ونجد المفاعلات في صور أكثر تعقيدا كما في المعامل والمختبرات الطبية كالمخابر والدوارق التي تتم فيها العمليات الكيميائية المختلفة ويزداد التعقيد عند النظر إلي المفاعلات الضخمة النووية مثلا و الطبية التي يتم إنتاج الأدوية فيها و كذلك المفاعلات الحيوية التي تعتبر القلب الرئيسي للتقنية الكيميائية الحيوية.

ففي هذا البحث تمت دراسة سرعة الخلط الميكانيكي بمفاعل خزان الخلط (STR) و تأثيرها في عمليات التخمر و نمو الكتلة الحيوية و كمية انتاج حامض الستريك فمن دراستنا والنتائج المتحصل عليها اتضح لنا ان سرعة الخلط العالية بالمفاعل تواتر سلبي في عملية التخمر وكمية انتاج الحامض.

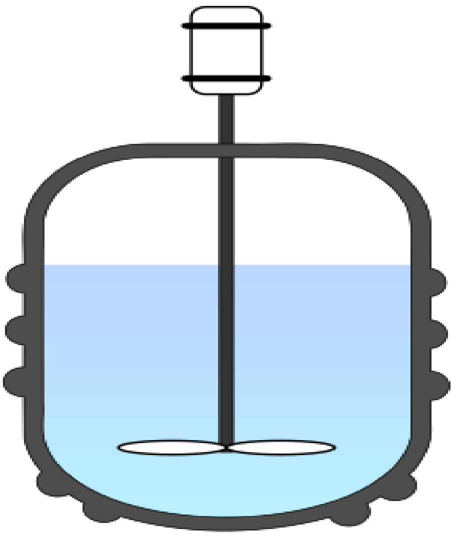
المقدمة:

ان روح البحث والتنقيب التي يحملها إنسان هذا العصر مما يدعوه إلى أن يبحث في خفايا المواد لمعرفة مكوناتها وأدق أجزائها لعله يجد لبعضها استعمالاً جديداً أو يقوم بواسطتها بتجديد مواد أخرى كان يعاني من مشاكل في استخدامها.

حمض الستريك إن الطرق التقليدية لإنتاج هدا الحامض من عصير الليمون بدأت منذ أوائل القرن الحالي إنتاج هذا الحامض بتخمير المولاس بواسطة خميرة خاصة ووسط ملحي ملائم في أجهزة للتخمير السطحي تمّ تطويرها إلى استعمال التخمير الغاطس مع سلالات جديدة. ومن خواص حمض الستريك أن بلوراته لا لون لها ولا رائحة وحمضية المذاق وتذوب في الماء والكحول [1].

لحمض الستريك عدة فوائد فهو يضاف للأغذية لإعطاء الغذاء الطعم الحمضي ويعزز فعالية مضادات الأكسدة ويمنع تلون الفاكهة ويمنع حدوث الروائح الغير مرغوب فيها وكذلك فهو يحافظ على فيتامين C وكدلك يعتبر وسيط مهم في دورة حمض الستريك وبالتالي فهو يتكون في كل التمثيل الغذائي لكل شيء حي تقريبا ويستخدم أيضا كعامل منظف للبيئة ويعمل كمضاد للأكسدة [2].

مفاعل الخلط الميكانيكي يصنف الى **مفاعل الدفعات:** وهذا المفاعل مشهور وقديم جداً وقلة ما يستخدم في الوقت الحالي وتعتمد فكرة عمله على خلط المتفاعلات بنسب معينة في وعاء ثم بعد ذلك يتم التقليب جيداً مع توفير الظروف اللازمة للتفاعل (انظر الى الشكل رقم 1)، وبعد إتمام التفاعل يتوقف التقليب ثم يتم تفريغ المفاعل من الناتج وتنظيفه وبعد ذلك يصبح المفاعل جاهزاً لشحنة جديدة.



شكل (1) يوضح المفاعل الدفعي STR

عيوب هذا المفاعل:

1- يحتاج لعمالة يدوية مكلفة للإشراف والتقليب والتنظيف.

2- لا يصلح لإنتاج كميات كبيرة من النواتج حيث سيتطلب الأمر مفاعل ضخم جداً ولذلك ظهرت فكرة المفاعل المستمر.

المفاعل المستمر: وهذا المفاعل جاء ليتغلب على عيوب مفاعل الدفعات حيث يتم إدخال المتفاعلات باستمرار وبنسبة معينة وتتم عملية التقليب بطريقة ميكانيكية مستمرة أيضاً أما النواتج فتخرج من المفاعل من فتحة جانبية على ارتفاع معين ولا بد أن يتم الحفاظ على النسبة بين المتفاعلات وكذلك معدل دخولها إلى المفاعل حيث يجب أن يترك الفرصة للمواد الموجودة في المفاعل أن تتفاعل مع بعضها البعض وفي نفس

الوقت يعجل من خروج النواتج من المفاعل، ويتم التحكم في معدل دخول المتفاعلات إلى المفاعل عن طريق استخدام صمامات تحكم. [4]

وغالباً ما يصلح هذا المفاعل لكثير من التفاعلات حيث يتم الحصول على نواتج بمعدل ثابت ومستمر وفي نفس الوقت لا حاجة للعاملة البشرية المكلفة إلا أنه يحتاج لتحكم جيد للحفاظ على النواتج.

التجارب المعملية

- **خطوات التجارب :**

1- يتم تعقيم جميع أجزاء المفاعل عن طريق جهاز التعقيم الأوتوكلاف وفي درجة حرارة ($120C^0$) ولمدة 40 دقيقة .

2- يتم توصيل المفاعل بجميع الأجهزة المطلوبة ويضاف إليه الحجم المطلوب وتثبت كل من درجة الحرارة عند ($32C^0$) و pH ما بين (2.8 -2.6) .

3- يتم فتح صمام تدفق الهواء إلى المفاعل والذي يجب أن يكون ما بين قيمة Vvm (0.5-3) كما يجب أن لا تقل نسبة الأكسجين بالمفاعل أقل من 10%.

4- معدل الخلط للمفاعل الخلط الميكانيكي هي ما بين (250-400) و(400-600) وفي بعض الأحيان تصل ما بين (600-700) دوره بالدقيقة.

5- توضع نسبة معينة من المواد الداخلة حسب الجدول 1.

6- يوضع حجم من الكائنات الحية بالمفاعل وهي نوع من أنواع الفطريات والتي تسمى الإسبيرجيلوس نيجر (The Aspergillus niger) .

7- نأخذ العينة في كل زمن معين ثم نقوم بمعالجتها.

8- نأخذ العينة وتوضع في جهاز فصل بسرعة (18000 r\m) لمدة 10 دقائق. بعد ذلك تنقل المادة السائلة إلى جهاز التحليل. والباقي يجفف تحت درجة حرارة (80-90 C^0) وذلك للحصول على وزن ثابت من الكتلة الحيوية.

و الشكل رقم (2) يوضح تركيز الكتلة الحيوية مع الزمن عند سرعة الخلط من(400−600)

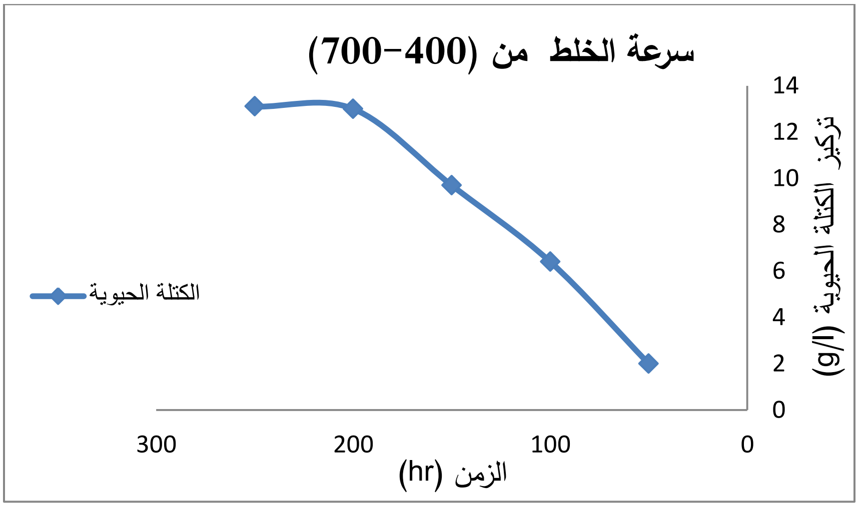
جدول (1) تركيب محلول التلقيح والتخمر

المركب	التركيز (g/L)
Sucrose	150
$(NH_4)_2SO_4$	2.8
KH_2PO_4	0.33
$CaCl_2$	0.33
$MgSO_4.7H_2O$	0.33
$FeSO_4.7H_2O$	0.075
$ZnSO_4.7H_2O$	0.05

شكل (2) يوضح تركيز الكتلة الحيوية مع الزمن عند سرعة الخلط من(400−600)

جدول (2) نمو الكتلة الحيوية مع الزمن

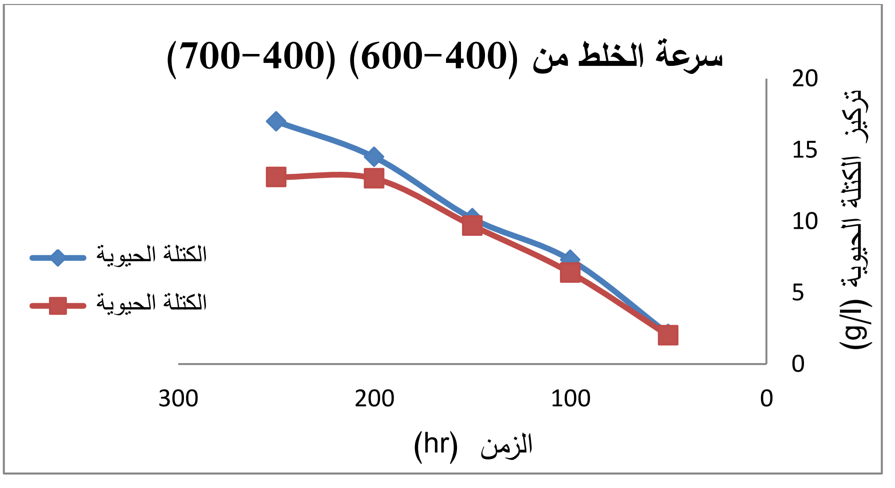
الزمن	الكتلة الحيوية
50	2.1
100	7.3
150	10.2
200	14.5
250	17.0



شكل (3) يوضح تركيز الكتلة الحيوية مع الزمن عند سرعة الخلط من (400-700)

جدول (3) نمو الكتلة الحيوية مع الزمن

الكتلة الحيوية	الزمن
2.0	50
6.4	100
9.7	150
13	200
13.1	250



شكل (4) يوضح تركيز الكتلة الحيوية مع الزمن عند سرعة الخلط من(400-600) و من (400-700) معا

جدول (4) نمو الكتلة الحيوية مع الزمن

الزمن	الكتلة الحيوية من (400–600)	الكتلة الحيوية من (400–700)
50	2.1	2.0
100	7.3	6.4
150	10.2	9.7
200	14.5	13
250	17.0	13.1

جدول (5) يبين معلومات التجارب و نتائجها

رقم التجربة	1	2
نوع المفاعل	STR	STR
حجم السائل (L)	2	2
تركيز التلقيح v/v%	2	2
زمن التخمر (hr)	250	250
سرعة تدفق الهواء (vvm at 20C^0,101,3Kpa)	0.5–1.6	0.5–1.6
سرعة الخلط RPM	400 – 700	400 – 600
Ph النهائية	2,7	2,7
أكبر كتلة عضوية جافة g/L	13.1	17
السكروز النهائي g/L	0	0
الجلوكوز النهائي g/L	15	0
الفركتوز النهائي g/L	20	
حمض الستريك النهائي g/L	58	

النتائج والمناقشة.

النتائج: من خلال التجارب المعملية تم الحصول علي النتائج الأتية:

1- تركيز الحمض يتزايد مع مرور الزمن.

2- تزايد الكتلة الحيوية مع الزمن.

3- نلاحظ أن الزيادة في سرعة الخلط الميكانيكي تواتر على نمو الكتلة الحيوية وخاصتا عندما تزيد سرعة الخلط وفي المعدل ما بين 600-700 دوره بالدقيقة.

4- كمية الحمض الناتجة في التجربة (2) أكبر منها في التجربة (1).

5- كمية الكتلة الحيوية المتكونة عندما كان معدل الخلط 600-700 دوره بالدقيقة اقل بكثير عندما كان الخلط من 400-600 دوره بالدقيقة

المناقشة: إن فوائد مفاعل الخلط الميكانيكي فوائـد يعزى سببها إلـى انتظام درجة الحرارة والضغط والتراكيب داخل المفاعل نتيجة المزج المستمر حيث يمكن تشغيل هذا النوع من المفاعلات عند ظـروف درجة الحرارة الثابتة حتى عندما تكون درجة حرارة التفاعل عـالية.

إن إمكانية التشغيل بظروف درجة الحرارة الثابتة تعتبر صفة مميزة ومفيدة لمفاعل الخلط الميكانيكي إضافة إلى ذلك فإن الحجوم الكبيرة لمفاعل الخلط الميكانيكي ستوفر لمزيج التفاعل زمن مكوث طويل.

إن هاتين الخاصيتين ستمكننا من تشغيل المفـاعل لدرجـات الحرارة المثلـى لفترات زمنية طويلة وعند التفاعلات المضـاعفة ولبعض أنواع سرعة التفاعل.

الاستنتاجات

ان عيب نضام الدفعات بالمفاعلات الحيوية هو ان في بداية كل دفعة يجب أن تزرع عدد كاف من خلايا الكائن الحي لتقوم بتحويل السكر الى حمض الستريك. ان هذا الجزء من التخمر يحتاج وقتا كافيا لعملية التخمير، ومن اجل ان تكون هده العملية

مستمرة الاقتصادية يجب أن يوظف تركيزات عالية من السكر، بالإضافة الى أن هذا السكر يجب الاستفادة منه بشكل كبير ولدلك يستلزم استخدام سلسلة من أجهزة التخمير وهذا التعقيد يميل إلى إلغاء المزايا المحتملة لوضع التخمير المستمر.

قياساتنا أظهرت النتائج الاتية هو أن الزيادة في سرعة الخلط الميكانيكي بالمفاعل اكثر من 600 دوره بالدقيقة فان الكتلة الحيوية و تكوين حمض الستريك يقل و اقل بكثير عندما كان الخلط اقل من 600 دوره بالدقيقة وهدا يعني ان سرعة الخلط العالية والأكثر من 600 دورة بالدقيقة تسبب في كسر خلايا الكائنات الحية الدقيقة المتمثلة في الكتلة الحيوية والتي هي إحدى العوامل المهمة في إنتاج حمض الستريك والكتلة الحيوية.

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عزل وتعريف الفطريات المرافقة لبعض حبوب المحاصيل النجيلية والمسببة للأمراض النباتية.

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المستخلص Abstract

هدفت هذه الدراسة الى عزل وتحديد الفطريات المرافقة لعدد ستة اصناف من القمح والمسببة لبعض الامراض النباتية التي تنتقل بواسطة البذور منها ثلاثة اصناف صلبة (بني سويف *Banisweif* ، النعمة *Annaama* ، بلتاجي *Beltagi*) وثلاثة طرية (شام 10 *Cham* ، بحوث *Bo-hott208* ، ابوالخير*Abou-lkheir*) بطريقة اوراق الترشيح والوسط الغذائي حيث تم عزل اربعة اجناس فطرية منها رمية وممرضة للنبات للفطريات *Aspergillus*spp ,*Fusarium*spp ,*Pencillium*spp ,*Rhizopus*spp على الاسطح الخارجية للبذور ، وثمانية اجناس للفطريات , *Chetomium*spp , *Rhizopus*spp , *Aspergillusclavatus* , *A.niger* ,*Stemphylium*spp , *Alternaria*spp , *Rhizoctonia*spp ,*Fusarium*spp , *Cladosporium*spp داخل المحتوى الداخلي للبذور ، حيث بينت النتائج ان اكثر الفطريات ترددا بطريقة اوراق الترشيح هو فطر *Rhizopusstolonifer*, يليه فطر *Pencillium*spp يليه فطر *Aspergillusclavatus* بنسب (90 ، 78.1

، 28 %) على التوالي للأصناف (بحوث 208 ، النعمة ، شام 10) ، بينما كانت اكثر الفطريات ترددا بطريقة الوسط الغذائي spp *Cladosporium* يليه فطر spp *Fusarium* وفطر spp *Rhizopus* و spp *Rhizoctonia* ، وفطر spp *Chetomium* بنسب (96.8، 64.5 ، 56.5 ، 47.3 ، 46.8 %) على التوالي وان نسبة انبات الحبوب المختبرة وكذلك نسبة الاصابة قد اختلفت باختلاف الاصناف ، وان بعض الاصناف التي كانت نسبة انباتها اكبر سجلت اقل نسبة للإصابة بفطريات البذور ، كما سببت الفطريات تشوهات للجذور وتغير لونها وتعفنها وخفض في اطوال البادرات وفي جذورها الجانبية وتوقف نموها .

الكلمات الدليلية :القمح الطري ، القمح الصلب ، فطريات تخزين الحبوب.

المقدمة Introduction

يعد محصول القمح *Triticumaestivum L* من اهم محاصيل الحبوب في العالم التابع للعائلة النجيلية[1]. كما يعتبر من اهم الاغذية الاساسية في حياة الانسان وتزداد الحاجة اليه مع زيادة السكان، وتشير الدراسات إلى ان سكان العالم سيحتاج في عام 2020 م الى بليون طن من القمح مقارنة مع الانتاج الحالي الذي لا يتجاوز عن 600 مليون طن[2]. ويزرع في ليبيا نوعان من القمح، القمح الصلب durum wheat (*Triticum durumDesf*) والقمح الخبز bread wheat (*Triticumaestivum L.*) تحت ظروف الزراعة المطرية في المناطق الشرقية من البلاد ، وفي المناطق الجنوبية في مشاريع الكفرة والسرير وفزان، وتبلغ المساحة الاجمالية للزراعات المطرية ما بين 100.000 – 200.000 هكتار، كما تبلغ المساحة المروية ما بين 40.000 –

70.000 [3]. وتقدر احتياجات سكان ليبيا من محاصيل القمح والشعير حوالي 557 ألف طن سنويا، وتنتج محليا حوالي 296 ألف طن حيث تساهم المشاريع الحكومية المتخصصة في زراعة الحبوب المروية بنسبة 32% تقريبا من إنتاج محصول القمح والشعير بحوالي 96 ألف طن، منها 80 ألف طن من حبوب القمح و16 ألف طن من الشعير، وان متوسط تكلفة إنتاج الطن الواحد من القمح قد بلغت 103.597 دينار في الموسم [4]. وتشكل الفطريات الخيطية التي تسبب فساد وتلف المحاصيل بعد حصادها أحد أهم الأخطار المرتبطة بتدني الإنتاجيات وحدوث خسائر كبيرة في المحاصيل الزراعية وكذلك عمليات تصنيعها وتخزينها، كما .يوجد عدد كبير من الفطريات التي تسبب امراضا عديدة على النباتات الهامة اقتصادياً منها امراض الذبول والعفن الاسود والبني و امراض اللفحة والتبقع، ولكن أغلب هذه الامراض تكون محمولة على البذور ثم تنتقل إلى الاجزاء المختلفة للنبات بعد نموه [5]. ويزيد عدد الفطريات التي تصاحب الحبوب الى 100 نوع من الفطريات بعضها يشكل مخاطر مرضية على النباتات المزروعة، وبعضها الآخر يسبب مشاكل تعفن وإفراز سموم أثناء التخزين مما يجعلها تشكل مخاطر صحية على المستهلكين[6، 7]. وتسبب الفطريات المنقولة عن طريق البذور موت البذور قبل الانبات وموت البادرات مما يؤدي الى خسائر اقتصادية كبيرة[8] .وتعد المجموعات الرئيسية للمسببات المرضية المنقولة ببذور القمح كفطريات التفحم السائب والمغطى وأنواع الفطريات *Fusarium*spp ,*Drechslera*spp ,*Alternaria* spp ,*Pyrenosporatritici* ,*Septoriaspp*من الفطريات الهامة التي تسبب امراض النبات[9]. ويتميز فطر *Rhizopus* spp بسرعة نموه وكذلك الأضرار التي يلحقها بحبوب الشعير في المخزن، بالإضافة إلى إفراز بعض السموم

الفطريةmycotoxins الضارة بصحة الإنسان والحيوان. ويعتبر فطر *Alternariaalternata* من الفطريات المصاحبة للبذور ومن المصادر الاولية لحدوث الاصابة فضلاً عن انتقاله الى النبات عن طريق التربة الملوثة [10] . كما يتميز الفطر *A.alternata* بقدرته على انتاج انواع مختلفة من السموم التي تساهم في غزو النسيج النباتي واحداث الاصابة [11]. تلعب الفطريات دوراَ اساسياً كمسبب للأمراض لما لها من مركبات ايضية ثانوية هي السموم الفطرية (Mycotoxin) تنتجها خلال فترات محددة من دورة حياتها وان اكثر الاجناس انتاجاً لهذه السموم هي *Pencillium*spp , *Aspergillusclavatus ,A.parasiticus,Fusarium*spp وقد تسبب العديد من الامراض وايضا تلحق اضراراً بالمحاصيل الزراعية والحبوب المخزونة وينتج عنها خسائر اقتصادية ، حيث تم حصر 85 نوعاً من الفطريات التخزين على حبوب القمح تتبع الاجناس *Mucor*spp *Alternaria*spp,*Rhizopus*spp. كما تتواجد بأعداد قليلة او على هيئة ميسليوم ساكن داخل انسجة البذرة [12] . وتعتبر عملية عزل الفطريات الممرضة المحمولة بالبذور وتعريفها من اهم الخطوات في دراسة امراض البذور والتي عن طريقها يمكن التأكد من انتقال الفطر الممرض بالبذرة من خلال اصابتها لها وتشير الدراسات السابقة الى ان الفطريات الاسكية والناقصة تشكل الغالبية العظمى للفطريات التي تنتقل عن طريق البذور والتي تؤدي الى امراض عديدة منها امراض التعفنات والذبول وغيرها [7]. واوضحت الدراسة التي قام بها[13] عند عزل وتعريف الفطريات المصاحبة لبعض بذور المحاصيل النجيلية لحبوب القمح الصلب صنف (كريم) بعد حصاد محصول القمح بطريقة اوراق الترشيح الى وجود فطر *Aspergillus flavus* بنسبة (88%) %

وفطر (38%) *Fusarium granarium*, بنسبة (13 %) ، بينما بينت طريقة الوسط الغذائي الى وجود فطريات *Alternaria*spp بنسبة (6 %) ، يليه *Fusarium granarium*, بنسبة (3%) ، *Stemphylium* spp بنسبة (3%) ، وفطر *Aspergillus flavus* بنسبة (1%) . ووجد في أحد الدراسات التي قام بها في ليبيا [141] عند عزل الفطريات المصاحبة لبذور القمح والشعير من صوامع تخزين الحبوب في وجود فطريات *Rhizoctonia*.sp ,*Aspergillus*.spp, *Fusarium*.spp, *Alternaria*.spp, *Rhizopus. stolonifer, Rhizopus*.sp والتي سببت تلف محتويات الحبوب وموت أجنة البذور .ونظراً لتكرار ظهور امراض اعفان الجذور و وتبقعات الاوراق وهي من الامراض الكامنة في البذور والتي تحدث اصابتها الابتدائية على البادرات وكذلك اعفان الجذور الرايزوكتوني على نباتات القمح في القطع التجريبية بمحطة صفيت للأبحاث الزراعية فلقد استهدفت الدراسة لغرض :

* عزل وتعريف الفطريات المصاحبة لبعض اصناف القمح المنتجة محليا والمسبب لبعض الامراض النباتية .

* دراسة نسب اصابة البذور بفطريات التخزين وتحديد الانواع الاكثر تردداُ على البذور ، وتأثيرها على بعض الصفات الظاهرية.

الـمواد وطرق العمل Materials and Methods

موقع الدراسة

أجريت هذه الدراسة المختبرية في معمل النبات التابع لقسم النبات، كلية العلوم، جامعة الزنتان / ليبيا سنة 2016 م .

مصدر البذور :

استخدمت في هذه الدراسة ستة اصناف من حبوب القمح النظيفة والمنقاة من الشوائب والاتربة بشكل جيد تستخدم لأغراض الزراعة البحثية والمخزنة في محطة صفيت للبحوث الزراعية بمدينة يفرن والواردة من محطة مصراته للبحوث الزراعية للأصناف ، قمح طري شام 10، قمح طري بحوث 208 ، قمح صلب بني سويف، قمح طري ابوالخير ، قمح صلب النعمة ، قمح صلب بلتاجي ومن انتاج الموسم الزراعي 2014 م ،حيث جمعت عينات عشوائية بوزن 200 جرام لكل عينة ثم مزجت العينات المختبرة جيدا داخل اكياس بلاستيكية نظيفة كلا على حده ثم نقلت هذه العينات إلى المختبر وقسمت إلى أجزاء متساوية واستخدمت كمكررات لأغراض البحث.

العزل والتعريف

تم عزل الفطريات المرافقة لبذور القمح المستخدمة في الدراسة بعد فحصها للتأكد من خلوها من الأضرار الميكانيكية وفق الاختبارات الدولية لصحة البذور [25] .حيث استخدمت في هذه الدراسة طريقتان تعتبران من أكثر الطرق شيوعاً للكشف عن الفطريات النامية علي الحبوب المختلفة واختبار سلامتها من حيث اصابتها أو تلوثها بالفطريات وهما طريقة ورق الترشيح (Blotter method) وطريقة الاجار (Agar method) [26] حيث ان هناك عدة طرق لاختبار سلامة البذور تختلف فيما بينها من حيث الغرض الذي يجري من اجله الفحص وفي السرعة التي تتم بها الطريقة وما اذا كانت الطريقة مكلفة أو غير مكلفة وسريعة ، ثم تحضين الاطباق في درجة حرارة 27 م^0 لمدة سبعة أيام. سجلت النتائج علي أساس نسبة إنبات الحبوب النامية في كل طبق وتم تحديد الاجناس المختلفة من الفطريات لأجل تعريفها وفقاً للمعايير

المورفولوجية والمجهرية مثل شكل المستعمرات وألوانها، شكل الأبواغ وحواملها الجرثومية وانتاجها للقطرات المائية ، وذلك بالاستعانة بالمراجع المتخصصة في تعريف الفطريات [28,27] . وكذلك تم تحضير شرائح وفحصها تحت المجهر للتعرف على الأجناس الفطرية تم إجراء عمليات العزل للفطريات بواسطة ابره معقمة ووضعها علي سطح بيئة غذائية نقية داخل أطباق بتري بعد تطهير مكان العزل بالكحول الايثيلي تركيز 20 % ومن ثم وضعها داخل الحضان الكهربائي علي درجة حرارة 25 م الى حين امتلاء الغزل الفطري داخل الاطباق وحدوث عمليات التجرثم ، وحسبت النسبة المئوية للإنبات بعد اسبوع من الزراعة ، وكذلك نسبة تردد الفطريات حسب طريقة [16، 17]

$$\textbf{النسبة المئوية للإنبات} = \frac{\text{عدد البذور النابتة}}{\text{العدد الكلي للبذور}}\, x\, \mathbf{100}$$

نسبة تردد الفطريات = عدد مستعمرات الجنس ÷ عدد المستعمرات الكلي × 00 .

قياس اطوال المجموعين الخضري والجذري

تم حسابها بعد اسبوع من انبات البذور [29] حيث تم قياس الرويشة من قاعدة الساق ولغاية اطول ورقة لكل نبتة بواسطة مسطرة بلاستيكية مرقمة بالسنتيمتر، ثم اخذ متوسطات البادرات ضمن المعاملة ، اما المجموع الجذري فتم بقياس طول الجذور لكل نبتة وأخذ معدلها ضمن المعاملة الواحدة للأصناف المختبرة، وحسبت نسبة البذور المتعفنة (غير نامية) والبادرات الطبيعية والبادرات غير طبيعية [30] .

قياس المحتوى المائي في البذور

جري تقدير المحتوى المائي للبذور المختبرة بمحطة صفيت للبحوث الزراعية الياً

باستعمال جهاز HE 50 EC PfeufferGmbh من انتاج شركة Kitzungen الالمانية وذلك بوضع10جرام من البذور داخل الجهاز وطحنها يدويا ومن ثم تسجيل القراءات الناتجة وهي من الطرق المتبعة والمتعارف عليها حديثا.

النتائج والمناقشة Result and Discussion

البذور في العينة

شملت عينة البذور المتحصل عليها بتلونها ظاهريا وجزئيا بالوان بنية اللون حيث اكدت العديد من الدراسات على ان اصابة البذور بفطريات التخزين تؤدي الى تغيير في لون البذور[31] . ويعود تغيير اللون في البذور الى ان معظم البذور الصلبة والطرية المصابة بأنواع الفطر *Fusarium*spp تحتوي على سموم مثل T-2 toxin *Fusarium* – c, والتي تسبب تغيير في لون قصرة البذور وهذا يتفق مع [30] بأن فطر *Fusarium* spp سبب تغيير في لون بذور الفاصوليا المصابة .

التأثير على انبات واصابة البذور

تشير نتائج اختبار نسبة انبات البذور بأن الاصابة ادت الى تعفن البذور وتوقفها عن الانبات مقارنة بالبذور السليمة (جدول 1-2) ويعود تدني انبات البذور وتعفنها الى ان الفطريات سببت موت الجذر الاساسي وكذلك افرازها للسموم التي تؤدي الى موت جنين البذور خاصة في البذور الملونة بينما يعزي عدم انبات في بعض البذور الى عوامل داخل البذور نفسها منعت انباتها مثل موت او عدم اكتمال نضج الجنين[30 ، 32] . وتتفق هذه النتائج مع ما ذكره[24] في حدوث تعفنات على بذور الفول وبذور اللوبيا المصابة بفطريات تخزين البذور.

جدول .1. يبين معدل عدد المستعمرات الفطرية ونسبة اصابة البذور المختبرة بطريقة ورق الترشيح .

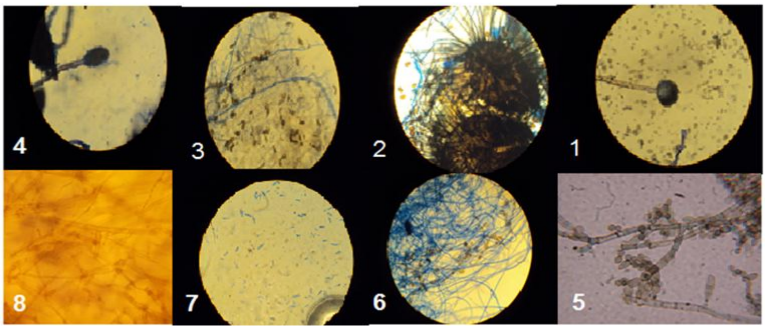
اصنـــــاف القمح	عدد المستعمرات	نسبة الاصابة %
قمح طري شام 10	73	71
قمح طري بحوث	100	100
قمح صلب بني	43	43
قمح طري ابوالخير	36	36
قمح صلب النعمة	55	55
قمح صلب بلتاجي	30	30

جدول 2. يبين عدد المستعمرات الفطرية ونسبة اصابة البذور المختبرة بطريقة الوسط الغذائي

اصنـــــاف القمح	عدد المستعمرات الفطرية	نسبة الاصابة %
قمح طري شام 10	32	100
قمح طري بحوث 208	23	71.8
قمح صلب بني سويف	27	84.3
قمح طري ابوالخير	26	81.2
قمح صلب النعمة	32	100
قمح صلب بلتاجي	31	96.8

تعريف الفطريات المرافقة للبذور

اظهرت نتائج الدراسة الى تلوث واصابة جميع عينات البذور المختبرة بأنواع مختلفة من الفطريات (شكل1) بعضها متطفل والبعض الاخر من فطريات المخازن وان البذور الغير مطهرة تكرر فيها وجود فطر *stoloifer* *Rhizopus* يليه فطر *Pencillium*spp, (جدول.3) ، كما لوحظ وجود فطريات *Fusarium*spp , *Rhizopus*spp , *Pencillium*spp ,*Aspergillus*spp والتي تكرر ظهورهما في كلتا المعاملتين (تطهير وبدون تطهير) وهذا يتفق مع الدراسة التي قام بها [12] في تكرار وجود فطريات تخزين الحبوب في كلتا المعاملتين على بذور بعض المحاصيل البقولية وتأتي هذه الفطريات في المرتبة الاولى من حيث الخطورة حيث تفرز السموم التي لها تأثير سلبي على الصحة العامة وخاصة الجهاز التنفسي [33 ، 34] . ومع الدراسة التي قام بها[19] الى وجود فطريات تخزين حبوب القمح spp , *Alternaria* spp , *Rhizopus*spp ، *Fusarium granarium* , *Penicillium*spp, *Aspergillus*spp , *Cladosporium*spp والتي تسبب ظهور اعراض مرض النقطة السوداء وتشوه الحبوب حقليا عند وصول الرطوبة الى اعلى من 90 %مما يؤدي الى تعفنها وقلة امتلاء الحبوب وتشوه شكلها وعدم استساغة الحيوانات لها .ومع الدراسة التي قام بها [15] عند اجراء المسح الشامل للفطريات المصاحبة لبذور القمح في العراق بأن معظم الفطريات المختبرة كانت لفطر *Pencillium* spp و *Aspergillus* spp.



الشكل رقم . 1 . الفطريات المعزولة من بدور القمح
1 *Rhizopus*sp. 2spp *Chaetomium*t. 3 *Alternaria*spp
4Aspergillusclavatus 5 *Cladosporium*spp. 6 *Stemphylium*spp
. 7 *Fusarium*spp 8 *Rhizoctonia*spp

ومع الدراسة التي قام بها [20] عند عزل الفطريات المصاحبة لبعض بذور المحاصيل النجيلية المحلية والمستوردة لبعض اصناف القمح بدون التعقيم السطحي الى انتشار فطريات التخزين بنسبة 100 % على حبوب القمح الصلب المستوردة من خارج ليبيا ونسبة 74.8% للقمح الطري وقد اثر هذا التردد الفطري على البذور في جودتها ونسبة انباتها حيث سببت الفطريات عفناُ للبذور المختبرة وعفن للجذور ولفحة وذبول للباذرات. وهذا يتفق مع الدراسة التي قام بها [21] عند مسح الفطريات المرافقة لعدد 8 اصناف من القمح في اليمن الى انخفاض نسبة انبات البذور الملوثة، وان وجود فطريات *Aspergillus*spp على اسطح البذور المخزنة قد تسبب فقد البذور قدرتها على الانبات ، كما تسبب امراضاً للإنسان والحيوان وخاصة الجهاز التنفسي. إن أغلب الأنواع المعزولة منها مثل *Rhizopus*spp ، *Penicillium*،*Aspergillus*spp

والتي تعرف بانها تفرز سموما خطيرة اهمها Aflatoxin B1 التي تسبب امراض خطيرة للإنسان والحيوان في حال استهلاك البذور المصابة بكميات كبيرة من هذه الأنواع الفطرية[5] . وان وجود الاجناس الفطرية على اغلفة البذور يرجع الى استقرارها على هيئة ميسليوم كامن في اغلفة الحبة الخارجية قرب مرحلة النضج وبتالي لا تستطيع اختراق الطبقات الداخلية وتبقى تواجدها سطحياً [15] . وتعمل فطريات *Rhizopusspp* ,*Fusariumspp* على تحويل سكر Xyloseالناتج من تحلل Hemicellulose الى الكحول الايثيلي[22].

كما انتجت بعض الفطريات تراكيب صلب له قشرة خارجية داكنة اللون تتكون من عدة طبقات مندمجة ذات لون اسود داكن حيث تتراكم داخله بعض المواد الغذائية مثل الجليكوجين والترايهالوز وان تكون اللون الاسود يرجع الى ترسيب مادة الميلانين في جدارها الخلوي مما تعمل على زيادة قدرة هذه التراكيب على البقاء محتفظة بحيويتها لفترة طويلة تحت الظروف البيئية السيئة وتنبت هذه الاجسام منتجة ميسليوم جديد على شكل اجسام حجرية على سطح البذور [23]والتي تحتاج الى اجراء المزيد من الدراسات.

اوضح الجدول (4) بوجود تباين في طول المجموع الخضري والجذري نتيجة اصابة البادرات بفطريات تخزين الحبوب حيث سبب فطر *Fusarium* spp خفض في اطوال المجموع الجذري واصفرار الاوراق وانتاج بادرات ضعيفة وتقرحات في الجذور بسبب حمل الفطريات على سطحها او بداخلها وهو من الفطريات الساكنة في البذور لمدة طويلة في أنسجة البذور وعلى السطح الخارجي لها، كما ساعدت الظروف الغير ملائمة لتخزين البذور وزيادة مدة تخزين البذور على زيادة اللقاح الفطري وإنتاج وحدات عدوي كثيرة من الجراثيم الكلاميدية والكونيدات وتراكيب ساكنة مثل الميسليوم [9، 32] . وان خفض اطوال وجذور البادرات يتفق مع ما اشار اليه [35] الى ان الفطر

Fusarium spp يسبب التقزم وتقرح الجذور مما يؤثر على اطوال النباتات ، كما له تأثيرا سلبيا على العائل عن طريق الاخلال بالوظائف الحيوية كعملية البناء الضوئي والتنفس والتأثير على صعود الماء والعناصر الغذائية ،وان نشاط الفطر يظهر في مرحلة البادرات اكثر منه عند تقدم عمر النبات [36] .

جدول.3. يبين معدل النسبة المئوية للفطريات المرافقة لسطح للبذور المختبرة معملياً

اصناف القمح Variety	% الفطـــريات المحمولة على سطح البذور				مـتوسط اطوال الباذرات والجذور الجنينية	
	Rhizopusstolonifer	*Pencilliumspp*	*Fusariumspp*	*Aspergillusclavatus*	طول الباذرات سم	طول الجذور الجنينية سم
قمح طري شام 10	46.5	13.9	10.9	28.7	13.3	6.9
قمح طري بحوث 208	90	3	-	7	13.5	5.5
قمح صلب بني سويف	48.9	39.4	-	11.6	15.1	4.7
قمح طري ابو الخير	33.4	66.6	-	-	14.5	10.8
قمح صلب النعمة	21.9	78.1	-	-	14.4	5.1
قمح صلب بلتاجي	60	40	-	-	14.9	5.1

جدول .4. يبين نسبة تواجد الفطريات داخل البذور للأصناف الصلبة والطرية

متوسط اطوال البادرات والجذور الجنينية		% الفطـــريات المحمولة داخلـــــــيا										
طول الجذور الجنينية (سم)	طول البادرات (سم)	*Chetomiumspp*	*Rhizopusspp*	*Aspergillusclavatus*	*Aspergillusniger*	*Stemphyliumspp*	*Alternariaspp*	*Rhizoctoniaspp*	*Fusariumspp*	*Cladosporiumspp*	*Penicilliumspp*	اصناف القمح
4.5	10.8	-	-	-	-	-	-	-	0.0	96.8	3.2	قمح طري شام 10
5.5	11.8	4.4	56.5	-	-	-	-	-	10.04	21.7	4.3	قمح صلب بحوث 208
5.2	12.8	-	-	-	-	-	-	-	40.7	40.7	7.4	قمح صلب بني سويف
5.9	11.9	-	-	-	3.8	7.6	-	-	38.4	19.2	-	قمح طري ابو الخير
2.3	9	-	-	3.1	3.1	3.1	6.2	-	56.2	6.2	3.1	قمح صلب النعمة
3.8	8.7	-	-	-	-	3.2	-	-	64.5	19.3	16.2	قمح صلب بلتاجي

النسبة المئوية للمحتوى المائي للبذور المختبرة

بينت نتائج تقدير المحتوى المائي للبذور بواسطة جهاز PfeufferGmbh HE 50 EC شكل (2) الى وجود اختلاف في النسب المئوية للمحتوى المائي للحبوب المختبرة حيث سجلت اعلى نسبة للصنف بلتاجي9.6 % واقلها للصنف شام 10 وان هذا التباين في معدلات نسب المحتوى المائي للبذور حالة طبيعية نتيجة اختلاف ظروف التخزين ودرجة نضج المحاصيل عند الحصاد [37،36]. الا انها اعلى من الحد المسموح به عند تخزين حبوب القمح، فكلما انخفضت نسبة الرطوبة البذور كلما قلت نسبة تدهورها فكل 1% انخفاض يضاعف من عمر الحبوب اثناء التخزين شريطة ان يكون محتواها الرطوبي ما بين (5 – 14 %) فكلما كانت نسبة الرطوبة مآبين (11 –13 %) كلما كانت اكثر ملائمة لفترات تخزينيها ولمدة قصيرة (6 – 12 شهر) وعند

وصولها مابين (8 – 10 %) تكون الحبوب اكثر ملائمة ولفترات تخزينية طويلة (1 – 3 سنوات) [38] . كما تنمو الكائنات الدقيقة التي تصيب البذور المخزنة عند المحتوى الرطوبي للبذور ما بين (10 – 30 %) وان أغلب الفطريات التي تسبب تدهور الحبوب اثناء التخزين تنمي الى الاجناس *Aspergillua* spp , *Penicillium* spp وتقضي الانواع الاخرى على حيوية البذور بإصابتها للأعضاء الاساسية وتحللها للأنسجة الميتة [32] . وان تعريض الحبوب للهواء والشمس يساعدان على خفض رطوبة البذور وبالتالي خفض نسبة اصابتها بالفطريات [39] .

الشكل رقم . 2 . جهاز PfeufferGmbh HE 50 EC لقياس نسبة رطوبة الحبوب.

الاستنتاجات

شكلت هذه الدراسة بداية لتحديد اهم الفطريات الموجودة على بعض البذور المحاصيل النجيلية تحت ظروف المحلية وقد اثبتت ابحاث متقدمة على المستوى الدولي بأن لها دور كبيرا في تلف القيمة الغذائية للبذور والتي تعتبر غذاء مهما للإنسان لمعظم الشعوب الى جانب دخولها في كثير من الصناعات حول العالم مما اذى الى ظهور بعض الامراض الوبائية ، وكذلك بكونها من المسببات المرضية الاقتصادية لنباتات القمح اذا ما تم زراعتها مرة اخرى ، وانصح مستقبلا بأجراء العديد من الدراسات المعملية لمعرفة انواع السموم الناتجة من هذه الفطريات على القيمة الغذائية لدقيق القمح والتي تستهلك في ليبيا تحت ظروف التخزين المختلفة، وكذلك معاملتها قبل الزراعة بالمطهرات الكيميائية او بالمستخلصات النباتية لضمان انباتها بالصورة السليمة .

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مقارنة عمليات أنتاج خميرة الخبز بواسطة مفاعلات الخلط الهوائية والميكانيكية

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ABSTRACT

Yeasts are microscopic plant biopsies, does not contain chlorophyll, it is a fungus, bread is yeast. A fungus is classified into chromases, it has the ability to resist chemical decomposition and the rapid spreal of water and stay for a reasonable period without damage in normal conditions, especially when it is dry, they form the dough and multiply in a split manner.

The idea of producing bread yeast depends on providing the best conditions to allow the yeast to reproduce and by giving the basic nutrients and provides the heat and acidity and ventilation necessary to feed the yeast and its reproduces

Our measurements and results show that the production of baker yeast in air left bioreactor more than in stirred tank reactor as shown in table 1 and 2

الخلاصة

الخمائر أحياء نباتية مجهرية لا تحوي المادة الكلوروفية وهي من فصيلة الفطريات وتمثل خميرة الخبز نوعاً من الفطريات تصنف إلى السكرومايزس ولها القابلية على مقاومة التحلل الكيماوي وسرعة الانتشار بالماء والبقاء لفترة معقولة دون تلفها في

الظروف الاعتيادية خاصة عندما تكون جافة وتعمل على تخمر العجين وتتكاثر بطريقة الانقسام.

إن فكرة إنتاج خميرة الخبز تعتمد على توفير أحسن الظروف الملائمة لفسح المجال للخمائر بالتكاثر وذلك بإعطاء المواد الغذائية الأساسية وتوفير الحرارة والحامضية والتهوية الضرورية لتغذية الخمائر وتكاثرها.

قياساتنا ونتائجنا الموضحة بالجدول1 والجدول2 أظهرت ان كمية انتاج الخميرة بمفاعل الخلط الهوائي اكثر مقارنتا بالكمية المتحصل عليها بمفاعل الخلط الميكانيكي.

1- المقدمة:

1.1 المفاعل الحيوي عبارة عن جهاز لإنتاج المركبات الثانوية حيت يحتوي على إناء كبير يتم فيه زراعة كائنات حية دقيقه في بيئة مغذية تحتوي على المواد اللازمة للحفاظ على خلايا الكائن الحي وفي صورة نشاط وانقسام مستمرين كما تحتوي على المواد المحفزة اللازمة لدفع هذه الخلايا لإنتاج المركبات الثانوية.

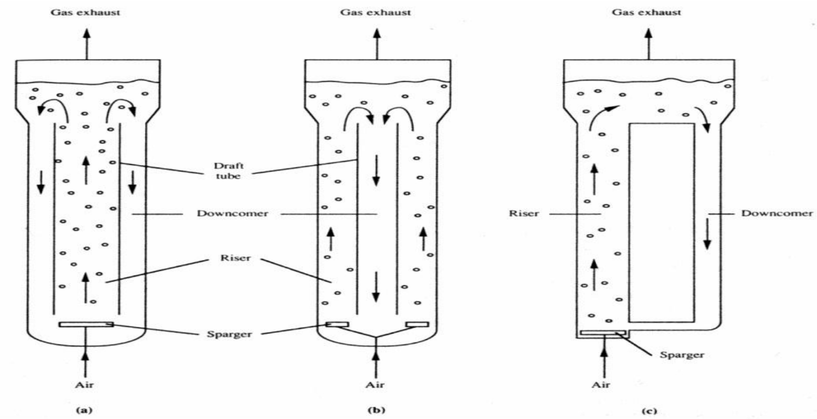
ويتم إدخال البيئة المغذية من مكان الإدخال في المفاعل ثم يتم استخراجها من مكان آخر محملة بالمواد الثانوية.

ويتم إدخال بيئة جديدة في دورة إنتاج أخرى. وللمفاعلات الحيوية اشكال مختلفة منها مفاعل خزان الخلط الميكانيكي والمفاعل الانبوبي الهوائي[3].

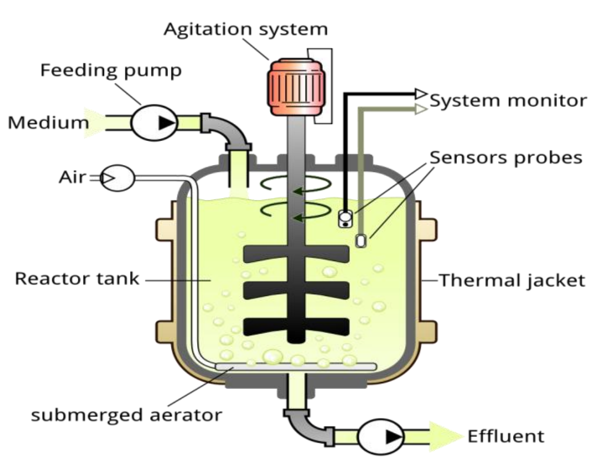
المفاعل الأنبوبي الهوائي تختلف هده المفاعلات من شكل إلى آخر من حيث التصميم وهذا يمكن أن يميزها كونها أجهزة ذات تصميم بسيط نسبيا من حيث استهلاك الطاقة و يعتبر هذا النوع من المفاعلات غالي الثمن و قد يوجد على اشكال مختلفة [4]

مفاعل الخلط الميكانيكي وتعتمد فكرة عمله على خلط المتفاعلات بنسب معينة في وعاء ثم بعد ذلك يتم الخلط جيداً مع توفير الظروف اللازمة للتفاعل ويتم الخلط

باستخدام طرق ميكانيكية ويعتبر هدا النوع من المفاعلات التي تستهلك طاقة اكثر من مفاعلات الخلط الهوائي.



شكل1 المفاعل الأنبوبي الهوائي: (a) الهواء يوجد في الأنبوب الداخلي.
(b) الهواء يوجد في الأنبوب الخارجي. (c) مفاعل ذو الأنبوب الخارجي.



شكل2 مفاعل خزان الخلط الميكانيكي

2.1 المولاس سائل لزج بني غامق وهو الناتج الثانوي العرضي عن مرحلة البلورة النهائية في مصانع السكر ويسمى عادة "دبس السكر" ويشبه إلى حد كبير دبس التمر.

و المولاس نوعان:

1- ***مولاس الشمندر***: وهو الناتج الثانوي من استخلاص السكر من الشمندر أو من تكرير سكر الشمندر الخامي.

2- ***مولاس القصب:*** وهو الناتج الثانوي من استخلاص السكر من القصب أو من تكرير سكر القصب الخامي.

أهم مكونات للمولاس:

1- ***الماء:*** يحوي المولاس التجاري من الماء حوالي 18- 20 % من وزنه، بينما المولاس المنتج من المصنع تكون فيه نسبة الماء 12-17 % وزناً،

2- الكربوهيدرات: وهي المركبات التي تحتوي على عناصر الكربون والأوكسجين والهيدروجين وتكون فيها نسبة الأوكسجين إلى الهيدروجين بنسبة (2:1) ويكوّن السكروز القسم الأكبر من محتويات المولاس.

3- المكونات غير السكرية: وهي صنفان:

أ- *مركبات عضوية نيتروجينية* : يدخل عنصر النيتروجين في تركيبها، وأهمها البروتينات والأحماض الأمينية وغيرها.

ب- *المركبات العضوية* غير النيتروجينية : و تتمثل في البكتين وأصناف السيليلوز، وكدلك الاحماض مثل حامض الخليك، و حامض الأكزاليك والسكسنيك والأدبيك، وكذلك حامض الجلوتاميك والطرطريك وحامض الستريك.

كما ان المولاس يحتوي على مواد دهنية بنسب قليلة جدا و على بعض الفيتامينات وخاصة فيتامين (ب1- ب6)

4-الأملاح : مثل أملاح الصوديوم والبوتاسيوم والكالسيوم والمغنيزيوم والحديد، ومصدر هذه الأملاح هي التربة والأسمدة.

3.1 خميرة الخبز : ان التخمر تحت الظروف الملائمة لفسح المجال للخمائر بالتكاثر وذلك بإعطاء المواد الغذائية الأساسية وتوفير الحرارة والحامضية والتهوية الضرورية لتغذية الخمائر وتكاثرها

ان بعض من العمليات الأكثر أهمية هي

- **الأكسدة:** مثل تحول الكحول الي حامض الخليك والسكروز الى حامض الستريك
- **الأختزال:** مثل تحول الألديهيدات الى كحول و الأستيالدهيد الى كحول إثيلي و الكبريت الى كبريتيد الهيدروجين
- **التميؤ:** مثال على دلك تحول السكروز الى الجلوكوز والفركتوز.
- **الأستره: فوسبوريك** هيكسوز من **الهكسوز** و حامض الفسبوريك. إن بعض التحويلات الكيميائية يمكن أن تتم بشكل كفؤ بعمليات التخمر عنه بالتأليف الكيميائي

العوامل التي تؤثر في سرعة نمو الخمائر

1-**المواد الغذائية** وتمثل المركبات العضوية والأملاح اللازمة لتوفير العناصر الضرورية لتغذية الخمائر وهي عنصر الكربون و عنصر النيتروجين و عنصر

الفوسفور وهو عنصر أساسي في تركيب الخمائر وبدونه لا يمكن الحصول على الخميرة بالكميات المطلوبة و كذلك عنصر المغنسيوم ويساعد في زيادة كميات الخميرة.

2-درجة الحرارة

أن أحسن الظروف الحرارية الملائمة لعملية التخمير هي درجة الحرارة ما بين 25-28 مْ وهي الظروف الملائمة لهدا النوع من الكائنات الحية فلكل كائن حي ظروف ملائمة فعند نقص او زيادة عن هدا المعدل يسبب في قلة الإنتاج او انعدامه.

3- درجة الـ PH

يجب السيطرة على درجة الـ PH للمحلول داخل المفاعلات وجعله ما بين درجة 4-6 مئوية

4-التهوية

يمرر الهواء أثناء عملية التخمير ومن القسم السفلي ويكون بشكل فقاعات صغيرة ومنتشرة وللأوكسجين تأثير كبير على سرعة التخمير للإسراع في عملية التنفس ويجب ان لا تقل نسبة الاكسجين بالمفاعل أقل من 20%.

تعتبر خميرة الخبز وغيرها من الخمائر المستعملة كغذاء على نسبة عالية من البروتين والألبومين وفيها نسبة لا بأس بها من أنواع متعددة من فيتامين ب.

يمكن الاستفادة من الفضلات الناتجة من وحدة إنتاج خميرة الخبز مجدداً لإنتاج أنواع أخرى من الخمائر مثل خميرة العلف لتغذية الحيوانات، ويتيح التحكم باختيار نوع الخميرة المراد إنتاجها مجالاً واسعاً للحصول على أنواع عدة من الخمائر تختلف عن بعضها في الخواص والتركيب.

من هذا يتضح بأن للخمائر فائدة غذائية مهمة لمختلف الحيوانات إضافة إلى استعمالها كخميرة خبز.

عند الرغبة في الاحتفاظ بالخميرة لفترة طويلة فتجفف بدرجة حرارة منخفضة بفعل تيار من الهواء، ثم تعبأ في أكياس أو صفائح لا تتأثر بالرطوبة ومفرغة من الهواء[1].

2- التجارب المعملية

1.2 خطوات التجارب:

الخطوات الأولى من التجربة

1- يتم تعقيم جميع أجزاء مفاعل الخلط الميكانيكي عن طريق جهاز التعقيم الأوتوكلاف (Outoklav) وفي درجة حرارة ($120C^0$) ولمدة 40 دقيقة، اما المفاعل الانبوبي الموضح في الشكل 1 والدي تمت هده الدراسة عليه فيتم تعقيمه عن طريق بخار الماء.

2- يتم توصيل المفاعل بجميع الأجهزة المطلوبة ويضاف إليه الحجم المطلوب وتثبت كل من درجة الحرارة عند C^0 (28) و pH (5.8)

3- يفتح صمام تدفق الهواء بالمفاعل على أن يكون ما بين قيمة 23-12 (dm^3/min) كما يجب أن لا تقل نسبة الأكسجين بالمفاعل أقل من 20% .

4- معدل سرعة الخلط الميكانيكي بالمفاعل تكون ما بين (450 -250) دورة بالدقيقة وفي بعض مراحل التخمر الى 600 دورة بالدقيقة للمحافظة على نسبة الاكسجين بالمفاعل أكثر من 20% .

5- توضع النسبة اللازمة من المواد الغذائية والاملاح الضرورية لتوفير العناصر الضرورية لتغذية الخمائر

6- يوضع كمية من الكائنات الحية بالمفاعل ودلك حسب الحجم المطلوب (تركيز التلقيح)

7- نأخذ العينة في كل زمن معين ثم نقوم بمعالجتها .

2.2 معالجة العينة:

نأخذ العينة وتوضع في جهاز فصل (Centrifuged) بسرعة (18000 r\m) لمدة 10 دقائق. بعد ذلك تنقل المادة السائلة إلى جهاز التحليل. والباقي يجفف تحت درجة حرارة C^0 (80-90) وذلك للحصول على وزن ثابت من الكتلة الحيوية.

3- النتائج و المناقشة :

جدول (1) يوضح الظروف والنتائج بالمفاعل الأنبوبي الهوائي : (Algae Light Reactor)

رقم التجربة	1	2	3	4
نوع المفاعل	ALR	ALR	ALR	ALR
حجم السائل [dm^3]	10	10	10	10
تركيز التلقيح [g/dm^3]	2.2	2.1	2.2	2.0
سرعة تدفق الهواء [dm^3/min]	13-16	13-16	13-16	13-16
زمن التخمر [min]	300	330	360	350
الكتلة الحيوية جافة [g/dm^3]	14.7	16.8	18.6	17.4

جدول (2) يوضح الظروف والنتائج بمفاعل خزان الخلط الميكانيكي : (Continuous Stirred-Tank Reactor)

رقم التجربة	1	2	3	4
نوع المفاعل	CSTR	CSTR	CSTR	CSTR
حجم السائل[dm^3]	4	4	4	4
تركيز التلقيح [g/dm^3]	2.2	2	2.2	2.1
سرعة تدفق الهواء [dm^3/min]	13-16	13-16	13-16	13-16
زمن التخمر [min]	360	310	370	385
الكتلة الحيوية جافة [g/dm^3]	15.4	16.8	16.3	17.1

4- الاستنتاجات

قياساتنا أظهرت :

1- كمية الكتلة الحيوية المتكونة بالمفاعل الانبوبي الهوائي 18.6 [g/dm^3] بينما كمية الكتلة الحيوية المتكونة بمفاعل الخلط الميكانيكي 17.1 [g/dm^3] فمن هده النتائج يتضح لنا ان كمية انتاج الخمائر بمفاعل الخلط الهوائي اكبر مقارنتا بالكمية المتحصل عليها بمفاعل الخلط الميكانيكي عليه ننصح باستعمال المفاعل الانبوبي ذو الاحجام الصغير نظرا لعدم التحكم في ثبوت درجة الحرارة بالمفاعلات الضخمة .

2- ان استهلاك الطاقة بالمفاعل الانبوبي ذو الخلط الهوائي اقل مقارنتا بمفاعل الخلط الميكانيكي و هدا يعطينا اكثر تحفيزا بان نستعمل مفاعل الخلط الهوائي.

3- يمكن استعمال المفاعلات الانبوبية في عمليات التخمر والتي لا تتطلب كميات كبيرة من الانتاج.

4- يعتبر المفاعل الانبوبي دو الخلط الهوائي اقل تعقيدا من حيت الشكل مقارنتا بمفاعل خزان الخلط الميكانيكي.

5- ان الاختلاف البسيط في تركيز التلقيح من تجربه واخري لا يواتر في عملية الإنتاج

6- ان تدفق الهواء بالمفاعل يجب ان يكون في معدل لنحافظ على نسبة الاكسجين بالمفاعل.

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دراسة بعض الخواص الميكانيكية لحديد تسليح المصانع الليبية الخاصة ومطابقتها للمواصفة القياسية الليبية

"دراسة مقارنة لحديد تسليح مصنع سيدي السائح ومصنع زليتن"

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الملخص

يعد الحديد أحد الفلزات القوية وأكثرها أهمية للأغراض الهندسية وأبرزها قضبان التسليح المستخدمة في أعمال البناء. ونظراً للتنافس المستمر في السوق الليبي بين القطاعات العامة والخاصة، أُنشئت حديثاً بعض المصانع الخاصة لتصنيع حديد التسليح ومنها على سبيل المثال لا للحصر مصنع زليتن ومصنع سيدي السائح الخاصّين بتصنيع حديد التسليح. إلا أن الإختلاف في طرق التصنيع من حيث الجودة والمواصفات القياسية أصبح محل اهتمام للباحثين لما له من آثار إقتصادية على المؤسسة والمستهلك. وبالتالي يجب التأكد من ملاءمة استخدام حديد التسليح للأغراض الوظيفية التي يتم إستخدامه فيها، حيث أنه هناك عوامل هامة مثل مقاومة الشد، مقدار الإستطالة والصلادة وكذلك نسب بعض العناصر مثل الكربون والكبريت والفسفور تلعب دوراً هاماً في تحديد كفاءة حديد التسليح.

تهدف هذه الدراسة إلى إجراء مقارنة عملية لبعض الخواص الميكانيكية وكذلك التحليل الكيميائي لعينات حديد التسليح (قطر 12 mm) المصنّعة من قبل المصنعين المذكورين سلفاً ومطابقتها للمواصفة القياسية الليبية. أظهرت نتائج الدراسة أن إجهاد

الخضوع وأقصى إجهاد شد لكل من حديد مصنع سيدي السائح ومصنع زليتن، يندرجان تحت الصنف (ص30) في المواصفة القياسية الليبية وهو حديد متوسط المقاومة، وكما أوضحت النتائج انخفاض كل من الوزن والقطر لكل من النوعين وكلاهما لم يكن ضمن نطاق المواصفة. إلا أن الصلادة أظهرت أن حديد مصنع سيدي السائح أعلى صلادة لاحتوائه على نسبة أعلى من الكربون وهذا ما أثبتته نتائج التحليل الكيميائي.

الكلمات الدالة: حديد التسليح، الخواص الميكانيكية، العناصر الكيميائية، الصلادة.

Abstract:
Iron is one of the most important metals used in engineering, most notably in reinforcing bars for construction work. Due to the continuous competition between the government and private sectors in the Libyan market, some factories have been established to manufacture reinforcing steel. One of these factories are Zliten and Sidi Saih. The difference between the manufacturing methods where quality and specifications are concerned has become an issue for researchers because of the economic effects on the factory and the consumer. Therefore, it is essential to ensure that rebar is functionally suitable. Many important factors, including tensile strength, elongation, hardness, and the ratios of some elements such as carbon, sulfur and phosphorus, play a vital role in determining the efficiency of reinforcing bars. The main aim of this study is to conduct a practical comparison of some mechanical properties and the chemical analysis of reinforcing bar samples (diameter 12 mm) that the aforementioned manufacturers produced and that conformed to the Libyan standard. The results of the study indicated that the yield stress and the maximum stress of the Sidi Saih and Zliten factories' steel fell under category (30) in the Libyan standard specifications. These are intermediate tensile forms of steel, and the results revealed that the weights and diameters of the two types fell outside the standard. On the other

hand, the hardness test indicates that Sidi Saih factory steel is harder, because it contained a higher percentage of carbon. The chemical analysis confirmed this result.

Keywords: reinforcement steel, mechanical properties, chemical components, hardness.

1. المقدمة

يُعَد حديد التسليح من السبائك الحديدية المنخفضة الكربون [2,1] ومن أهم المواد الداخلة في عمليات البناء، حيث يوجد في ليبيا العديد من المصانع الخاصة بصناعة حديد التسليح مما أدى إلى تنوع حديد التسليح في السوق الليبي واختلاف خواصه. فالخرسانة والتي تعتبر أساس البناء هي مادة قوية جداً في مقاومة الضغط ولكنها ضعيفة جداً في مقاومة الشد [3]، ولذا يتم اضافة حديد التسليح لزيادة مقاومة الشد للخرسانة لهذا السبب وجب الحرص على أن يكون حديد التسليح الموجود بالسوق الليبي المحلي ملبياً لمتطلبات المواصفات القياسية الليبية رغم تعدد مصادره واختلاف مصانعه. أُجريت دراسة سابقة على أنواع أخرى من حديد التسليح ومدى مطابقتها للمواصفة القياسية الأمريكية ASTM [4]، إلا أن هذه الدراسة تهدف إلى معرفة مدى تطابق بعض خواص حديد التسليح الموجودة بالسوق المحلي مع المواصفات القياسية الليبية. وفقاً للمواصفات الليبية القياسية (م ق ل 2013:75) [5]. يوضح الجدول (1) النسب الكيميائية المسموح بها في حديد التسليح الليبي، كما يوضح الجدول (2) الخواص الميكانيكية المسموح بها.

الجدول (1). يوضح الحد الأقصى لنسب العناصر الموجودة في الصلب [5]

النوع	الرمز	القطر (mm)	الكربون %	السيلكون %	المنجنيز %	الكبريت %	الفوسفور %
الصلب الطري الأملس ذو نتوءات	ص25	10 – 6	0.25	0.30	0.90	0.05	0.05
صلب متوسط المقاومة ذو نتوءات	ص 30	40 – 6	0.35	0.30	0.90	0.05	0.05
صلب عالي المقاومة ذو نتوءات	ص 40	8 – 6	0.35	0.40	1.50	0.05	0.05
صلب عالي المقاومة ذو نتوءات	ص 42	40 – 6	0.44	0.40	1.50	0.05	0.05
*الصلب منخفض السبائك عالي المقاومة (قابل للحام)	ص 50	40 – 6	0.24	0.60	1.60	0.05	0.05

*بالإضافة إلى العناصر المبينة بالجدول تضاف عناصر أخرى مثل : الكروم، الموليبدينوم، النيكل، والتيتانيوم للصلب المصهور حسب اختيار المصنع لتحقيق الخواص الكيميائية المطلوبة [5].

الجدول (2). يوضح الخواص الميكانيكية لأسياخ الصلب [5]

النوع	الرمز	القطر mm	إجهاد الخضوع N/mm^2 (كحد أدنى)	مقاومة الشد N/mm^2 (كحد أدنى)
الصلب الطري الأملس ذو نتوءات	ص 25	10 - 6	250	390
صلب متوسط المقاومة ذو نتوءات	ص 30	40 - 6	300	420
صلب عالي المقاومة ذو نتوءات	ص 40	8 - 6	400	620
صلب عالي المقاومة ذو نتوءات	ص 42	40 - 10	420	620
صلب منخفض السبائك وعالي المقاومة (قابل للحام)	ص 50	40 - 6	500	550

2. الدراسة التجريبية

تم استخدام القطر الأسمى المتعارف عليه لأسياخ حديد التسليح بشكلها الطبيعي وهو 12 mm، على الرغم من أن القطر الفعلي وجد أقل من ذلك، حيث تم قياس القطر الفعلي "بدون نتوءات" لأسياخ التسليح قيد الدراسة بواسطة قدمة ذات ورنية دقة قياسها 0.02 mm لعدد ثلاث عينات من كل نوع من أنواع حديد التسليح ومن دفعات مختلفة Different Batches لتحديد نسب التجاوز في الأقطار، كما تم حساب وزن المتر الطولي لعينات حديد التسليح لمطابقتها لاحقاً بالمواصفة القياسية الليبية والمحددة بـ 0.888 kg/m يزيد أو يقل بمقدار (5%) كما ذكر في المواصفة [5].

1.2 التحليل الطيفي

تم إجراء هذا الاختبار بجهاز يعرف بجهاز التحليل الطيفي

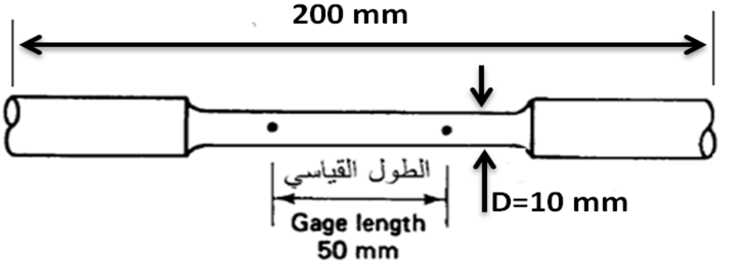
(ARL™ 7200 OPTICAL EMISSION SPECTROMETER-OES)، حيث تم أولاً تسخين العينات (عينة عشوائية من كل نوع) بطول حوالي 40 mm في الفرن الحراري لمدة تتراوح من (30–40) دقيقة وبدرجة حرارة تتراوح بين (700 °C– 600C°)هذه العملية يراد بها الحصول على مقطع مساحي مناسب أثناء ضغطها باستخدام آلة الضغط وذلك عند تجهيزها لإختبار التحليل الكيميائي. بعد إخراج العينات من الفرن تم وضعهما في جهاز حمل (ضغط) وطبق عليهما حمل وصل إلى 40 طن لنحصل على الشكل المطلوب والموضح بالشكل (1). وللحصول على نتائج دقيقة تم صنفرة العينات للتخلص من الشوائب الموجودة على السطح، ثم وضعت العينات بعد تجهيزها في جهاز التحليل الطيفي.

شكل (1). يوضح العينات قبل وبعد إجراء اختبار الضغط

2.2 إختبار الشد

تم اختبار 6 عينات (3 عينات من كل نوع) لأسياخ الحديد بقطر 12 mm ومن دفعات مختلفة للحصول على قراءات دقيقة. تم اجراء اختبار الشد على عينات اخذت من الحديد بشكله الأصلي كما هو منتج في المصنع وذلك باستخدام آلة الشد، حيث تم تطبيق حمل الشد على جميع العينات الى حين وصولها الى نقطة الكسر. تم تسجيل قيم إجهاد الخضوع وأقصى إجهاد شد. كما تم أيضاً إختبار 6 عينات (3 من كل نوع) ومن دفعات مختلفة لأسياخ بقطر 12 mm ولكن تم خرط مقطعها الدائري كما هو موضح بالشكل (2) إلى قطر 10 mm وذلك لتوحيد الأقطار وفقاً للمواصفة القياسية الليبية [5] كما هو موضح بالشكل (3).

الشكل (2). يوضح عينات حديد التسليح بشكلها القياسي



شكل (3). يوضح عينة قياسية لاختبار الشد

3.2 اختبار الصلادة

تم اختبار 6 عينات (3 من كل نوع) بطول حوالي 50 mm لأسياخ الحديد بقطر 12 mm، وبتمييز العينات عن بعضها لكل من عينة حديد التسليح لمصنع سيدي السائح ومصنع زليتن الخاص باستخدام إختبار روكويل Rockwell Hardness (Testing Machines-Model HR) كما هو موضح بالشكل (4). وعند تطبيق حمل 100 Kg كما هو موضح بالجدول إستناداً إلى المواصفة القياسية لجهاز روكويل

والذي يحمل رأس كرة حديدية بقطر 1.588 mm. تم أخذ القراءة من الجهاز لكل عينة لمصنع سيدي السائح ومصنع زليتن الخاص أي (6) عينات مختبرة وكذلك تسجيل قيم الصلادة للعينات المختبرة.

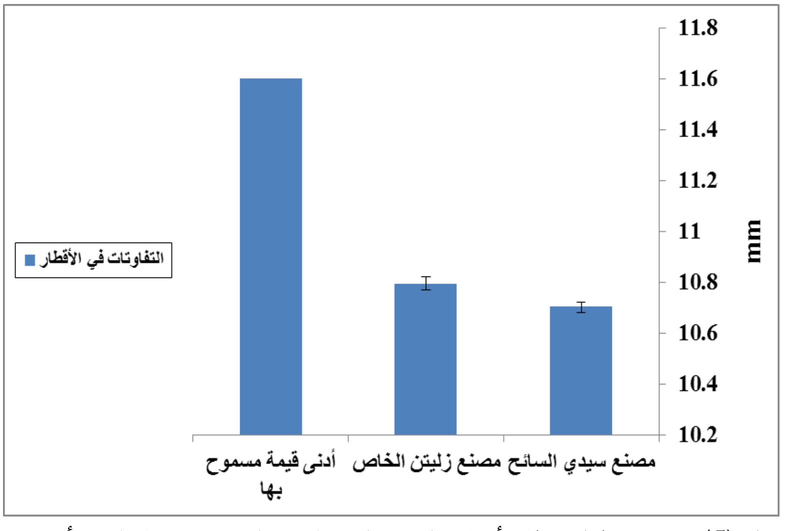
شكل (4). يوضح وضع العينة في جهاز روكويل وتطبيق الحمل عليها

3. النتائج والمناقشة

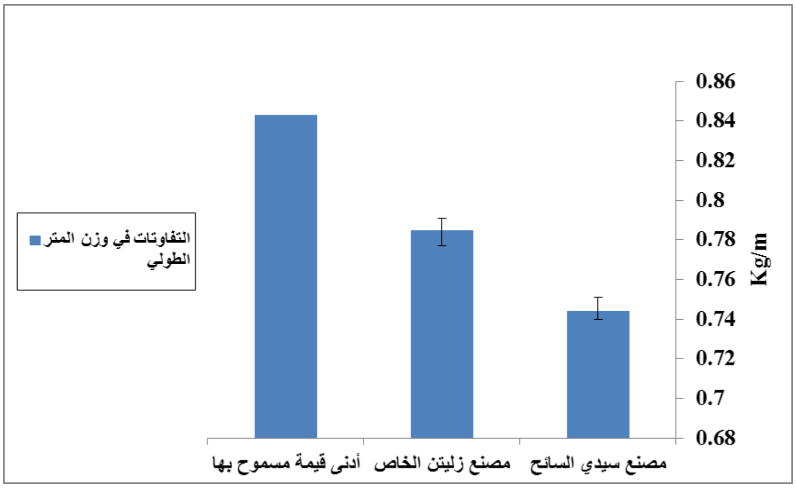
تم تحليل النتائج التي تم الحصول عليها باستخدام برنامج أشرطة الخطأ (Error bars)، وذلك لتحديد نسبة الخطأ في القراءات التي تم تسجيلها وتحديد التفاوتات في القيم المتحصل عليها ومطابقتها للمواصفة الليبية القياسية لحديد التسليح الليبي.

1.3 التفاوتات في أقطار أسياخ الحديد

لوحظ من خلال نتائج قياس أقطار الأسياخ الفعلية (دون نتوءات) أن قطر حديد تسليح مصنع زليتن الخاص أكبر من قطر حديد تسليح مصنع سيدي السائح كما هو موضح بالشكل (5)، وكلاهما لم يكن ضمن نطاق المواصفة والمحددة بـ (القطر الاسمي ±0.5 mm). ويلاحظ أن النقص في قطر السيخ المنتج في مصنع سيدي السائح ومصنع زليتن الخاص يصل إلى 11% و10% على التوالي. كما يتضح من خلال النتائج الموضحة بالشكل (6) أن وزن المتر الطولي لحديد مصنع سيدي السائح ومصنع زليتن خرجا عن نطاق المواصفة والمحددة بـ 0.888 ± 0.04 (Kg/m).



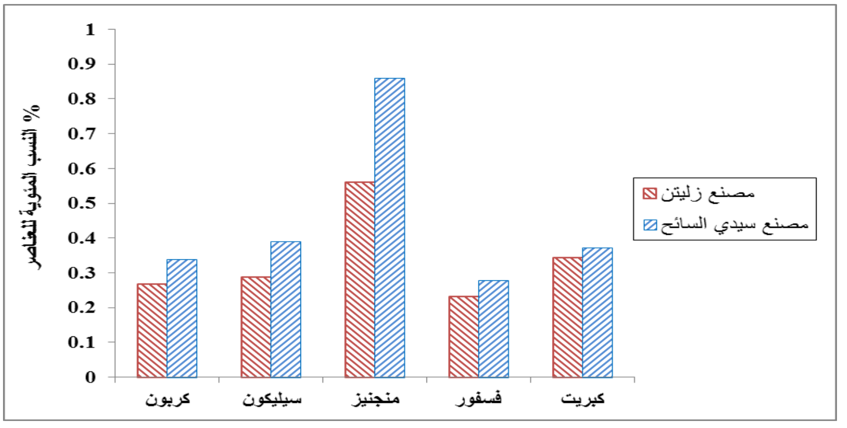
الشكل (5). يوضح طول اقطار أسياخ الحديد المنتجة في المصنعين مقارنة مع أدنى قيمة مسموح بها في المواصفة



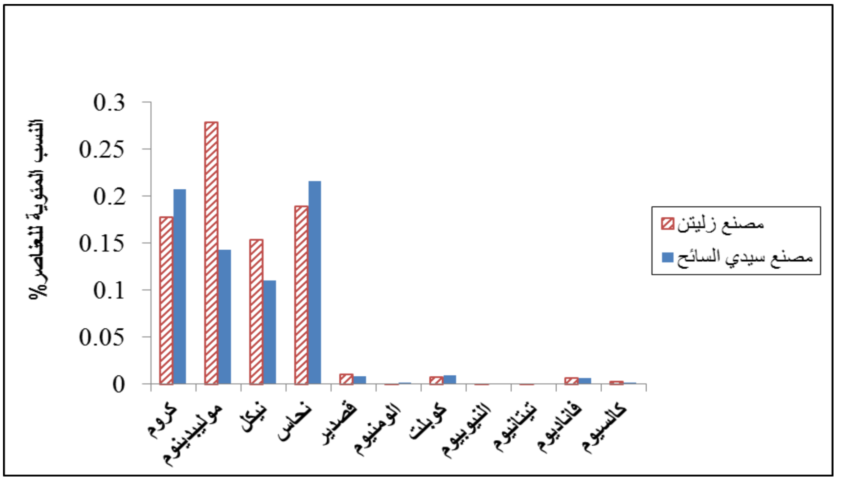
الشكل (6). يوضح وزن المتر الطولي للعينات مقارنة مع أدنى قيمة مسموح بها في المواصفة

2.3 العناصر الكيميائية

يتضح من خلال النتائج الموضحة بالشكلين (7)، (8) أن النسب المئوية للعناصر الكيميائية لحديد مصنع سيدي السائح ومصنع زليتن الخاص تبين أن كلاهما يندرج داخل نطاق المواصفة (ص 30) وهي أسياخ حديد متوسط المقاومة، كما هو موضح بالجدول (1). ويمكن القول أيضاً أن حديد التسليح يعد من المعادن الحديدية المنخفضة الكربون [6]. وأيضاً نلاحظ أن النسب المئوية للعناصر الكيميائية لحديد مصنع سيدي السائح أعلى من مصنع زليتن الخاص ويعود السبب إلى نوع الخردة التي يستخدمها المصنع.



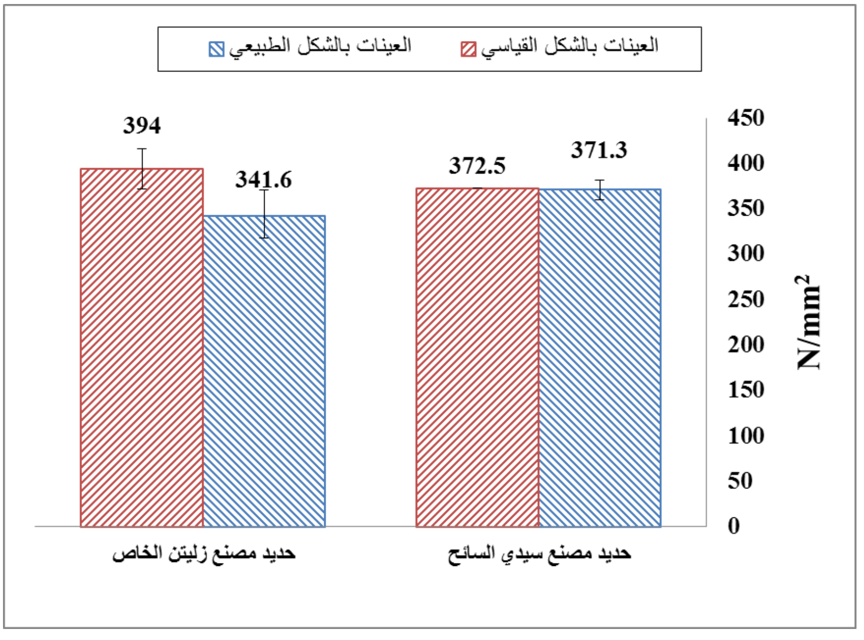
الشكل (7). يوضح النسب المئوية للعناصر الكيميائية الموجودة في أنواع حديد التسليح قيد الدراسة



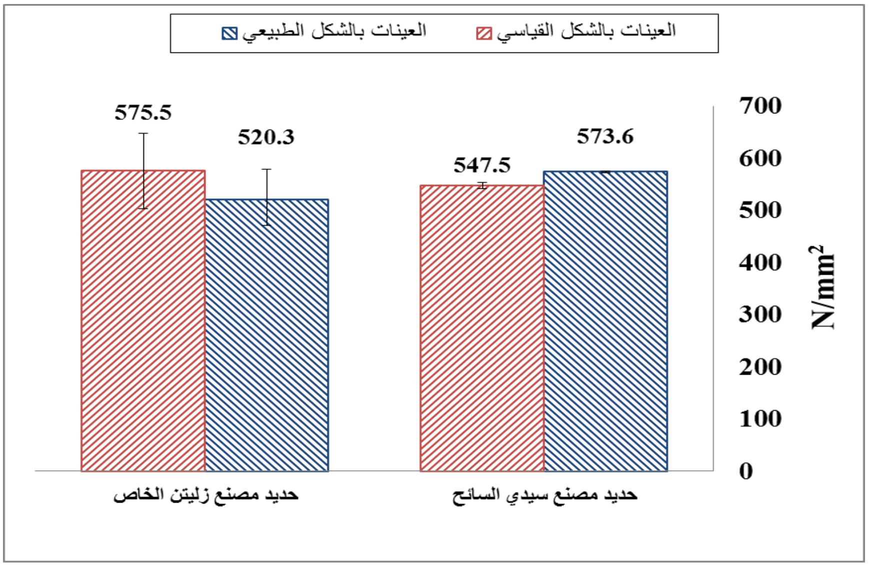
الشكل (8). يوضح باقي النسب المئوية للعناصر الكيميائية الموجودة في أنواع حديد التسليح قيد الدراسة

3.3 نتائج اختبار الشد

يتضح من خلال النتائج الموضحة بالشكل (9) والشكل (10) أن متوسط قيم إجهاد الخضوع وأقصى إجهاد شد لحديد تسليح مصنع سيدي السائح متقاربة سواءً بالشكل الطبيعي أو القياسي، وذلك لعدم وجود فارق كبير في قطر العينات سواءً في وضعها الطبيعي أو القياسي. حيث أن قيمة الإجهاد تعتمد على مساحة المقطع، وهو على غرار مصنع زليتن الذي في وضعه الطبيعي قطره أكبر من قطر حديد تسليح مصنع سيدي السائح في الوضع ذاته. إلا أن النتائج أوضحت بأن كلاهما داخل نطاق المواصفة تحت الصنف (ص 30) وهي أسياخ حديد متوسط المقاومة، كما هو موضح بالجدول (2).



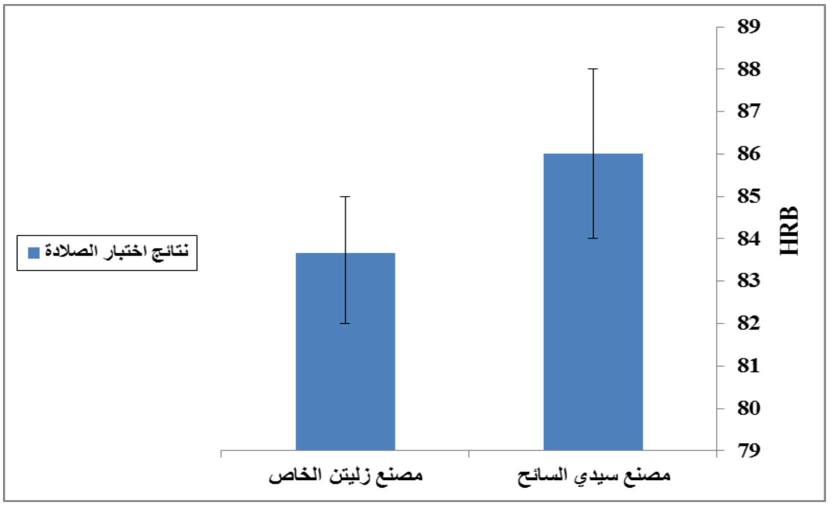
الشكل (9). يوضح إجهاد الخضوع لعينات بالشكل القياسي والطبيعي



الشكل (10). يوضح أقصى إجهاد شد لعينات بالشكل القياسي والطبيعي

4.3 نتائج اختبار الصلادة

لوحظ في الشكل (11) أن متوسط صلادة حديد التسليح لمصنع سيدي السائح أكبر من متوسط صلاة حديد التسليح لمصنع زليتن، وذلك لزيادة نسبة الكربون في حديد تسليح مصنع سيدي السائح عن حديد تسليح مصنع زليتن.



الشكل (11). يوضح نتائج إختبار الصلادة لمصنع سيدي السائح ومصنع زليتن

4. الإستنتاجات

بناءً على النتائج المتحصل عليها في هذا البحث يمكن إستنتاج الآتـي:-

1. احتواء حديد مصنع سيدي السائح على نسبة كربون أعلى من حديد مصنع زليتن.
2. احتواء حديد مصنع سيدي السائح على نسب عالية من عناصر المنجنيز والنحاس والكروم وذلك لتأثره بنسب الخردة الموجودة به.
3. حديد مصنع سيدي السائح وحديد مصنع زليتن كلاهما يندرج تحت المواصفة (ص 30) وهي أسياخ حديد تسليح متوسط المقاومة.
4. إنخفاض أوزان وأقطار أسياخ حديد التسليح لكلا المصنعين بشكل ملحوظ.
5. زيادة نسبة الكربون إلى حد ما يزيد من قيمة إجهاد الخضوع وأقصى مقاومة شد.

5. التوصـــيات

1. مراقبة وضبط أقطار وأوزان حديد التسليح والتحقق منها.
2. إجراء المزيد من التجارب على أنواع أخرى من حديد التسليح الموجود بالسوق الليبي.
3. إجراء بعض الإختبارات الأخرى ومنها على سبيل المثال إختبار الثني واختبار مقاومة التآكل.
4. إجراء إختبار البنية المجهرية لعينات حديد التسليح التي تم دراستها في هذا البحث.
5. مقارنة النتائج المتحصل عليها في هذا البحث بنتائج حديد تسليح المصانع الليبية العامة (الشركة الليبية للحديد والصلب– مصراتة).

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Table of Contents

CRITICAL SUCCESS FACTORS IN E-LEARNING FOR ADOPTION IN LIBYAN SECONDARY SCHOOLS

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الخلاصة

نتيجة للتطورات المواكبة في عالم تكنولوجيا المعلومات والاتصالات، اصبح التعليم الإلكتروني عنصر أساسي في البيئات التعليمية. و على الرغم من ذلك، فإن عددًا كبيرًا من مشاريع التعليم الإلكتروني تفشل في تحقيق أهدافها. حيث حفز ذلك الباحثين والممارسين على دراسة أسباب الفشل والنجاح والعوامل التي تؤثر على التعليم الإلكتروني. وبالتالي تحاول هذه الدراسة تحقيق نجاح التعليم الإلكتروني في المدارس الثانوية في ليبيا، من خلال التحقيق في العوامل التي تؤثر على تنفيذ وتطوير التعليم الإلكتروني والإطار الأنسب للمدارس الثانوية في ليبيا. لذلك اعتمدت الورقة الدراسة الميدانية، لدراسة اراء المعلمين والطلاب حول العوامل الحاسمة في المدارس الثانوية في ليبيا. وبذلك تبين أن هناك أربع مجموعات من العوامل التي تؤثر على نجاح التعليم الإلكتروني في قطاع التعليم المدرسي وهي كالاتي: خصائص الطلاب (مهارات الكمبيوتر؛ الدافع والاسلوب)؛ خصائص المعلمين (الاسلوب؛ التحكم في التكنولوجيا والتربية وطريقة التدريس)؛ التكنولوجيا (جودة التكنولوجيا وفعالية البنية التحتية) والتصميم والمحتوى (سهولة الاستخدام وجودة المحتوى). وبالتالي فأن المساهمة الرئيسية لهذا البحث تتمثل في نجاح التعليم الإلكتروني في قطاع المدارس الثانوية في ليبيا.

بالإضافة إلى ذلك، يقترح البحث نموذج عمل مناسب يدمج العوامل الحاسمة والمتغيرات الديموغرافية لنجاح عملية التعليم الالكتروني لدى المدارس الثانوية في ليبيا.

Abstract

As a result of the advances in information and communication technology, E-Learning has been integrated as an essential element in educational settings. Despite its successful implementation, a significant number of E-Learning projects fail to achieve their goals. This has motivated researchers and practitioners to study the reasons for failure and success and the factors that impact E-Learning. This paper attempts to implement the success of E-learning in secondary schools in Libya, by investigate the factors that influence the implementation and development of E-Learning and the most appropriate framework for secondary schools in Libya. The paper adopted a quantitative approach to examine both teachers' and students' perceptions of critical factors in secondary schools in Libya. So it was revealed that there are four sets of factors which influence the success of E-Learning in the school education sector. These are: students' characteristics (computers skills; motivation and attitudes); teachers' characteristics (attitudes; control of technology and pedagogy and teaching style); technology (quality of technology and effectiveness of infrastructure) and design and content (perceived ease of use and quality of content). The main contribution of this research is that it addresses the success of E-Learning in the schools sector in Libya as this area of research lacks theoretical and empirical studies. In addition, the research proposes a conceptual framework that integrates the critical factors and demographic variables.

Keywords: eLearning, critical success factors, Libyan secondary schools, conceptual framework for eLearning success.

INTRODUCTION

1.1 Introduction:

The advances in information and communication technology have stimulated progress in various areas such as the economy, business, communication, health, training and education. Since its inception in 1990, E-Learning has grown rapidly and education has been motivated to adopt E-Learning to transform traditional learning environments and create more efficient and attractive learning experiences. E-Learning is a direct result of the amalgamation of technology and education, which enables the creation of innovative research and delivery mechanisms which is one of the features of modern learning, and the main focus of this research. The fields of learning and education have benefited from electronic delivery to overcome obstacles of time, space and geography providing learning opportunities for anyone, anytime, anywhere, and in any mode. Therefore, E-Learning creates a platform to create knowledge-based communities as a source of education as well as to redesign the future of the nation and achieve educational security.

Additionally, according to Al-Harbi (2010) E-Learning transcends temporal and geographical barriers by offering learning anytime and anywhere; students can access not only the course materials, but also a massive amount of information from the internet relevant to their studies at any time and from anywhere. E-Learning can be scheduled to meet the needs of the learner and is the encouragement of lifelong learning. E-Learning has the ability to bring together two paradoxical concepts, independence and collaboration (Asiri et al., 2012). E-Learning also supports synchronous and asynchronous communications in various formats ranging from text, voice and video, which means connecting people in personal and public ways and so nurturing both independence and social interdependence simultaneously as well as developing students' understanding and enriching their educational experiences (Al-Harbi, 2010).

1.2 Problem Statement

The major problems E-Learning projects in the Libyan education are facing are related to a shortage in user awareness, attitudes and motivation, lack of a conceptual framework, absence of a clear vision and strategy, insufficient ICT infrastructure, lack of adequate internet connectivity, lack of technical and administrative support, and lack of E-Learning repositories that contain educational material and content in the Arabic language.

There is also a lack of academic and practical studies that involve both stakeholders (students and teachers) for a more comprehensive overview of the obstacles to the educational process. It is documented in a significant number of articles that problems and major challenges to E-Learning projects faced are related to institutions (administrative, academic affairs, and student services), management (maintenance of E-Learning environments and distribution of information), technology (infrastructure planning and hardware and software), pedagogy(teaching and learning), ethics (learner diversity; social, cultural, political, and geographical diversity; legal issues; and protocols), interface (the overall look and feel of E-Learning programmes), resource support (the support and resources needed to promote learning) and evaluation (judgements about the progress of learners and the effectiveness of the E-Learning environment) (Khan 2005; El-Gamal and Abd El- Aziz, 2011; Alkharang and Ghinea, 2013). Further research into the factors of E-Learning implementation would help to eliminate obstacles and challenges that may hinder E-Learning projects from achieving their goals and benefits. It is asserted from the literature that E-Learning is a concept that has been implemented in higher education. However, taking into consideration the nature of learners in a knowledge-based economy and the learning societies as well as the nature of key players (students and teachers) in the digital era, E-Learning should also be considered an essential element in the school education sector (Vrana et al., 2006).

Identifying the successful implementation and development of E-Learning projects and examining critical success factors is one method of increasing the percentage of success and effectiveness and of minimizing the percentage of failure in these projects. Such an approach is believed to overcome different types of obstacles and challenges when implementing and developing E-Learning such as focusing on the technological aspect of E-Learning and neglecting other dimensions of E-Learning such as human and individual characteristics, content and design and the administrative and guidance aspects, which include support and assistance. Therefore, the literature in the field of E-Learning has witnessed increasing academic and practical contributions to the subject.

In particular, there is little empirical research that has attempted to develop a conceptual framework to examine the success of E-Learning implementation (Sun et al., 2008). There is therefore a need for a conceptual framework that can be used to identify the factors that result in the success of E-Learning (Al-Sabawy, 2011; Wagner et al, 2009). Furthermore, much of the research on the implementation of E-Learning has largely focused on higher education rather than the school sector, even though E-Learning implementation in the school sector faces many challenges and obstacles such as ICT infrastructure, school support human capacity teachers attitudes and learners readiness (Ajelabi and Agbatogun, 2010;Redempta and Elizabeth, 2012; Mulwa and Kyalo, 2013).

Moreover, the majority of the research has largely focused on students or teachers only, even though both students and teachers play a crucial role in E-Learning (Kituyi and Tusubira, 2013). Therefore, there is a need to investigate the perceptions of both students and teachers (Penna and Stara, 2008; Umrani-Khan and Iyer, 2009). Thus, this research focuses on both students and teachers. Understanding why the students and teachers adopt or reject E-Learning will help to create a more favorable learning environment for greater adoption and implementation, as well as help to develop a conceptual framework to promote its success and effectiveness (Al-Harbi, 2010). Predominantly, when a new system is introduced, a greater understanding of the factors affecting its implementation and development will lead to an improvement of development, deployment and implementation. Likewise, careful consideration of the factors affecting E-Learning implementation is important to avoid a failed of E-Learning projects (Salmon, 2005; Ozkan and Koseler, 2009; Al-Harbi, 2010; Shroff et al., 2011; Alsabawy et al. 2013).

Thus, there is a great need for more research in this context to better understand and implement E-Learning. In addition, the current study creates a conceptual framework which identifies the factors that influence the success of E-Learning in secondary schools. It hoped that this research will provide significant information to promote the successful and effective implementation of E-Learning within Libyan schools.

1.3 Aim and Objectives

Prior studies have emphasized the importance of E-Learning success, yet there is a lack of clarity about how E-Learning could be implemented successfully and effectively. Moreover, little systematic empirical research has been directed towards a thorough investigation and analysis of key factors that impact E-Learning success. The primary aim of this research is, therefore, to investigate the factors that influence the implementation and development of E-Learning and the most appropriate framework for secondary schools in Libya.

The above aim drives development of a conceptual framework that can be used as a frame of reference by government and school educational settings which seek to implement and develop E-Learning projects and initiatives in Libya. It is hoped that this conceptual framework will contribute to the field of E-Learning by helping to establish a better understanding in the field of E-Learning, and in particular the issues surrounding implementation and development in a Libyan context. Further, it is proposed that this conceptual framework could serve as a decision-making framework for practitioners in their efforts to implement and develop E-Learning in Libya. The conceptual framework will integrate critical E-Learning factors and independent demographic variables for both teachers and students as a way to understand the successful implementation and development of E-Learning in school education. This research will contribute to the current knowledge about E-Learning success in general and the current situation of E-Learning in the school education sector. The importance of this research is generated from the absence of studies that focus on E-Learning frameworks and critical factors as a way to leverage the success rate and effectiveness of E-Learning projects in school education. Given this context, this thesis aims to answer the following questions as follows:

- What are the critical factors that influence the success of E-Learning?
- How do the teachers and students differ in their perceptions of critical E-Learning factors?
- How do the teachers differ in their perceptions of critical E-Learning factors based on selected demographics (e.g., gender, specialization, teaching experience and E-Learning experience)?
- How do the students differ in their perceptions of critical E-Learning factors based on selected demographics (e.g., gender, level of study (years in school) and specialization)?

To achieve the research aim, and attempt to answer the research questions, the following research objectives will be pursued:

- To critically analyze the literature on E-Learning.
- To identify critical factors that influences the success of E-Learning.
- To develop a conceptual framework that integrates critical E-Learning factors and demographic variables.
- To revise and modify the conceptual framework for the successful implementation of E-Learning in the educational sector.

1.4 The Significance of the research:

The significance of this research is generated from its usefulness to various fields. The research extends the line of developing an E-Learning success Framework by identifying the critical factors of E-Learning. The educators and the practitioners may use the findings of this research to design the learning and teaching process in learning environments to create suitable E-Learning based on specific elements of the environment. In addition, the research provides the E-Learning Success framework as a guide to unravel and investigate key factors that might help and drive the successful implementation of E-Learning in school education in particular and the educational sector as a whole. Therefore, it is significant that educators and practitioners understand the effects of E-Learning CSFs and how this might affect the quality of E-Learning in school education and help to develop effective E-Learning that can cater to both teachers and students.

1.5 Possible outcomes

The possible outcomes of using the success E-Learning in secondary school in Libya is that Learners follow their own rhythm in learning and filter the knowledge that suits their needs. Students may explore current and future technologies and learning systems; they can also impact E-Learning development, management, and implementation. Ideally, E-Learning often works best when it is combined with face-to-face classroom experience. In the following a sequence of steps an online course could go through:

- Students are enrolled in the online course and given private access to course material.
- A facilitator is assigned to each course, and can also have many courses at the same time.
- Technical background is a required facilitator's skill.
- The instructor of the course and its facilitator manage lessons and materials, quizzes and assignments and other activities.
- Students work on their own time and pace, going over the online course material using any personal computer with web access.
- Students submit completed assignments via the e-learning software tool and communicate with the instructor and the facilitator at any time by using the school's email as a tool of online communication.
- Students are assessed and graded on a combination of assessment components: quizzes, individual assignments, project, participation in class discussion, etc.
- Students can develop knowledge and skills when they need it.
- Self-paced learning provides teachers with the time to focus more attention on students who need assistance. Although students who are not having difficulties certainly should not be neglected, this

approach allows the teacher to spend time with participants who do require assistance.

1.6 The secondary school in Libya:

Secondary education is by definition including the last 3 years of primary education. After the 9 years, pupils may pass 3-4 of schooling to prepare for universities and other higher institutions at Upper Secondary Schools.

Upper secondary education is offered in the fields: (science and arts); it takes 3 years. Pupils in the last year must take final exams, and with a score above 65% they are awarded the Secondary Education Certificate.

There are a number of challenges facing the education sector, these are: low enrolments, inadequate and obsolete physical facilities and infrastructure at all levels; inadequate qualified teaching staff at all levels; inadequate teaching and learning materials and equipment at all levels; curriculum not demand driven; inadequate capacity in governance, management, monitoring and evaluation; inadequate capacity of the existing education system to address cross cutting issues; inadequate linkages and synergies within the education sector and the overall inadequate funding of education programmes. The capacity of secondary education in Libya is still very low.

Secondary education in Libya occupies a strategic place in the education and employment motives for many of the students at that level to remain in school, and it feeds the tertiary and higher education sector with its graduates. Most workers in the formal and informal sectors of the economy are likely to remain secondary school leavers for a long time to come and the expansion of the modern sector depends, to a great extent, on the supply of suitably educated and trainable secondary schools students. It is crucial that secondary education to be developed in a systematic way if the diverse challenges and expectations of Libyans in an expanding free market economy are to be effectively addressed.

Education is one of the most powerful instruments for reducing poverty and inequality and lays a foundation for sustained economic growth. The importance of secondary education includes (MoEC, 2004);

(a) Modern economies needs educated and trainable labour force with secondary education as the minimum qualification

(b) Secondary education is essential for the improvement of the quality and retention in primary education

(c) Secondary education is a necessary condition for economic competitiveness in the context of globalization and liberalization.

(d) Secondary education is one of the major components of the poverty reduction in Libya.

(e) Expansion of secondary education especially at advanced level in order to enlarge the supply of students for expansion of tertiary and higher education

(f) Chances of achieving gender balance in tertiary and higher education is depend on the girls graduates of secondary education.

Thus secondary education occupies a strategic place for future growth and economic development of the country.

2 E-Learning Overview

2.1 E-Learning Definitions

E-Learning has become a core element in the educational process, transforming traditional learning environments to integrate technology to create more efficient and attractive learning experiences.

In the context of this study, E-Learning can be defined as educational and learning instruction supported by the use of information communication technology tools and applications which allow learners to acquire new knowledge and skills, and support teaching and learning processes, deliver content and enhance interactive learning among students and teachers. In essence, E-Learning in this research refers to the use of the technology tools and applications as either a resource utilised by the students to aid their study or as a means for delivering learning courses and content.

2.2 E-Learning Benefits

It is important to cover briefly the major benefits of E-Learning in order to provide a context aimed at explaining why E-Learning is crucial for the development of the learning process and the reasons why E-Learning provides more efficient learning environments compared with the traditional learning experience. E-Learning is rapidly growing as an acceptable way of education. E-Learning provides a wealth of benefits which serve the main educational stakeholders in the learning environment, namely students and teachers (Al-Harbi, 2010; Bhuasiri et al., 2012; Alkharang and Ghinea, 2013; Al-Marabeh and Mohammad, 2013).

These include an increased accessibility to information, better content delivery, personalized instruction, content standardization, accountability, on-demand availability, self-pacing, interactivity, confidence, and increased convenience. E-Learning reduces costs, enables a consistent delivery of content, and improves tracking. The benefits of E-Learning can be summarized in three advantages as follows:

A- Delivering Effective Learning

E-Learning has the potential to create successful and meaningful learning environments that motivate the learners and offer powerful tools for interaction and communication. Al-Harbi, (2010) argues that in an E-Learning course, using stimulations created by software, such as Flash and Shockwave can support the cognitive work of analyzing data, manipulating models and exploring ideas and concepts (Khan, 2005). In addition, using multimedia enrichment resources develops the learners' understanding and enriches their educational experiences (Al-Harbi, 2010). E-Learning also creates an opportunity for learners to learn according to their individual learning styles and preferred cognitive style, be it visual, audio or text oriented, and allows learners to arrange the content and knowledge for their own needs and learning styles, and to improve the quality of learning experience and support learning by offering differentiated learning (Jethro et al., 2012). Ibrahim et al., (2007) report that the learner must be responsible for actively seeking solutions to problems contained within the course framework and through knowledge generation as students generate and construct their own knowledge in line with the guidance and help them receive from the instructor.

B- Enabling Interaction and Communication

E-Learning has the potential to enhance the traditional communication patterns between students and teachers and students themselves by creating a new learning environment. Mahdizadeh et al., (2008) specified that the relationship between teachers and students is no longer a one-way relationship, but rather it is about creating more collaboration and interaction between students to increase their participation and involvement in the classroom. E-Learning can be more flexible and often involves technologies such as audio-chatting, video- conferencing and online discussion, which provide learners the opportunity to interact with teachers and others students effectively and flexibly (Al-Adwan and Semedly, 2012). The literature highlights that the role of teachers and students is changing under the impact of the new learning environment (McGhee and Kozma, 2003). These changes have repercussions on the roles of both teachers as well as students. McGhee and Kozma, (2003) and Dargham et al., (2012) suggested that students play a vital role in collaborative learning environments as they participate in discussions among the whole class or within smaller groups, search for information and exchange opinions with their peers, where there is both shared and individual responsibility for their success in the learning process. They also pointed out that students work collaboratively with other students and with their teachers to achieve success, and that their role of team member is supported through the use of communication hardware and software.

Additionally, Dargham et al., (2012) suggested that teachers play a vital role in E-Learning as collaborators. Additionally, they explained that teachers work with other teachers to create a variety of activities and to improve the instruction process. They also work with students to achieve the same ends. Vrana et al., (2006) and Al-Homod and Shafi, (2013) argued that providing teachers and students with opportunities to interact, collaborate and use educational technologies improves students' participation in the educational process (Vrana et al., 2006; Ibrahim et al., 2007). This indicates that E-Learning creates real prospects for learners and teachers to get more involved in the learning process by allowing them to share their ideas and suggestions in different E-Learning modes (synchronous and asynchronous E-Learning). Moreover, E-Learning environments encourage students to construct knowledge and to communicate with the teacher to enhance learning experience and educational performance (Yongsheng et al., 2012).

C- Providing Flexibility in Learning Delivery

One of the main potentials of E-Learning is flexibility. The literature indicates that educational settings have been found to share certain common beliefs about the practical benefits that E-Learning can provide in delivering flexible learning. As John Chambers, president and CEO of Cisco Systems stated; "There are two fundamental equalizers in life: the Internet and Education. E-Learning eliminates the barriers of time and distance, creating universal, learning-on-demand opportunities for people, companies and countries." Al-Harbi (2010) supports the idea that E-Learning transcends time and geographical barriers and offers new learning environments. Alkharang and Ghinea, (2013) and Kwofie and Henten, (2011) also agree with this concept and mention that the key benefit of E-Learning is the provision of flexibility. In this context, many researchers support the fact that E-Learning projects provide flexibility and offer improved learning environments by focusing on learning without any bounded geographical location (Asiri et al., 2012; Odunaike et al., 2013; Al-Yaseen et al., 2012). Kwofie and Henten, (2011) suggested that the flexibility of E-Learning can be provided by the various forms of learning materials which allow the learner to select from a variety of options based on their needs and demands (Mapuva, 2009). Dargham et al., (2012) specified that the flexibility of E-Learning consist of different aspects relating to time, place and online feedback, as they increase the opportunities for life-long learning. This indicates that E-Learning implementation and development can generate flexible learning environments, bring together different people from different locations and increase accessibility to information. Al-Adwan and Semedly (2012) supported some of the above benefits of E-Learning as they pointed out that E-Learning provides the opportunity to interact between teachers and students at any mode and from any source (Rajasingham, 2009).

2.3 Critical Success Factors (CSFs) of E-learning:

2.3.1 Definition of a Critical Success Factor of E-learning:

To be able to assess E-Learning projects to identify strengths and weaknesses, the researcher utilised the concept of CSFs. CSFs provide insight into the relationship between factors with the greatest impact on the major components of any given system. Rockart (1982) identified the concept of CSFs as "the limited number of areas in which satisfactory results will ensure successful competitive performance for individual, department or organisation" and he added that CSFs are the few key areas where things must go right (Rockart 1982). Leidecker and Bruno (1984) and Boynton and Zmud (1984) affirmed that the CSFs are those few things, characteristics, conditions, or variables that when properly sustained, maintained, or managed can have a significant impact on the success of the system. In addition, Frimpon (2011) considered CSFs as variables that are fundamental to the success of the implementation stage, and an organisation must handle CSFs well in order to have a successful implementation. It is evident from the previous definitions that CSFs are variables and features that must be considered carefully during the planning phase to ensure a robust execution of the project. Therefore, CSFs must be verifiable, controllable and measurable to dictate the success of the whole system.

2.3.2 Exploring Critical Factors Influencing E-Learning

In order to identify the critical factors that influence E-Learning, it must be follow four steps: 1) A systematic analysis of the relevant studies in the E-learning literature were reviewed, which comprised a total of 33 studies that looked at E-Learning factors in both higher and further education; 2) Identify and calculate the frequency of the critical e-learning factors; 3) Categorize the factors according to the core components of the E-Learning environment, which are students, teachers and technology. The analysis of the study revealed an additional category of design and content; and 4) Categorised sub-factors under the main factors, which were renamed as follows: students' characteristics (computer skills, students' attitudes, and motivation), teachers' characteristics (teachers' attitudes, control of technology and pedagogy), technology (quality of technology, effectiveness of IT), and design and content (perceived ease of use and quality of content).

To summarise, previous studies have investigated the importance of critical factors in E-Learning implementation. For example, Selim (2007) identified students' characteristics as a major factor during the implementation and adoption of various integration technologies such as E-Learning (Presley and Presley, 2009; Hammoud, 2010; Chokri, 2012; Taha, 2013). In addition, Al-Fadhli's (2008) study found that the teacher dimension is the most important factor in the E-Learning environment which directly influences the students' satisfaction (Sun et al., 2008; Chen et al., 2009; Wang and Wang, 2009; Owens and Price, 2010; Jan and Contreras, 2011; Musa and Othman, 2012). In terms of the technology factor Pituch and Lee (2006) showed that technology in general and the effectiveness of the technology employed is considered the most significant. These highly influence E-Learning acceptance.

2.3.1.1 Student Characteristics

E-Learning is about using new technology to provide flexibility in learning to deliver and enable interaction and communication between students and teachers, and to deliver effective learning. Therefore, the progress and growth and implementation of E-

Learning will greatly depend upon students' characteristics (Chen and Lin, 2002; Masoumi, 2006; Liaw et al., 2007; Al-Fadhli, 2009). A number of studies have examined the influence of the students' characteristics in E-Learning implementations. According to Selim (2007), the student factor is considered crucial to determine the acceptance of E-Learning technologies and tools. Also, the characteristics of students play an important role in the success of E-Learning implementation. One of the important factors that influence E-Learning is computer skills and competencies in order to be successful in the E-Learning era (Selim 2007). Students' characteristics commonly consist of computer skills, motivation and attitudes towards E-Learning (Selim 2007; Sun et al., 2008; Teo et al., 2011). Malik (2010) emphasises that the most critical skill for students is computer efficacy, which is necessary for engaging in online environments. Alack of computer skills leads to anxiety in the online experience and will result in the student's inability to reap the benefits of E-Learning (Selim, 2007).

Another factor that influences E-Learning implementation is students' attitudes towards E-Learning. Students' behaviour and attitude determine their satisfaction and acceptance of E-Learning; a more positive attitude towards a newly introduced technology enhances the experience and, ultimately, influences students' satisfaction rates (Malik, 2010; Friedrich and Horn, 2010; Zewayed et al., 2011). Fageeh (2011) also mentioned a strong correlation between a learner's attitude, enhanced communication and ease of technology. In addition, other researchers (Abdel-Wahab, 2008; Presley and Presley, 2009; Hammoud, 2010) also concur that students' attitudes contribute significantly to the successful implementation of E-Learning. Moreover, Fageeh (2011) mentions other factors that determine the acceptance of technology by the learner: motivational and learner's control factors (Chen and Tseng, 2012).

2.3.1.2 Teacher Characteristics

In an E-Learning environment, it is necessary for the instructor to acquire a new set of skills and roles since the latest technologies, and their rapid development, create challenges for adoption even though the same tools increase efficacy (Ali and Ahmad, 2011). In addition to students' characteristics, teachers' characteristics are also considered as an important factor that affects E-Learning. A number of studies investigated the influence of teacher's characteristics in E-Learning implementation. According to Chen et al. (2009) who investigated the students' perspective on Critical Success Factors in E-Learning, the participants who completed the questionnaire were 46 adult students selected from National Open University in Taiwan that attended a training program about distance learning. The results revealed that the instructor was the most important factor influencing E-Learning projects and the students believed that instructors must approach E-Learning in a friendly and energetic manner to create a positive E-Learning environment.

Other studies (Volery and Lord, 2000; Govindasamy, 2002; Bolliger and Martindale, 2004; Sun et al., 2008) suggested the significance of instructor's characteristics, attitude, and teaching styles, as the instructors play a key role in learning activities in interaction between the students themselves, and between the students and the teachers, and in the traditional role of guiding the learning process. Ali and Ahmad (2011) mentioned that there is a relationship between student satisfaction and instructors' performance and student-instructor interaction in a distance learning environment. Ali and Ahmad's (2011) study results closely echo those of the previous results mentioned in this section: the instructor's conduct influenced the student-instructor interaction and the student's acceptance of and satisfaction with the learning experience.

Moreover, the study discussed the aspects of teachers' characteristics that influence E-Learning: teachers' availability for consultation and their readiness to provide feedback and answer questions (especially in distance education) is crucial for the success of the learning experience. Moreover, Chen et al. (2009) emphasised that the instructor was the most important factor influencing E-Learning projects and students believe that instructors must approach E-Learning in a friendly and energetic manner to create a positive E-Learning environment. However, these findings are in line with that of studies by Selim (2007) and McPherson and Nunest (2008), which indicated that the teaching style and methods applied during the instruction process, and collaboration and interaction during the instruction process also increased the students' motivation and attitudes towards E-Learning and improved the students' satisfaction.

These results are generally consistent with research on the impact of teachers' characteristics on E-Learning (Al- Fadhli 2009; Goi and Ng, 2009; Ferdousi, 2009; Friedrich and Hron, 2010; Malik, 2010), which concludes that teachers' characteristics are an important contributor to the success of E-Learning implementation. Furthermore, Mosakhani and Jamporazmey (2010); Teo (2011); FitzPatrick (2012) reviewed the teachers' characteristics that influence in E-Learning and concluded that in any E-Learning environment , teachers' characteristics can be assumed to be an important factor in E-Learning and must be taken into consideration when implementing and developing successful and effectiveness E-Learning.

2.3.1.3 Technology

Technology is the core enabler of E-Learning. To achieve a successful implementation of E-Learning the quality of technology and the effectiveness of Information Technology need to be considered (Malik, 2010). Pituch and Lee (2006) studied the influence of interaction on students' intentions to use E-Learning. The results revealed that the functionality of the system, perceived usefulness, and perceived ease of use had the strongest effects on E-Learning for supplementary learning purposes. The results also indicated that system functionality and use for supplementary learning was the most important factor and had the strongest effect on E-Learning. Ahmed (2010) found that the technology infrastructure had significantly affected learners' decisions to accept a hybrid E-Learning course and it could increase the successful introduction of E-Learning and impact the attitudes of both groups of users: students and teachers.

In addition, Malik (2010) and Selim (2007) have reported that the quality of technology and the efficiency of the infrastructure encouraged students and teachers to interact with the multimedia resource in E-Learning environments and increased the satisfaction of the users with regard to E-Learning implementation. Friedrich and Hron (2010) pointed to a positive significant effect of technical variables on the perceived usefulness which successfully predicts students' acceptance of the E-Learning system. Zewayed et al. (2011) showed that the perceived ease of use of the technology was found to be an important determinant that influenced students' intention to use the E-Learning system because it did not require advanced computer skills and competency.

2.3.1.4 Design and Content

In addition to students' characteristics, teachers' characteristics, technology, content is also considered as significant factors that affect E-Learning (Zewayed et al., 2011; FitzPatrick, 2012; Hassanzadeh et al., 2012; Musa and Othman, 2012). Content characteristics include the accuracy, authenticity, accessibility, the design and the appropriateness of outputs (Al-Ammary and Hamad, 2008; Hassanzadeh et al., 2012). Several studies have investigated content and its effect in the success of E-Learning and have found that the quality of content influenced the learning experience and students' satisfaction with the E-Learning environment. Al-Ammary and Hamad (2008), for example, investigated the content quality factor affecting the acceptance and use of the E-Learning system at the University of Libya. The results showed that the content quality affect the perceived ease of use and perceived usefulness which, ultimately, affect students' performance. Similarly, Sun et al. (2008) found that the course quality is the most significant element of an E-Learning environment and also suggested that a well-designed delivery process, with appropriate assistance to students for meeting their needs, can increase students' confidence when using E-Learning environments.

The aforementioned studies suggested that a higher quality of content provided to students enables them to fully absorb the delivered knowledge to meet their needs and demands while increasing the students' satisfaction towards E-Learning. The studies show that the content indirectly affects other factors (mentioned in previous sections) and sub-factors and, therefore, this indirect relationship must be examined further to uncover the possible subtle effects of content on E-Learning environments.

Research Methodology:

In this study, quantitative research and the survey strategy will be selected to investigate the critical factors . It will distribute a set of questionnaires to collect data from the respondents. The collected data will be analyzed through statistically using the SPSS software package. Inferential statistical analysis will be conducted in order to achieve the objectives of this study. The Likert scale rating is used for data collection. The Likert scale rating is a rating system in which the respondents indicate how strongly they agree with the questions or disagrees with them (Saunders et al., 2009).

The finding and result:

With the advancement of information and communication technology, E-Learning has become more widespread in educational settings. E-Learning can enhance educational reform by creating a paradigm shift from teacher-centered and retention-based education to a student-centered education where students work collaboratively, construct their own knowledge, and enhance problem solving and higher-order thinking skills.

E-Learning is also characterized by flexibility of access to the information, emphasizing a learner-centered approach, and promote the opportunities to the learner to produce knowledge and enable the learner to turn the information into useful knowledge to meet their needs and capabilities. However, existing research indicates that not all E-Learning in an educational setting is successful and effective, which suggests that as the adoption of E-Learning increases, there is a need to develop a conceptual framework to successfully deploy an E-Learning environment. Therefore, this paper has two major goals: firstly, to investigate the Critical Success Factors (CSFs) that influence the success of E-Learning and secondly, to develop an E-Learning conceptual framework for a successful deployment of E-Learning projects.

Figure 1.1 shows an E-Learning conceptual framework. It shows the ranking of the sub-factors of each main factor from teachers and students perceptions and ranking based on in its important as follows: students' characteristics (motivation, attitudes and computer skills), teachers' characteristics (control of technology, pedagogy and attitudes), technology (quality of technology and effectiveness of IT), design and content (quality of content and perceived ease of use). This means that the factors and sub-factors should be considered based on its priorities and importance in successful implementation and development of E-Learning.

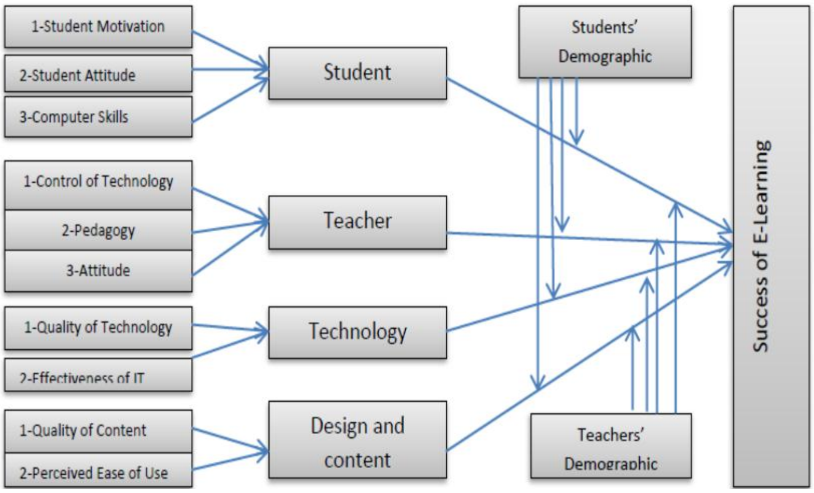

Figure 1.1(conceptual framework for ELearning successes

Recommendations and Implications:

Recommendation 1–Develop learning activities

The aim of this recommendation is to address the issues of the lack of effective and meaningful learning opportunities to stimulate the individual learning styles and preferences of students. The potential solutions are as follows:

Firstly, teachers can provide activities which integrate visual, audio or text materials, for example by using software such as flash to allow students to explore relevant ideas and concepts and provide tailoring opportunities to adapt the learning content to the learning needs. Secondly, teachers must show a genuine interest level in the students by replying to their e-mails promptly and allowing them to actively contribute to the course content. Additionally, teachers should be enthusiastic about teaching in E-Learning in order to motivate the students. Thirdly, teachers should rely on E-Learning tools such as online exams, posting e-announcements, and attracting the students to rely on E-Learning tools embedded in the course. They should provide activities that encourage students to rely on e-tools embedded in E-Learning such as e-mails, e-discussions, virtual classrooms, online collaboration, and an active role in classroom. The students in an E-Learning environment should gain a high level of computing competency. They should master applications such as e-mail, presentation and communication, and all the software applications needed to enhance the E-Learning process.

Fourthly, as teachers are keen on findings suitable teaching and learning methods that will enrich the learning experience of students and increase the learning attainment of students, teachers should be selective in finding the most suitable E-Learning activities to achieve the aforementioned factors. Teachers should include wherever possible interesting and motivating E-Learning activities such online games, educational videos, online testing to increase students‟ centric learning and other factors such as independence, self exploring, creativity, taking the initiative and life long learning. It is worth noting that the quality of student learning is partly a function of their learning environment. If students perceive their learning environment as positive or satisfying, their motivation to learn will increase and they become more apt to engage in positive learning. Therefore, it is important to provide a positive and rich learning environment to provide support for quality learning among students.

Recommendation 2–Facilitate engagement between students and teachers

The aim of this recommendation is to address the issue of the paucity of interaction, particularly in the male-only schools. Additionally, for male social interaction is a salient factor affecting the success of E-Learning, a potential solution is to provide educational forums through an E-Learning portal to exchange ideas and transfer experience around best practices between teachers and students either from the same schools or from other areas. Another potential solution is to provide social media such as instagram and twitter. For instance, students can record their experiments and share the results by posting them online on social media channels such as instagram and youtube. This will allow for the development of social relationships that will enrich peer learning, and allow educators to observe all students‟ social interaction.

Additionally, students will be more socially engaged and satisfied with their learning if they see „liveliness‟ and „dynamism‟ with the diverse media formats used by the teacher. This may include opening asynchronous discussions, facilitating quality interaction, and providing useful resources in the form of images, graphics and even audio or video files. In addition, it should be noted that the primary goal in online learning is not only to increase a social presence among participants, but to ultimately enhance student‟s learning through constructive discussions and collaborative inquiry. Building a social atmosphere by putting welcome messages and including students" profile on course sites using humor and emoticons and disclosing the self can only be meaningful when it comes with learning activities such as generating and facilitating effective discussions, providing timely feedback and meeting overall students" academic demands via emails and the e-forum. Only then can social presence contribute to students" successful and quality learning experiences. Teachers should provide both synchronous and asynchronous tools to minimize communication barriers. They can also employ a variety of get-to-know.

Recommendation 3 - Build the capacity of the teachers

The aim of this recommendation is to address the issues of teachers having problems with integrating technology in their teaching methods and therefore preventing them from delivering material that suits different style of student learning. A potential solution is to introduce professional development training programs that empower and support the teachers in developing their competencies to use multimedia and virtual laboratories. The teachers" professional development programs should enhance teachers" skills to manage and organize the technology tools and applications during class. The teachers should be able to handle the technology used in E-Learning based courses such as e-mails, e-discussions, and website maintenance.

Another potential solution is to provide training programs such as simulation programs and instructional games programs that increase the ability of teachers to integrate technology while teaching in a time and manner suitable for the students" learning style. In addition, construction of teachers" development plans in both the short and long term to enhance and improve their technology-related skills and different interactive learning methods. For teacher‟s content development, and management, the teachers should learn about the benefits and risks of technology.

Recommendation 4 –Provide supportive infrastructure

The aim of this recommendation is to address the issues of the inefficiency of the technology infrastructure and the lack of resources. Two potential solutions are: to provide new authoring tools, which would help both the teachers and the students to customize learning materials and also to increase the number of computers in the classroom with new ways of sharing and expanding knowledge such as a networked curriculum that promotes the results of experiments in labs. Another potential solution is to install enough bandwidth in order to have fast enough web access and browsing, and also install a wide single student authentication in order to have access to data from anywhere at any time.

Recommendation 5–Create an e-content bank

The aim of this recommendation is to address the issues of the lack of flexible and customizable learning opportunities that are targeted at both the E-Learning content and the various learning styles and preferences of students. A potential solution is to provide a comprehensive electronic library that comprises different resources which would help teachers to plan lessons and select the most appropriate assessment to evaluate the students‟ level of learning. Another potential solution is to provide the content in a consistent manner that introduces the objectives and the content, and deliver the feedback and provide support and assistance to the students.

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Effect of Inlet Flow Conditions on the Counter Flow Double Pipe Heat Exchanger Performance

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الملخص

تتناول هذه الورقة تأثير ظروف تدفق المدخل على أداء مبادل حراري مزدوج الأنبوب متعاكس الجريان. تم الحصول على النتائج من خلال كل من التحليل النظري والبيانات التجريبية. تم إجراء البحث التجريبي على مبادل حراري مزدوج الأنبوب متعاكس الجريان بقيم متغيرة لمعدلات تدفق كتلة الماء الساخن والبارد ودرجات حرارة دخول الماء البارد والساخن. زيادة معدل تدفق كتلة الماء الساخن ودرجة حرارة دخول الماء الساخن تزيد من درجة حرارة خروج الماء الساخن والبارد ومعدل نقل الحرارة بين السائلين. زيادة درجة حرارة دخول الماء البارد تزيد من درجات حرارة خروج الماء الساخن والبارد وتقلل من معدل نقل الحرارة بين السائلين. وكانت النتائج التي تم الحصول عليها من التحليل النظري في اتفاق مع تلك التي تم الحصول عليها من التجارب.

الكلمات المفتاحية: المبادل الحراري، متعاكس الانسياب، أداء، مزدوج الأنبوب، حالات الدخول.

Abstract

This paper study the effect of inlet flow conditions on the counter flow double pipe heat exchanger performance. The results were obtained by both theoretical analysis and experimental data. The experimental investigation was performed on a counter flow

double pipe heat exchanger at variable values of hot and cold water mass flow rates and cold and hot water inlet temperatures. Increasing hot water mass flow rate and hot water inlet temperature increase the hot and cold water outlet temperatures and the heat transfer rate between the two fluids. Increasing the cold water inlet temperature increases the hot and cold water outlet temperatures and decreases the heat transfer rate between the two fluids. The results obtained from the theoretical analysis were in agreement with those obtained from the experiments.

Keywords: heat exchanger, counter flow, performance, double pipe, inlet conditions.

1. Introduction

Heat exchangers are devices that provide the flow of thermal energy between two or more fluids at different temperatures. Some everyday examples of heat exchangers are the automobile radiator, and the domestic hot water heater. Heat exchanger are widely used in chemical industries and power plants [1].

Dang, Teng, and Chu [2] study the effect of flow arrangement on the heat transfer behaviors of a micro channel heat exchanger. The results were obtained by both numerical simulations and experimental data. The solver of numerical simulations COMSOL was developed by using the finite element method.

Vinothkumar, Raveendiran, and Salman [3] analysis the thermal performance of double pipe heat exchanger using heat pipe, with composite of wick, are compared with three different working fluid. The working fluid chosen for the study were water, methanol and ethanol.

Khaled et al. [4] evaluate the thermal performance based on known parameters, namely, distribution of upstream velocity of an air liquid heat exchanger, the flow rate of heat exchanger liquid, and the inlet air and liquid temperatures.

Abu-shanab [5] develop mathematical relationships describe the dimensionless temperature profiles for both fluid streams along parallel and counter flow heat exchangers for steady state case for the two case.

Idrissi and Bagui [6] obtain governing mathematical relationships to describe the dimensionless temperature profiles of hot and cold fluids depending on the convective heat transfer coefficients of hot and cold fluids in the case of a counter flow heat exchanger.

Bhanuchandrarao, Chakravarthy, Krishna, Rao, and Krishna [7] use ANSYS FLUENT12.1 software and hand calculations to analyze the temperature drops as a function of both inlet velocity and inlet temperature and how each varies with the other in a double pipe heat exchanger.

The purpose of this paper is to analysis the thermal performance of the counter flow double pipe heat exchanger under variable inlet conditions. The experimental work was performed on a counter flow double pipe heat exchanger at different values of inlet temperatures and mass flow rates for both hot and cold water.

2. The Experimental Setup

The experimental test rig used to characterize the effect of operating conditions on a counter flow double pipe heat exchanger performance presented schematically in figure (1). Figure (2) shows a photograph of the test rig and the measuring instruments.

The flow rate of the hot water can be measured by means of flow meter 2 and adjusted by means of control valve 2. The temperatures of the hot water entering and leaving the exchanger are measured by means of two thermocouples (Type T) located at inlet and outlet of a heat exchanger. The thermocouples readings were measured by a digital thermometer via a selector switch. The digital thermometer is (T) type with accuracy of ±0.3 ^{o}C.
The cold water taken directly from the water network is measured by means of flow meter 1 and controlled by means of control valve 1. The temperatures of the cold water entering and leaving the heat exchanger are measured by means of two thermocouples, and can be read by a digital thermometer via a selector switch. A series of valves (1, 2, 3, and 4) make it possible to select parallel or counter flow for the heat exchanger.
A concentric tube heat exchanger was manufactured and used in the present work. The heat exchanger consisted of two tubes, one fitted in the core of the second. The inner tube made from copper, and used for hot water. The second one made from galvanized cast iron, and used for cold water. The physical and geometrical characteristics of the tubes are reported in table (1) and (2).
The heat exchanger was insolated thermally by using wool glass with 3cm thickness. Therefore, only heat exchange takes place between hot and cold fluids.

Table (1) The physical characteristics of inner and outer tubes.

Tube	Thermal Conductivity ($W/m^{o}C$)	Specific heat ($J/kg^{o}C$)	Density (kg/m^3)
inner	348	394	8900
outer	52	420	7272

Table (2) The geometrical characteristics of inner and outer tubes.

Tube	Outer diameter (m)	Inner diameter (m)	Length (m)
inner	0.0142	0.0126	2.5
outer	0.034	0.0284	2.2

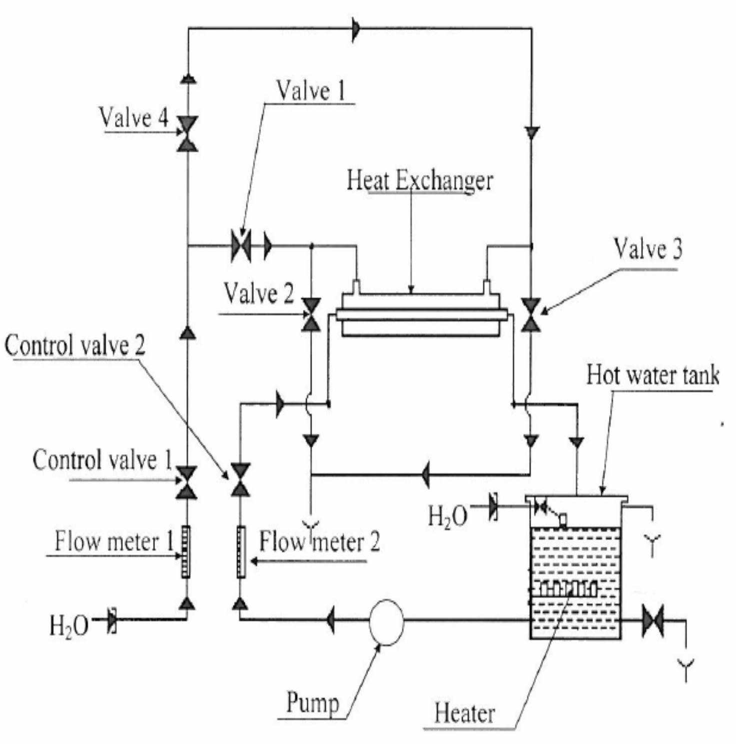

Figure (1) General layout of The Experimental Test Rig.

Figure (2) Photograph of The Experimental Test Rig.

3. Data Processing

In this experimentation, data was evaluated with the help of following relations:

To obtain the Reynolds number for both inner tube Re_i and annulus Re_o, the following relations presented in [9] were used:

$$Re_i = \frac{4m_h}{\pi\mu d_i} \qquad \textbf{(1)}$$

$$Re_o = \frac{4m_c}{\pi\mu(D_i+d_o)} \qquad \textbf{(2)}$$

Where m_h and m_c mass flow rate of hot and cold water, µ viscosity of water, d_i and d_o inner and outer diameter of inner tube, and D_i annulus inner diameter.

The Nusselt numbers Nu are calculated from correlations presented in [1].

For laminar flow in circular annular duct:

$$Nu = Nu_{\infty} + \left[1 + 0.14\left(\frac{d_o}{D_i}\right)^{-0.5}\right] \frac{0.19\left(\frac{Pe_b D_h}{L}\right)^{0.8}}{1+0.117\left(\frac{Pe_b D_h}{L}\right)^{0.467}} \qquad \textbf{(3)}$$

Where Pe_b is the Peclet number at a bulk fluid condition (Pe =Re Pr), Pr Prandtl number, D_h hydraulic diameter of a tube, L length of a circular annulus, and Nu_{∞} Nusselt number for fully developed flow, and the outer wall of the annulus is insulated which is given by:

$$Nu_{\infty} = 3.66 + 1.2\left(\frac{d_o}{D_i}\right)^{-0,5}$$

$$D_h = D_{i-}d_o$$

For turbulent flow:

$$Nu = \frac{(f/2)Re_b Pr_b}{1.07+12.7(f/2)^{0.5}({Pr_b}^{2/3}-1)} \qquad \textbf{(4)}$$

Equation (4) predicts the results in the range $10^4<Re_b<5*10^6$ and $0.5< Pr_b<200$. In the transition region where the Reynolds numbers are between 2300 and 10^4:

$$Nu = \frac{(f/2)(Re_{b-}1000)Pr_b}{1+12.7(f/2)^{0.5}({Pr_b}^{2/3}-1)} \qquad \textbf{(5)}$$

$$f = (1.58 \ln Re_b - 3.28)^{-2}$$

The hot and cold water outlet temperatures were calculated from mathematical relationships presented in [5].

$$\theta_h = \frac{\exp(\gamma) - C_r \exp(\gamma X)}{\exp(\gamma) - C_r} \qquad \textbf{(6)}$$

$$\theta_c = \frac{\exp(\gamma) - \exp(\gamma X)}{\exp(\gamma) - C_r} \qquad \textbf{(7)}$$

$$\theta_h = \frac{C_r \exp(-\gamma) - \exp(-\gamma X)}{\exp(\gamma_1) - C_r} \qquad \textbf{(8)}$$

$$\theta_c = \frac{C_r[\exp(-\gamma) - \exp(-\gamma X)]}{C_r \exp(-\gamma) - 1} \qquad \textbf{(9)}$$

Where θ_h and θ_c dimensionless temperature of hot and cold fluid, C_r heat capacity rate ratio (= C_{min} / C_{max}), and X dimensionless distance in x direction (= x / L), x = L at the outlet of hot fluid.

$$\theta = \frac{T - T_{c,i}}{T_{h,i} - T_{c,i}}$$

$$\gamma = NTU(1 - C_r)$$

T temperature in x direction, $T_{c,i}$ and $T_{h,i}$ inlet temperature of cold and hot fluid, NTU number of heat transfer units (= UA / C_{min}), where U overall heat transfer coefficient, A heat transfer area, C heat capacity rate (= m c_p), c_p specific heat at constant pressure.
Equations (6) and (7) using when the heat capacity rate of a cold fluid is smaller than for the heat capacity rate of a hot fluid, while

(8) and (9) when the heat capacity rate of a hot fluid is smaller than for the heat capacity rate of a cold fluid.

The overall heat transfer coefficient U is calculated from the following relation presented in [9].

$$U = \frac{1}{\left(\frac{1}{h_i}\right)+\left(\frac{1}{h_o}\right)} \qquad \textbf{(10)}$$

Where h_i and h_o convection coefficient at inner tube and annulus.

The analytical relation for heat transfer are available in [8–10] .

To calculate the heat transfer rate following relations were used :

$$Q_h = m_h c_{ph}(T_{hi} - T_{ho}) \qquad \textbf{(11)}$$

$$Q_c = m_c c_{pc}(T_{co} - T_{ci}) \qquad \textbf{(12)}$$

The average value of heat transfer rate Q_{avg}, supplied and absorbed by both fluids calculate from the following relation:

$$Q_{avg} = \frac{Q_{h+}Q_c}{2} \qquad \textbf{(13)}$$

To calculate the LMTD (logarithmic mean temperature difference) the following relation was used :

$$LMTD = \frac{(T_{h,i}-T_{c,o})-(T_{h,o}-T_{c,i})}{\ln\left[\frac{(T_{h,i}-T_{c,o})}{(T_{h,o}-T_{c,i})}\right]} \qquad \textbf{(14)}$$

The effectiveness ϵ is determined by:

$$\epsilon = \frac{T_{h,i} - T_{h,o}}{T_{h,i} - T_{c,i}} \qquad \textbf{(15)}$$

$$\epsilon = \frac{T_{c,o} - T_{c,i}}{T_{h,i} - T_{c,i}} \qquad \textbf{(16)}$$

Equation (15) was used when the heat capacity rate of a hot fluid is smaller than for the heat capacity rate of a cold fluid, while (16) when the heat capacity rate of a cold fluid is smaller than for the heat capacity rate of a hot fluid.

4. Results and Discussions

Experiments have been conducted to evaluate the heat exchanger performance under variable inlet conditions. For study the effect of hot water volume flow rate variation, the inlet temperature and the volume flow rate of cold water were fixed at 23^{o}C and 250Lt/hr respectively, the hot water inlet temperature fixed at 42^{o}C, the heat exchanger was tested at hot water volume flow rate 100, 200 and 300Lt/hr. The influence of hot water volume flow rate on the cold water outlet temperature is plotted in figure (3) for both experimental readings and theoretical calculations. It can be noted from the figure that the cold water outlet temperature increases as the hot water volume flow rate increases. The influence of hot water volume flow rate on the hot water outlet temperature is plotted in figure (4) for both experimental and theoretical results. It can be observed that the hot water outlet temperature increases as the hot water volume flow rate increases. The increasing on the hot water outlet temperature is greater than on the cold water outlet temperature and is found to be 3% higher for the hot water at 300Lt/hr volume flow rate than that at 100Lt/hr, and for cold water is found to be 0.25%. The relationship between heat transfer rate and hot water volume flow rate is plotted in figure (5) It can be noted from the figure that the heat transfer rate in the heat exchanger increases as the hot water volume flow rate increases.

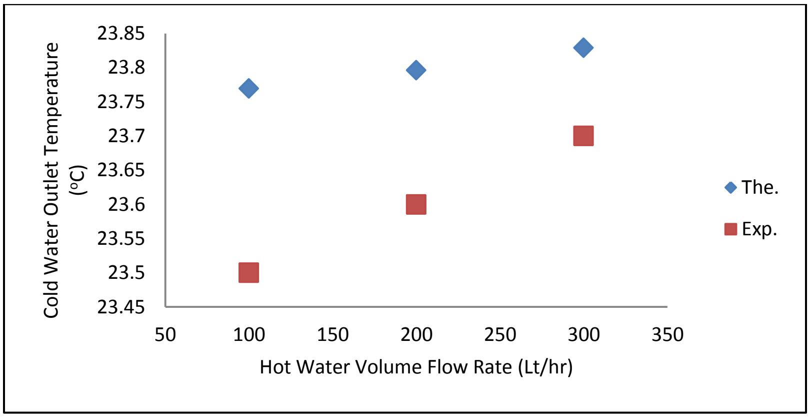

Figure (3) Effect of hot water volume flow rate on cold water outlet temperature.

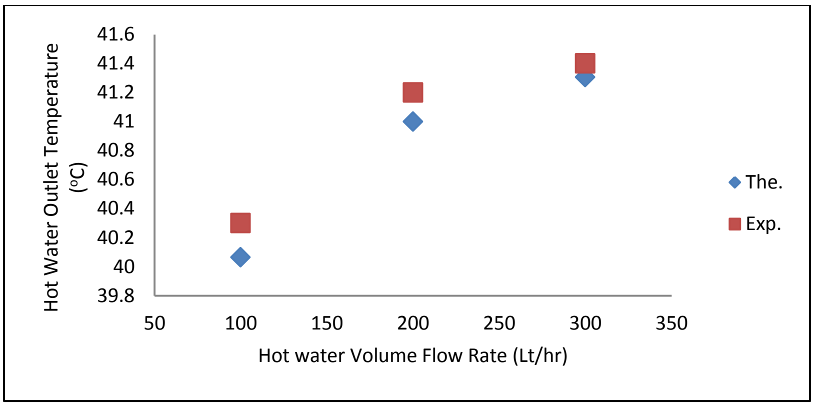

Figure (4) Effect of hot water volume flow rate on hot water outlet temperature.

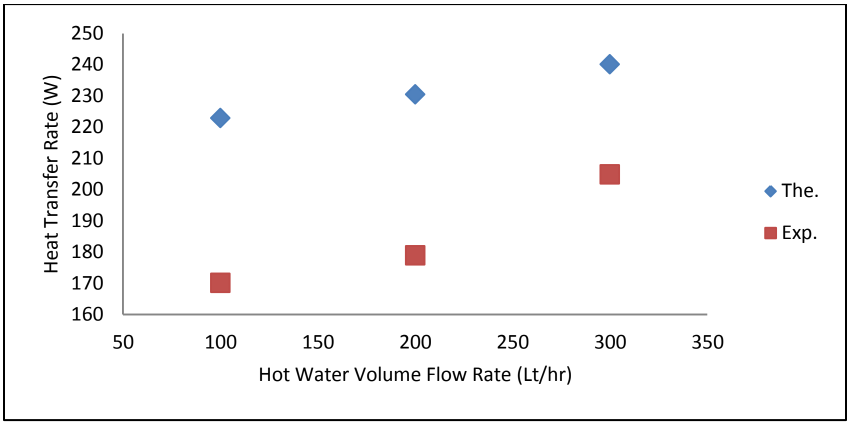

Figure (5) The relationship between heat transfer rate and hot water volume flow rate.

The heat exchanger effectiveness decreases with the increase of volume flow rate of both hot and cold water, The relationship between effectiveness and hot water volume flow rate is plotted in figure (6).

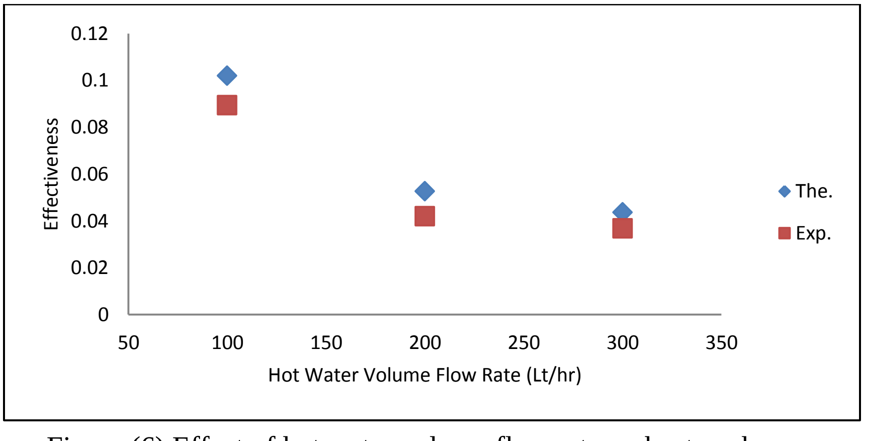

Figure (6) Effect of hot water volume flow rate on heat exchanger effectiveness.

The heat exchanger effectiveness is found to be 57.2% higher for the hot water at volume flow rate 100Lt/hr than that at 300Lt/hr.

For study the effect of cold water volume flow rate variation, the inlet temperature and the volume flow rate of hot water were fixed at 42^{o}C and 250Lt/hr respectively, the cold water inlet temperature was 22.8^{o}C, the heat exchanger was tested at cold water volume flow rate 100, 150, and 200Lt/hr. The influence of cold water volume flow rate on the cold water outlet temperature is plotted in figure (7) for both experimental readings and theoretical calculations. It can be noted from the figure that the cold water outlet temperature decreases as the cold water volume flow rate increases.

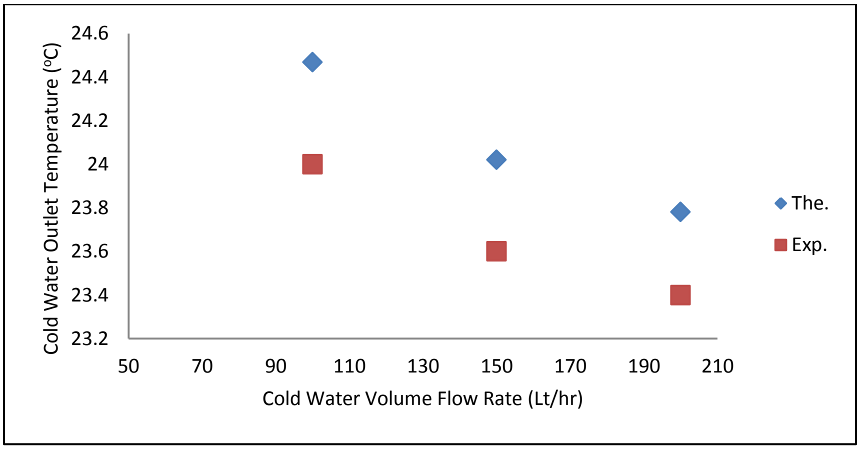

Figure (7) Effect of cold water volume flow rate on cold water outlet temperature.

The influence of cold water volume flow rate on the hot water outlet temperature is plotted in figure (8) for both experimental readings and theoretical calculations.

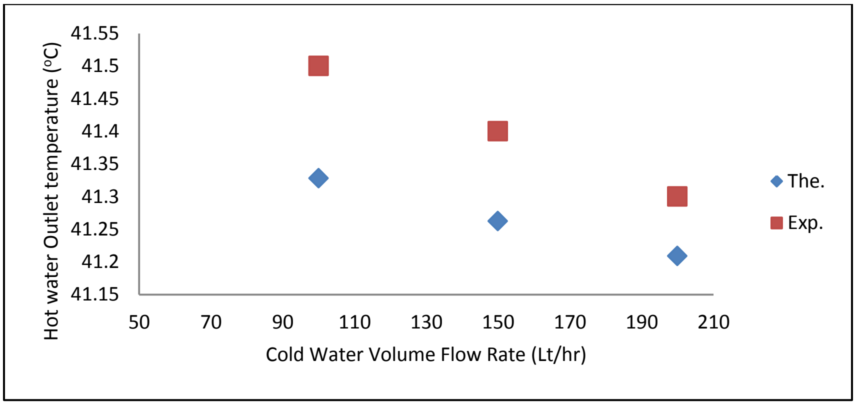

Figure (8) Effect of cold water volume flow rate on hot water outlet temperature.

It can be observed that the hot water outlet temperature decreases as the cold water volume flow rate increases. The decreasing on the cold water outlet temperature is greater than on the hot water outlet temperature as showed in figures 7 and 8. The relationship between heat transfer rate and cold water volume flow rate is plotted in figure (9).

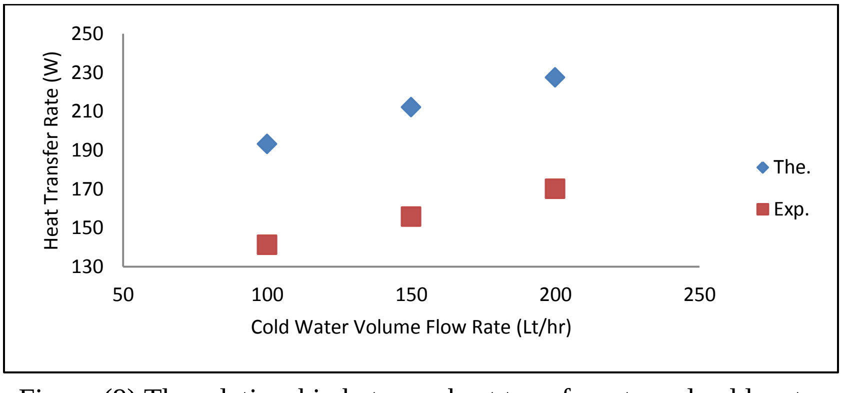

Figure (9) The relationship between heat transfer rate and cold water volume flow rate.

It can be noted from the figure that the heat transfer rate in the heat exchanger increases as the cold water volume flow rate increases.

For study the effect of hot water inlet temperature variation, the inlet temperature and the volume flow rate of cold water were fixed at 23^{o}C and 100Lt/hr, respectively, the hot water volume flow rate fixed at 250Lt/hr, the hot water inlet temperature changed from 42^{o}C to 47^{o}C to 52^{o}C. The influence of hot water inlet temperature on the cold water outlet temperature is plotted in figure (10) for both experimental readings and theoretical calculations. It can be noted from the figure that the cold water outlet temperature increases as the hot water inlet temperature increases.

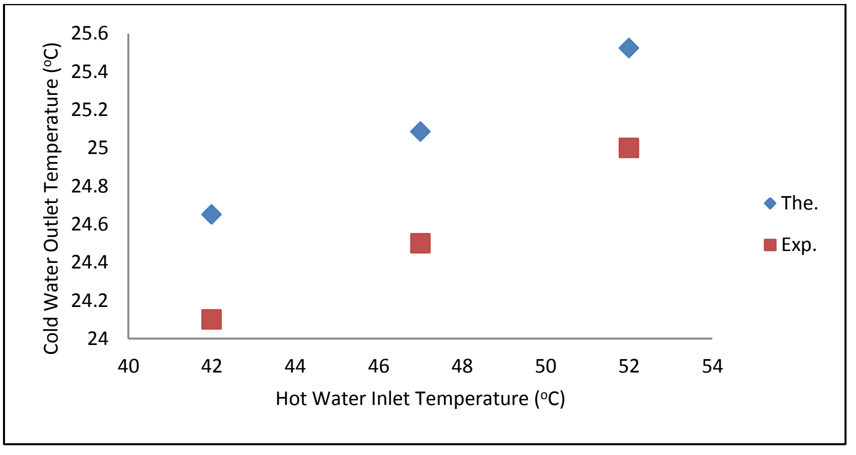

Figure (10) Effect of hot water inlet temperature on cold water outlet temperature.

The influence of hot water inlet temperature on the hot water outlet temperature is plotted in figure (11) for both experimental readings and theoretical calculations. It can be observed that the hot water outlet temperature increases as the hot water inlet temperature increases.

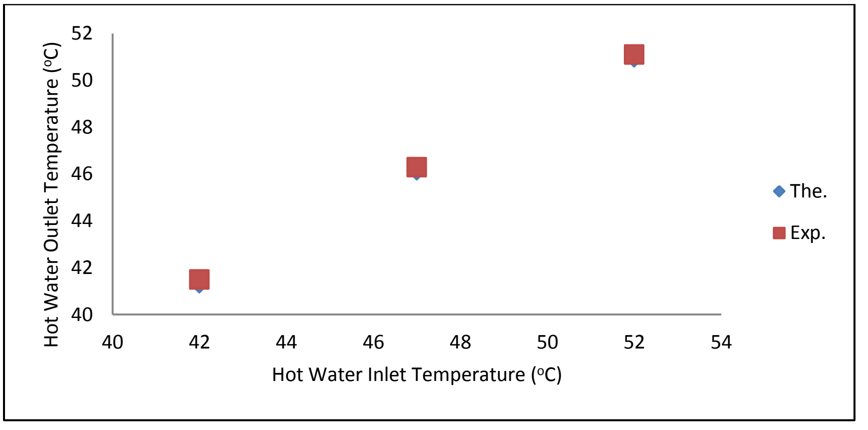

Figure (11) Effect of hot water inlet temperature on hot water outlet temperature.

The relationship between heat transfer rate and hot water inlet temperature is plotted in figure (12).

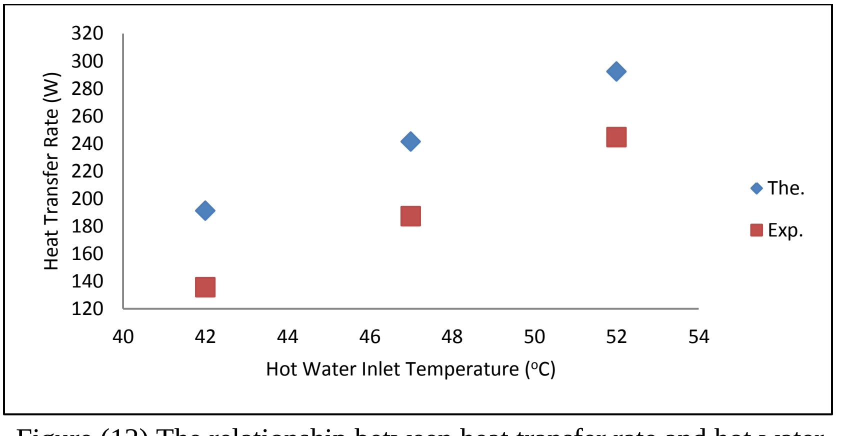

Figure (12) The relationship between heat transfer rate and hot water inlet temperature.

It can be noted from the figure that the heat transfer rate in the heat exchanger increases as the hot water inlet temperature increases. The heat transfer rate in the heat exchanger with hot water at 52°C inlet temperature is found to be 34.6% higher than the hot water at 42°C.

The logarithmic mean temperature difference increases with the increase of both hot and cold water inlet temperature. Figure (13) shows that at the logarithmic mean temperature difference with hot water at 52°C inlet temperature is found to be 34.5% higher than the hot water at 42°C.

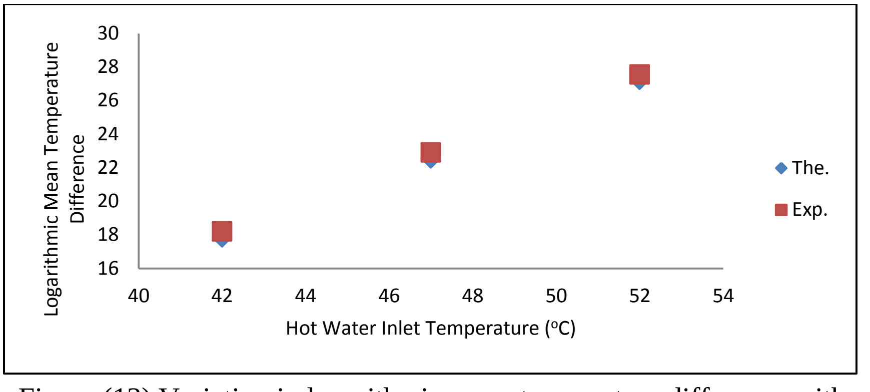

Figure (13) Variation in logarithmic mean temperature difference with hot water inlet temperature.

For study the effect of cold water inlet temperature variation, the inlet temperature and the volume flow rate of hot water were fixed at 42°C and 250Lt/hr respectively, the cold water volume flow rate fixed at 100Lt/hr, the cold water inlet temperature changed from 17.9°C to 20.1°C to 22.4°C. The influence of cold water inlet temperature on the cold water outlet temperature is plotted in figure (14) for both experimental readings and theoretical calculations. It can be noted from the figure that the cold water outlet temperature increases as the cold water inlet temperature increases. The influence of cold water inlet temperature on the hot water outlet temperature is plotted in figure (15) for both experimental readings and theoretical calculations. It can be observed that the hot water outlet temperature increases as the cold water inlet temperature increases. The relationship between heat transfer rate and cold water inlet temperature is plotted in figure (16). It can be noted from the figure that the heat transfer rate in the heat exchanger decreases as the cold water inlet temperature increases.

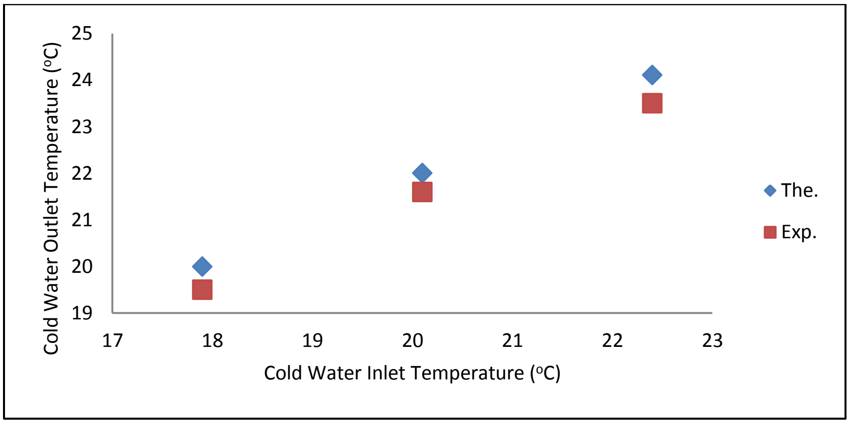

Figure (14) Effect of cold water volume flow rate on hot water outlet temperature.

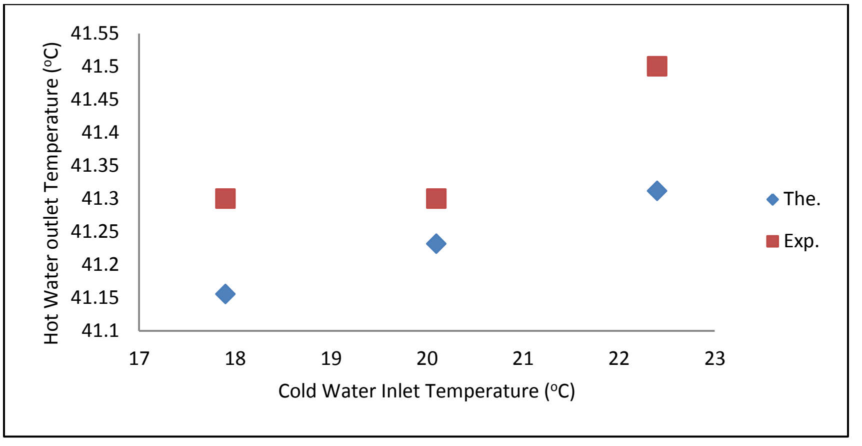

Figure (15) Effect of cold water volume flow rate on hot water outlet temperature.

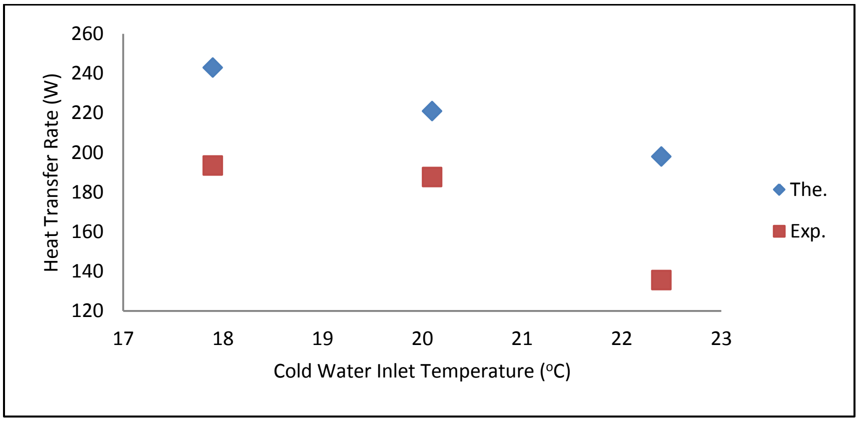

Figure (16) The relationship between heat transfer rate and cold water inlet temperature.

5. Conclusions

In this study, effect of variable inlet conditions on the performance of a double pipe counter flow heat exchanger is investigated experimentally and analytically.

Increasing the hot water mass flow rate increases the hot and cold water outlet temperatures and the heat transfer rate between the two fluids. Decreasing the cold water mass flow rate increases the hot and cold water outlet temperatures and the heat transfer rate between the two fluids.

The heat exchanger effectiveness decreases with the increase of mass flow rate of both hot and cold water.

Increasing the hot water inlet temperature increases the hot and cold water outlet temperatures and the heat transfer rate between the two fluids. Increasing the cold water inlet temperature increases the hot and cold water outlet temperatures and decreases the heat transfer rate between the two fluids.

The logarithmic mean temperature difference increases with the increase of both hot and cold water inlet temperature.

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Effects of sintering processing parameters and benchmarking on the orange peel texture of Polyamide PA3200 glass filled

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Abstract

This work aims to identify the quality of polyamide PA3200 GF and reduce the orange-peel effect and consequent improvement of part quality. The research intends to study the orange-peel effect and its causes, and implement screening test to determine the range of laser sintering LS parameters for acceptable build quality. The work begins with the experimental procedure and examination of the orange-peel texture, followed by analysis of results, and determination of improvement and control of input parameters. The benchmarking of the sintered part designs and their geometric features were intended to allow for evaluation of the performance of the LS process in terms of the orange-peel effect. These investigations were intended to find a systematic approach to the setting of the baseline for the quality of powder in terms of minimum acceptable value of MFR that can be used without the occurrence of the orange-peel effect.

Keywords: Powder EOS PA3200, Laser sintering, Benchmarking, Melt flow rate and Orange peel texture.

الملخص

يهدف هذا البحث إلى تحديد جودة مسحوق مادة البوليمير (PA3200 GF) بالتعرض للحرارة بأزمنة مختلفة اثنا التصنيع بواسطة عملية التلبيد (Laser Sintering) ودراسة تأثيرها على ظاهرة الخشونة السطحية (Orange Peel) وما يترتب عليه من تحسين في هذه الظاهرة على أسطح الأجزاء المصنعة.

حيث انه في هذا البحث تم التعرف على الظاهرة وأسباب ظهورها و إجراء الاختبارات المعملية لتحديد نطاق المدخلات المطلوبة لأجراء عملية التلبيد (Laser Sintering) وذلك للوصول إلى أفضل الظروف التشغيلية الملائمة في عملية التلبيد بجودة أسطح مقبولة. و قد تم تقسيم العمل لهذا البحث باختيار المدخلات المبدئية و إجراء التجارب المعملية و من تم دراسة النتائج والتحليل ثم مرحلة التحسين و التحكم في هذه المدخلات من حيث كفاءة نتائجها، وكما انه تم تصميم نموذج بمجموعة مختلفة من الأشكال الهندسية لتقييم جودة الأسطح بواسطة أسلوب عملية التلبيد و دراسة ظهور هذه الظاهرة على هذه الأشكال .ومن خلال النتائج المتحصل عليها تم الوصول إلى أفضل الحدود التي يمكن استخدامها كمعيار لتحديد جودة مادة مسحوق البوليمير دون حدوث ظاهرة الخشونة السطحية (Orange Peel) عن طريق اختبار معدل تدفق ذوبان المسحوق (Melt Flow Rate).

1. Introduction

The production of sintered parts with an orange-peel texture on the surface is directly dependant on the degree of exposure of the composite powder to the laser beam, the orientation of the sintered parts and the properties of the powder. This work investigates the PA3200 material developed by EOS GmbH and is a mixture of PA2200 polyamide powder and glass beads. PA3200 is used to produce sintered parts via a rapid prototyping process known as Selective Laser Sintering (SLS) or simply Laser Sintering (LS).

Laser Sintering LS is a complicated comprehensive process affected by chemical, physical and mechanical properties, thus owing some of problems such as orange peel texture. Various process parameters that are effective on the orange peel texture in LS, and the relations between the effective process parameters and material properties and the resulting part orange peel texture are sought [1]. Polymer powders can be easily reinforced with other materials in order to further improve their mechanical and thermal properties [2]. Several grades of glass fiber reinforced PA powders are readily available on the market. Parts fabricated from glass filled polyamide (PA3200 GF for example), have excellent mechanical properties and high accuracy [3]. The polymer composite has two main components of a polymer matrix such as Polyamide 66 (nylon 66 or PA 66 - the first nylon produced was in 1935 after extensive and classical research into condensation polymerisation) reinforced with a glass fiber filler [4]. The filler is usually applied in the form of solid additives such as glass beads or glass fibres, incorporated into the polymer to modify its physical (usually mechanical) properties. Once glass filler has been added, the name becomes PA 66 GF. Currently available are PA6 with glass beads, PA11 with glass beads, PA12 with glass beads and Acrylonitrile- Butadiene- Styrene (ABS). The commonly used thermoplastic matrices for composites are polypropylenes, polyamides, and polyketones. Engineering thermoplastic composites, such as PA66 reinforced with 30% short glass fibre, are high performance materials with high added value. The performance gain of these composites is more than compensates for their higher economic cost; therefore the recycling of such high performance plastics usually requires that their characteristic high level of properties is maintained. The most studied materials are PA 66, polycarbonate and polyeretherketone [5].

Several researchers have been devoted to the recycling of PA66 polyamide. Most of them used glass fibre reinforced PA66, although carbon fibres have also been used [6]. The tensile strength of 20% short glass fibre reinforced PA66 was studied by Yang (1976). The influence of reprocessing on the properties of the 20% short fibre reinforced PC was also studied by Chrysostomou and Hashemi (1996); reprocessing reduced the mean fibre length and increased the melt flow index (MFI) [6]. In other work, Eriksson, Alertsson and Praautsch studied re-used PA66 reinforced with 30% short glass fibres that had been through the LS process. The thermal stability and melting temperature of re-used composites were investigated by Licea, Carrillo and Castano and were found, generally, to be lower than for the virgin composite [5].

1.1 Powder

1.1.1 Definition of powder

Powder is a dry, bulk solid composed of a large number of very fine particles that may flow freely when shaken or tilted [7]-[8]. A powder particle may be defined as a small solid object having precise physical boundaries in all directions. Particles are sometimes described as fine or coarse according to the particle size [9].

1.1.2 Main characteristics of powders

The main characteristics of powders are the particle size and distribution (granulometry) and particle shape (morphology). Technological properties of powders are its bulk density, flowability and surface area. The potential areas of their application depend on these characteristics [10].

1.1.3 Morphology of powders

The morphology of powders can be critical in determining flow characteristics and plays an important role in heat and momentum transfer to the powder during the LS process "3D Systems"[11]. Generally, the morphology of powders can be described as irregular, blocky or spherical. Irregular powders are characterised by the presence of a wide range of shapes from cube-like structures through to needles. Blocky powders tend to have shapes where the largest and smallest dimensions of the powder particles are quite close. Spherical powders are broadly spherical in shape. Size parameters (for example, average diameter, area or perimeter) describe a geometrical object independently of its shape [9].

1.1.4 Particle size range and distribution

Powders are designated in terms of a simple size range. Historically these are often quoted in terms of the mesh size used in traditional sieving classifications, where the mesh number actually defines the number of wires used per inch in a "standard" sieve. While sieves are still used for classification of powders, the laser light scattering techniques is used today to carry out the measurement of particle size [12] and [13]. The particle size distribution of a powder is a list of values or a mathematical function that defines the relative amounts of particles present, sorted according to size. Particle size distribution method produces information about the average particle size and the distribution of particle size and the output data as histograms.

1.1.5 Density of powders

The mechanical and physical properties of an LS fabricated part were found to be highly related to its density, and one of the methods employed in increasing the density of fabricated parts is to increase the density of the powder bed prior to LS processing [14]. The density of powder is a variable that depends not only on the density of the solid particles but also on their packing. Packing density is a function of the particle size, particle size distribution, particle shape and the particulars of the process used to pack the particles. Common packing processes that are used to characterize powder density include random placement of particles through pour or bulk density measurement or tap density measurement [15]. An optimal packing density of the powder bed could be achieved if the voids between the largest particles in the bed are filled with smaller particles, the spaces between which are, in turn, filled with smaller particles, and so on [9]. In principle, spherical particles can be packed in different arrangements such as the cubical and the orthorhombic. PA has an irregular shape with a range of particle sizes, while the glass beads have a spherical shape with a range of particle size which varies from one supplier to another, depending upon the sieving process used. It is expected that the smaller the diameters of the finest particles, the denser is the bed, which is due to the finest particles filling more of the interstitial spaces between the more coarse particles. To achieve maximum density the powders should be vibrated to help the finer particles fill the spaces between the larger [9]-[14].

1.1.6 Relationship between powder properties, fabrication parameters and parts produced using LS process

It is well known that powder properties are directly related to the fabricated parameters in the laser sintering process [16]-[17]. It is also identified that both powder properties and fabrication parameters have a great influence on the mechanical properties and surface qualities for LS parts. A relationship between powder properties, fabrication parameters in LS process and parts quality produced as in Fig.1 was investigated. In rapid prototyping parts quality appearance is usually defined by the dimension of the accuracy and quality surface put the mechanical properties are usually defined by tensile strength and density [16]-[17].

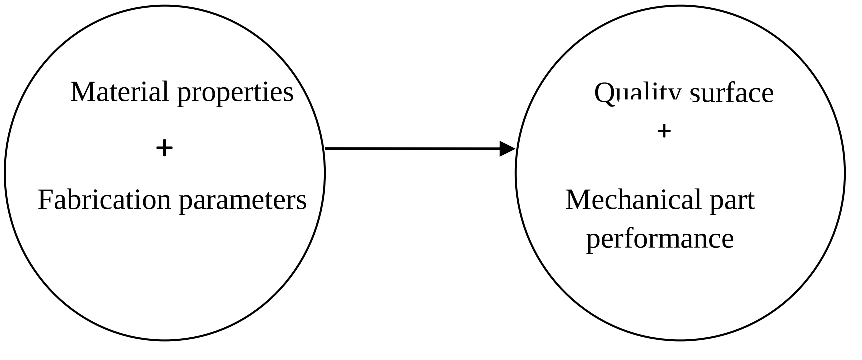

Figure 1. Relationship between LS input factors and part output factors.

1.1.7 Normal cycle management of new and recycled powder

In an ideal process, all of used powder can be recycled; the repeated heat cycles change material characteristics resulting in part quality issues. Starting with virgin powder can provide good builds with excellent surface finish as the powder reused. However, the surface finish can be deteriorated at some point and becomes unacceptable. Therefore virgin powder is blended into the mix in a challenge to maintain the part quality at a tolerable level [18]. The normal cycle of flow of the powder in HIQ and EOS machines is classified into several stages as shown in Fig. 2. These technologies have high level of automation, easily handling (EOS) and machine manual loading, and easily handing (3D) [19].

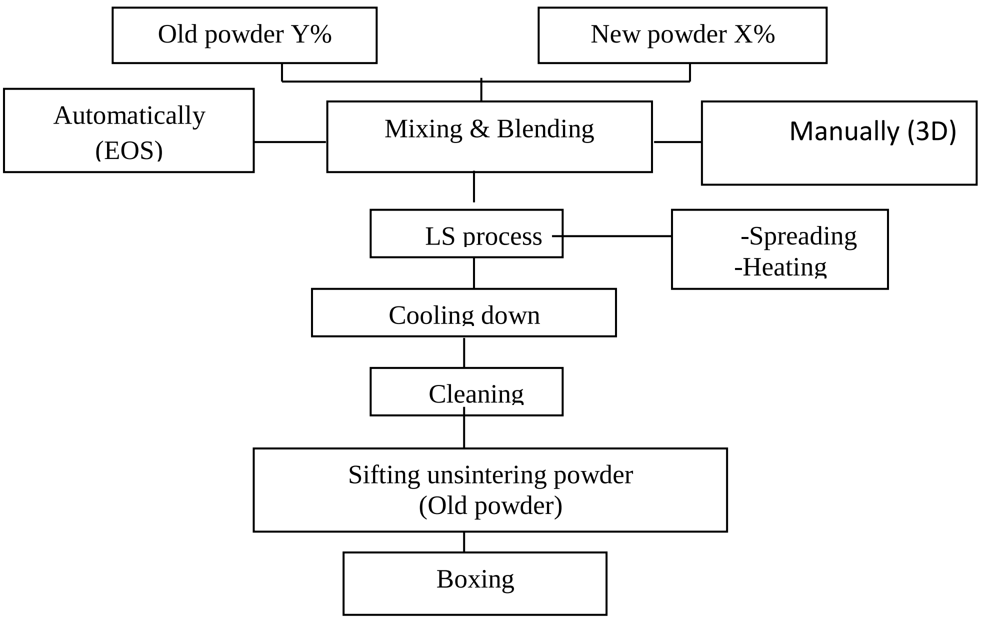

Figure 2. Flow chart of the powder in LS machine [20].

2.0 General proposed design for the benchmarking part

Benchmarking part is designed using ProE software. The geometric features of benchmark part aimed to improve the performance of evaluation of LS process in terms of the orange peel texture. The evaluation is based on a benchmark part consisting of 3D part features of different sizes at different locations, and orientations. The geometry dimensions of the benchmark part are 80X80mm in area and 38mm in thickness designed of the top surfaces which varies in orientation angles 0,20°,30°,40°, 50°,60°,70° and 80° for thicknesses 2 and 6mm, and 90° with the flat surfaces thickness of 1,2,3 and 4mm. The radius R8 has orientation angles of 10°, 20°,30°,40° and 50 thickness 2 and 6mm, while R10 has orientation angles of 50°, 54°and 90° from the four sides of top and bottom surfaces, from the bottom surface different features designed thickness 1,2,3 and 4mm designed with 45° angle ,thickness 4mm with 90° and three different thicknesses cylindrical 1,2 and 3mm specified to evaluate the orange peel texture. The parts separately fabricated where different exposure time of old polyamide PA3200 glass filled used. Figure 3 shows the details of the assumed benchmark. The geometric features of benchmark part are identified by two latter, such as CH, SB and the ranges for parameters are summarised in Table 1 in section 4.1. Orientations and curved shapes are also a major factor in affecting the quality of surfaces formed by the same approximation. Orientation is quantified in terms of the build angle between the parts of longitudinal axis and the horizontal plane of the powder bed. The range for part orientation is chosen so that surfaces built at an angle can be compared to the best surfaces obtained from horizontal built parts; thus, part orientation varies between 0^{o} to 90^{o} as in Fig .3[19]-[22].

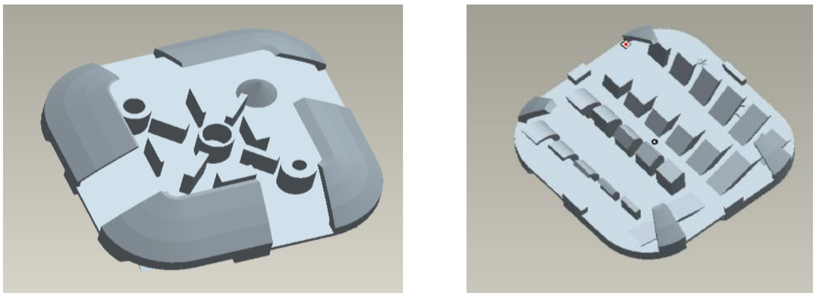

Figure 3. Front and back sides and features of the proposed benchmark.

3.0 Laser sintering machine and powder used

A sinterstion 2500 HiQ machine was used in the experiments. MFR test was used to evaluate the quality of powders. Simple test part was fabricated to select the parameters ranges and this combination of parameters was used to fabricate the benchmark parts. Old powder glass bead was used in this work have 26, 74, 114 and 144MFR, respectively. Benchmark parts designed with different thickness, shapes, and orientations. Visual evaluation and touch was used to indicate the degree of quality of surface finish.

4.0 Methodology

This work is based on two methods; these are powder quality improvement, and part quality improvement in case of orange peel texture. In the later method the investigation is divided into nine phases: define the problem, causes, screening test, benchmarking part design, experiments, measurement, analysis, improvement and control parameters (DCSBEMAIC). In these investigations the aim was to find a systematic approach to improve the quality of powder and quality of parts aimed to minimize the orange peel texture.

4.1 Method 1 (New/Recycled Powder Blends)

Pham, et al. [1] classified the powder grades of PA2200 powder consistency. Table 1 shows the different levels of grades as (A, B and C), and this classification is estimated according to MFR testing to clarify the quality of powder. The samples were taken from new powder, once used and recycled powders, which, were heated continuously at different exposure time [23]-[24]. Three factors were considered: classifications of grades, time of exposure and different powders. The levels of grades are defined as follows:

Grade A: New powder is the best powder grade. The different batched (LOTS) of new powder have variation in the MFR.
Grade B: Old powder is type of powder that has been used in the LS process; quality was deteriorated due to long hours expose at elevated temperature caused molecular weight and thermal properties changed and can be reused, according to MFR measurements Grade B divided into six groups.

Grade C: Old powder is the worst grade of PA3200 powder quality (table1). This type of powder deteriorated due to long hours expose at elevated temperature caused molecular weight and thermal properties changed. For this reasons the powder must be discard if the quality of the powder badly that related to MFR measurement.

TABLE 1. The quality of polyamide PA3200 powder consistency.

GRADE	A	B1	B2	B3	B4	B5	B6	C
MFR (g/10min)	>50	49-45	44-40	39-35	34-30	29-25	24-20	19-15

4.2 Method 2 (Quality of parts)

Part quality improvement is divided into nine phases; definition of the problem and causes, screening test and benchmarking part design, run of experiments, measurement and analysis, improvement and control parameters (DCSBEMAIC) as shown in Fig. 4.

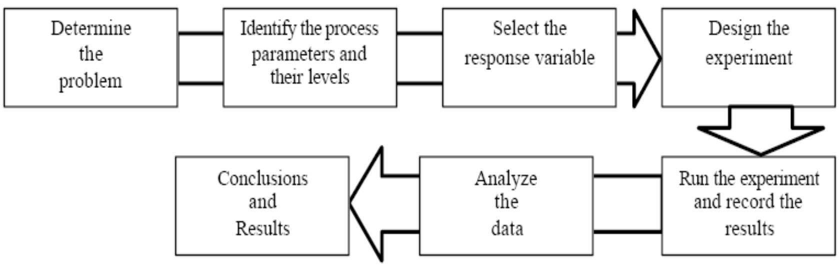

Figure 4. The flow chart of the quality improvement of the process [25].

5.0 Orange peel phenomenon

5.1 Orange peel definition

Orange peel is a surface defect where the surface condition texture can appear if the part is subject to high or low heat as it enters the oven. High heat can make the reaction happen before the part has had time to properly flow out. A surface roughening (defect) encountered in forming products from powder that has a coarse grain size as shown in Figure 5 [23].

One of the most common causes for this effect is the quality of the powder, mainly the particle size distribution, inadequate flow-out characteristics, and incorrect choice of powders mixture. Other cause of orange peel is high viscosity that develops orange peel during application. In this case, the powder does not flow enough to "level" and achieve a smooth surface. Fast cooling rate tends to orange peel because of its short "open" time. But adding the blend of powder may lower viscosity causing it to flow enough to eliminate orange peel. Changing the powder blend to increase cooling time may also help.

Figure 5. Orange peel texture.

5.2 Orange peel texture causes

LS is a complicated comprehensive process affected by chemical, physical and mechanical properties which owing some of problems such as orange peel texture. The orange peel texture can be occurred due to many factors as shown in Figure 6. These include orientation, position, geometry and number of parts, reuse of powder, process parameters, and thermal problem in the process chamber, slice thickness, lack of density at the parts surface and inconsistency of new powder.

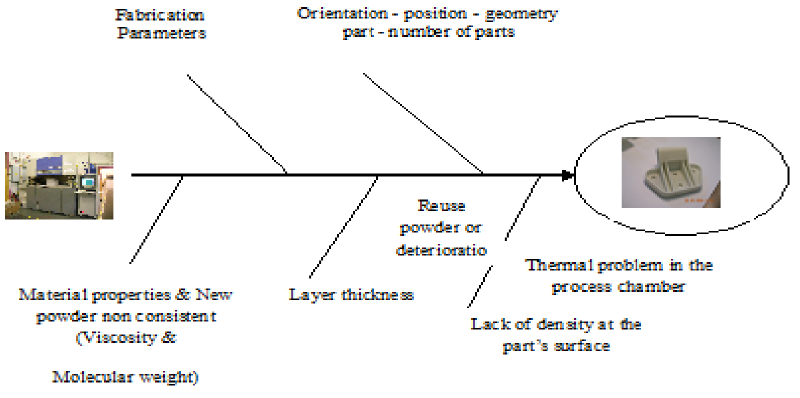

Figure 6. Fishbone diagram of factors influencing the orange peel.

6.0 Screening test

6.1 Test part

A rectangular part having (L x w) 114 x 25.4mm cross section with 5mm thickness as shown in Fig. 7 is selected as the test specimens. It is designed on the basis of selection of the range of the LS process parameters and screening test. The material used was polyamide (PA3200) EOS glass filled powder 26 MFR and 28 hours exposure time. The LS sintering parameters used are: Part heater=174 °C, Piston heater=150 °C and Cylinder heater=130 °C.

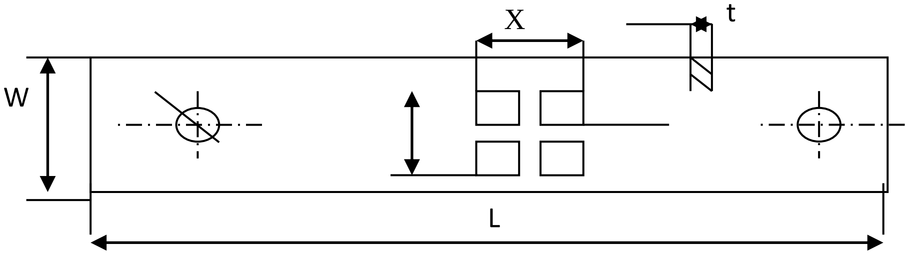

Figure 7. The dimensions of test part specimen.

6.2 Selection of laser sintering parameters and their ranges

The range of parameter values of laser power, laser speed, scan spacing, layer thickness and the maximum energy density are chosen based on the practical considerations because higher energy density causes degradation of the material and the lower energy density causes sintering not to occur, or may produce a weak part. Equation 1 of [26]- [30] was used to determine the energy density.

$$ED = \frac{L_p}{L_s.ScSp.L_t} \quad (1)$$

Where ED is energy density, L_p laser power (watt), L_s laser speed (mm/s), ScSp scan spacing (mm) and L_t layer thickness (mm). The parameters in the experiments are laser power, layer thickness, laser speed and scan spacing. Laser power determines the severity of temperature gradients, which introduce deviations due to thermal modes on parts. The laser powder is the mechanism by which melting and sintering of the powder particles is initiated. As a result, the level of power is a significant contributor to the surface quality. Layer thickness affects the quality of the surfaces that are approximated due to the layer –forming property of SLS, creating an irregular pattern on angled surfaces.

7.0 Details of experiments

The selection of the parameters is initially chosen based on the experience and default parameters which recommended by the manufacturer (EOS supplier). Test parts fabricated according to those parameters are shown in Table (2 and 3) and the energy density calculated based on Eq.1.

TABLE 2. LS process parameters and energy density calculation.

Parts No.	Laser Power (Watt)	Scan spacing (mm)	Layer thickness (mm)	Laser Speed 5080 (mm/s)	
				Ed (J/cm^3)	Weight (g)
1	10	0.15	0.10	131.20	11.1
2	12	0.15		157.48	12.8
3	15	0.10		295.20	15.4
4		0.15		196.85	14.2
5	18	0.10		354.30	15.8
6		0.15		236.20	14.5
7	20	0.10		393.70	15.8
8		0.15		262.46	15.8
9	23	0.10		452.75	15.8
10	25	0.10		492.12	15.6

TABLE 3. LS process parameters and energy density calculation.

Parts No.	Laser Power (Watt)	Scan spacing (mm)	Layer thickness (mm)	Laser Speed 5080 (mm/s)	
				Ed (J/cm^3)	Weight (g)
1	10	0.15	0.12	109	11.2
2	12	0.15		131	12.3
3	15	0.10		246	15.5
4		0.15		164	13.7
5	18	0.10		295	15.7
6		0.15		196	14.7
7	20	0.10		328	15.9
8		0.15		218	15.0
9	23	0.10		377	16.0
10	25	0.10		410	15.9

7.1 Results

All test parts were examined by visual observation and touching of the surfaces, and Fig.8 shows examples of test specimens. The high and low levels of the processing parameter window were chosen as follows: at the combination of all the parts were built with energy density higher than 280 J/cm^3 over heated and details on parts disappeared.

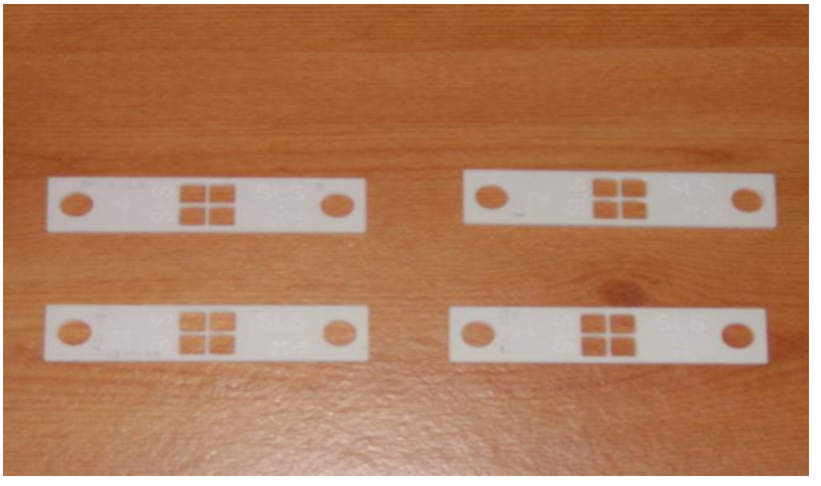

Figure 8. Test parts specimen of the rectangular geometry.

In contrast the parts were built with lower energy 180 J/cm^3 were weakly parts and colour became white rather than grey. The default energy density according to EOS recommendation is 196 J/cm^3. Therefore, ranges of the parameters chosen depend on the maximum and minimum energy density of the parts varies from 180 to 280 J/cm^3. The glass filled powder was melted by using these values, emitting small amounts of smoke. Figures 9 and 10 show the ranges of this energy density.

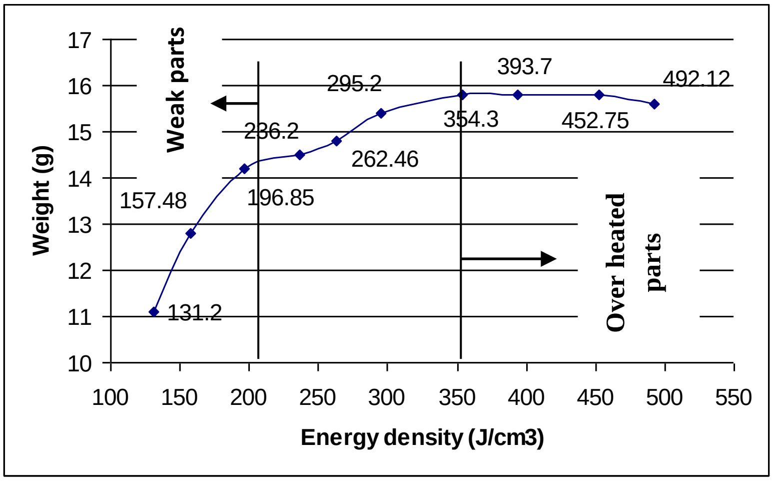

Figure 9. The range of energy density for layer thickness 0.1mm.

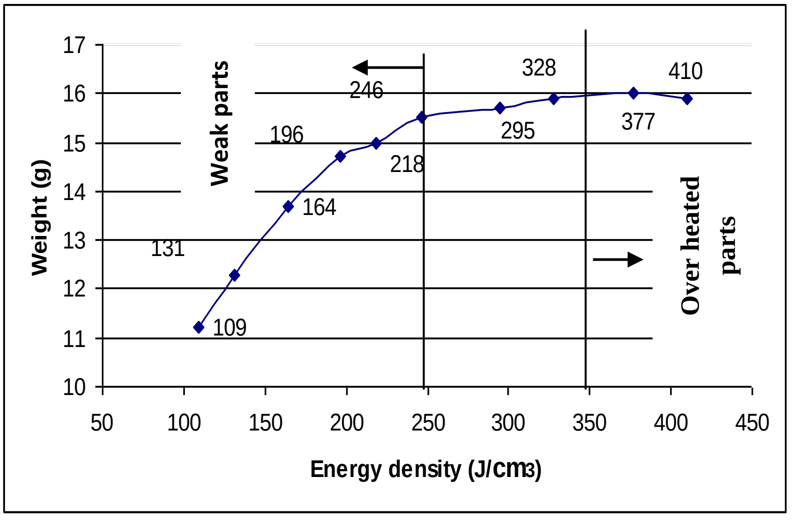

Figure 10. The range of energy density for layer thickness 0.12mm.

7.2 Taguchi method

Taguchi method is used in this work as a powerful tool to run the experiments and to eliminate the number of experiments as the process is affected by number of parameters. In classical methods of experimental planning (factorial design, fraction factorial design) a large number of experiments have to be carried out as number of the process parameters increases, which is difficult and time consuming and results in higher cost. To solve this difficulty Taguchi planned an experimental arrangement in terms of orthogonal array which gives different combinations of parameters and their levels for each experiment [28].

8.0 Fabrication of the benchmark part on LS machine

Six parts were fabricated as shown in the build chamber in Fig 11. The material used of Polyamide PA3200 glass beads was old exposed to 28 hours exposure time 26 MFR, 74 hours 21MFR, 114hours 19MFR, 144hours 15MFR, and a mixture of recycled and new PA3200 powder was in the ratio of (70:30) %.

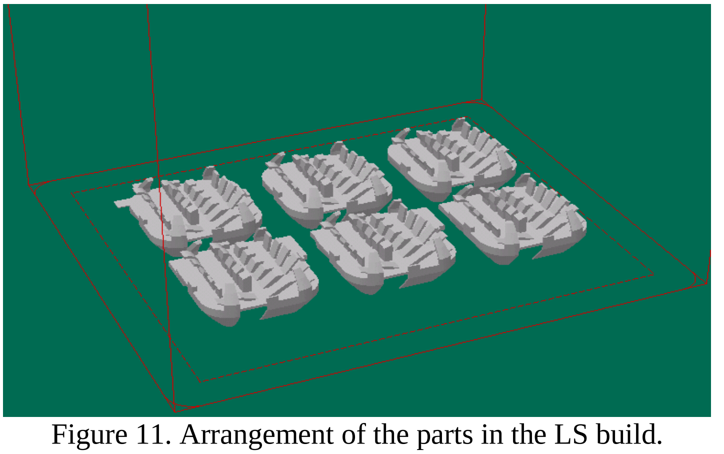

Figure 11. Arrangement of the parts in the LS build.

8.1 Powder deployment

The SL process can be generally described in four steps:

- Run a build
- Break out the parts, segregating the unsintered powder that can be easily broken up as 'used' powder.
- Sift the used powder in a vibratory sifter.
- Blend in a weight percentage of virgin powder and old [21].

Powder management and blending is a key part of the LS process as powder used in LS process is too expensive comparing with other processes. When the amount of virgin powder is too high, costs of the parts may increase in contrast to small amount of virgin powder as the details and function of the part will not satisfy. In this work five runs each with six parts were evaluated after break out the parts and unsintered powder sift and its deployment depends on their exposure time, properties and its quality. The height of the benchmark was 38 mm and the total weight of every build was 4.6 kg. The five runs showed that about half of the remained powder (%) through away during the process for instance build run number 2 remained powder was approximately 63% and powder discarded during cleaning in this run was approximately 30%. In general, the average deployment powder for the five builds was approximately 7.8 %, the powders have lost during process and cleaning was approximately 30% and the powder not sintered and could be recycled for once build approximately 63.5%.

9.0 Discussion

9.1 The effects of PA3200 powder grades on the quality of powder

The effect of PA3200 powder grades on the quality of powder with the default parameters can be better clarified by observing the MFR values against the powder time heating. The aim of these experiments is to realize and find out significance refresh rate and minimum level of MFR required to determine good surface finish without orange peel appearance on the parts. The data of samples were taken from five different samples 30, 26, 21, 19 and 15MFR; respectively. The results of the experiments are shown in Figs 12, 13, and 14. For instance the powder 30MFR produced a good quality surface and a lesser amount of deteriorated as show in Fig 12. It can also be seen from the part produced by 26 MFR powder was signed orange peel texture and 21, 19 and 15 MFR used as well to evaluate the quality of powder and the results clarified the fabricated parts were not strong and more whiter.

According to data presented in Table 1, it can be seen the quality of the powder consistency, samples from B1 to B4 grads have higher values of MFR more than 30MFR this lead to unwanted to refresh these groups of grads, the purposed of this experiments are to investigate the grads of powder less than 30MFR B5, B6 and C to improve the quality of powder and to evade the orange peel texture appearance. The samples B5, B6 and C grads were mixed with virgin powder (Grade A) in diverse ratio from 40% to 70% virgin powder. The quality of powder tested using MFR test and the average of these measuring was taken and the results were recorded. The results in Figure 15 report the effect of grades and on the quality of these powders, it can seen from the Fig.13 grade

B5 (26MFR) were blended with different ratios of virgin powder. 40% virgin powder blended with B5 grade still under the mean line 30MFR recorded as grade B5this powder can not be used once more. By increasing the ratio of virgin powder (50%, 60% and 70%) the mixed powder is improved, undergoes above mean line 30MFR above grade B4 and can be reused in the LS process.

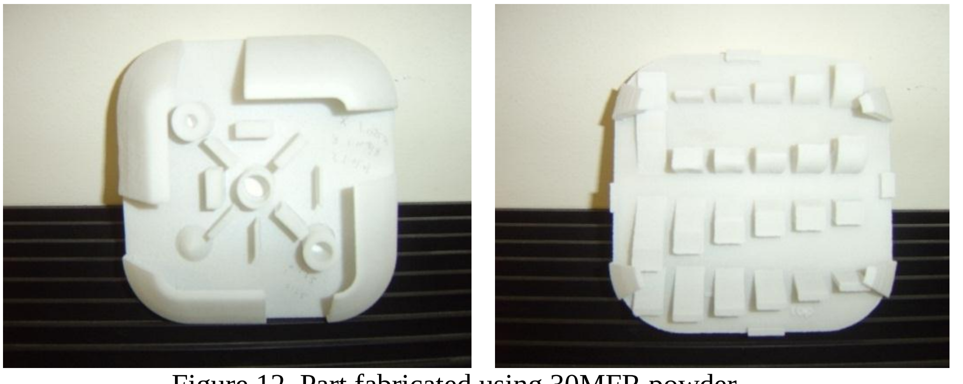

Figure 12. Part fabricated using 30MFR powder.

Figure 13. Orange peel texture for the part fabricated using 26 MFR powder.

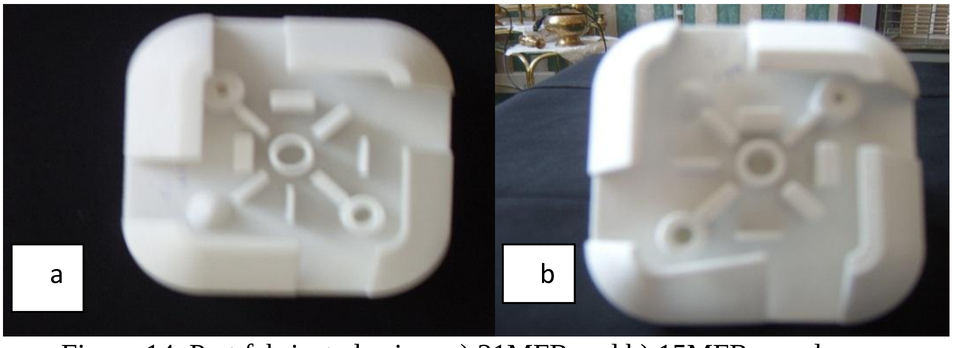

Figure 14. Part fabricated using: a) 21MFR and b) 15MFR powders.

Grade B6 in this case the powder improved when blended with 60% and 70% virgin powder and the quality of the powder undergoes above mean line and recorded as grade B5. 19MFR grade C can be improved just with 70% virgin powder and quality of powder was 30MFR. it is evidence that the quality of 26 MFR glass filled powder can be improved with 50, 60 and 70% virgin powder. 60% virgin powder must be blended with 21 MFR and more. In case of 19MFR the experiments showed slightly improvement in the quality of powder with all the ratios. For instance 70% virgin powder blended with grade C has been improved but still with the same level of mean line, 50% and 60% with grade C the powder became badly and undergoes a worsening of the these powders also orange peel texture will still appearance in this case of powder.

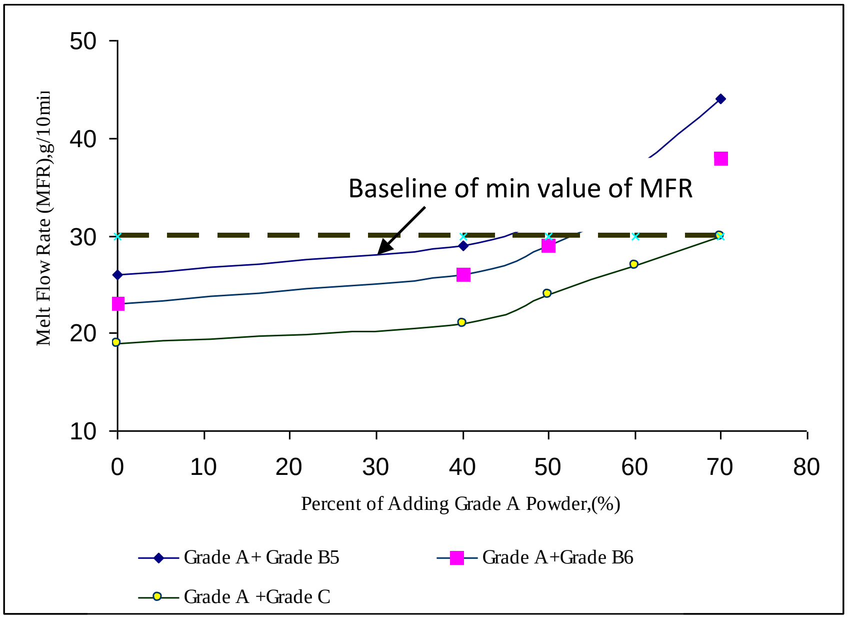

Figure 15. The MFR of B5 to B6 powder grades mixed with different Ratio of virgin powder.

9.2 The effect of laser energy density on orange peel

In order to study the orange peel phenomenon with the features of benchmark which could be signed in LS process for the test part fabricated, the range of the LS process parameters was selected. The screening test and data obtained from Eq.1 was used to calculate the energy density with parameter combination to predict the range of parameters where the values of energy density less than 180 J/cm^3 were considered weak parts and the values of energy density higher than 280 J/cm^3 were considered over heated. In general, it was found that in all experiments, the powder surrounding the features part that fabricated with the energy density higher than the upper limit 280 J/cm^3 was stuck with the features and found difficulty to remove it. The score of the quality of surface can be classified as shown in Table 4. The results of experiments of the designed benchmark are presented and discussed in terms of runs as follows:

TABLEL 4. The scoring system for evaluation of the surface quality.

No.	Score	Part quality
Orange peel texture	0	Poor
Slightly rougher and orange peel	0.5	Good
Excellent surface finishing	1	Excellent

Run No 1: In the first run, the parameters were adjusted and the part bed temperature maintained at 170 °C, with fixed layer thickness and laser speed. After the fabrication of benchmark, sand blasting alone was used to remove the unsintered loose powder around the features of benchmark parts. All the six benchmarks were examined and each feature in the benchmark evaluated carefully by touching and visual inspection.

Run No. 2: The 2nd run of the benchmark was manufactured similar to the 1st run with the part bed temperature was increased to 174 °C. As in run no. 1, in the higher energy density 328 and 295 J/cm^3 the amount of orange peel texture eliminated for all the thicknesses and small amount still appeared, and the benchmark can be accepted in case of quality surface. In contrast the details were disappeared similar as the high energy density of the run no.1. In this case of high energy density the powder inside and near the features part was difficult to remove. The fabricated part with energy density 264 J/cm^3 occurs with the acceptable range, and all features has good surface and can be accepted. For 218 J/cm^3, the orange peel can not be eliminated for 3 and 4 mm thickness and orange peel still appeared but the details of the features become clear compared with the high energy density.

Run No. 3: Unlike runs no.1 and 2, run no.3 includes changes in energy density due to change in the laser speed from default value 5080 mm/s to 4000 mm/s which is selected according to the orthogonal matrix. The combinations of parameters of fabrication was selected based on the setting of the machine where the machine can use one value of laser speed and one value of layer thickness in one layer of manufacturing process in which the tables of runs were set.

Run No. 4: Benchmark in the run 4 was manufactured similar to run 2. However, the parameters were selected during the process according to the setting of HiQ machine where layer thickness is reduced from 0.12 to 0.1mm, this combination of the parameters is shown in Table18. In this combination the higher energy density was 295 J/cm^3 and the lower one was 177 J/cm^3 which means the energy density changed due to variation of the parameter combination. It is seen that the benchmark parts improved and orange peel is eliminated in some thicknesses.

Run No.5: Benchmark in the run 5 was manufactured similar to run 4. However in this case, the parameters were also selected during the process according to the setting of HiQ machine where layer speed is reduced from 5080 mm/s to 4000 mm/s to run the process in one layer and the part bed temperature value was fixed the combinations of the parameters used in these experiments. In these combinations the highest energy density was 333 J/cm^3 and the lowest one was 187 J/cm^3 means the energy density changed due to varies of the combination and higher than the parts which fabricated with energy density in the run no.4, it can be noticed from this batch of benchmark parts, the quality surface of all thicknesses are improved.

Run No.6: Based on the method implemented in the previous runs, the orange peel was eliminated and in some parts still signing. In the following run the part bed temperature is increased from 174 °C to 176 °C to explore the affect of this factor on the quality of surface. The combinations of parameters were selected based onto the best batch run which was found run no. 6. It can be concluded that the part bed temperature highly influences the quality of surface (orange peel texture).

Run No.7: The benchmark in this run was fabricated from more old powder specified by 74 hours, 21 MFR and mixed before used with ratio (70:30) using the default laser speed 5080 mm/s, layer thickness 0.1 mm, part bed temperature 174 °C and vary laser power and scan spacing. The results showed the parts have rough surface and little bit orange peel signed in the thickness 4mm.

Run No.8: In the following experiments the benchmark has been fabricated from more old powder specified by 114 hours, 19 MFR and mixed before used with ratio (70:30) using the same combination which are used in the run no.7. The results and the observation noticed no change in the results owing to the melt flow rate 19 and 21 MFR which was fairly close.

Run No.9: In the following experiments the benchmark has been fabricated from more old powder specify by 144 hours, 15 MFR and mixed before used with ratio (70:30) using the same combination which are used in the run no.7. The results and the observation noticed all parts in this batch weak companied with change in the colour of the parts to the white. From these experiments it can be concluded the powder 144 with 15 MFR is deteriorated and must be discard as shown in Figs 16.

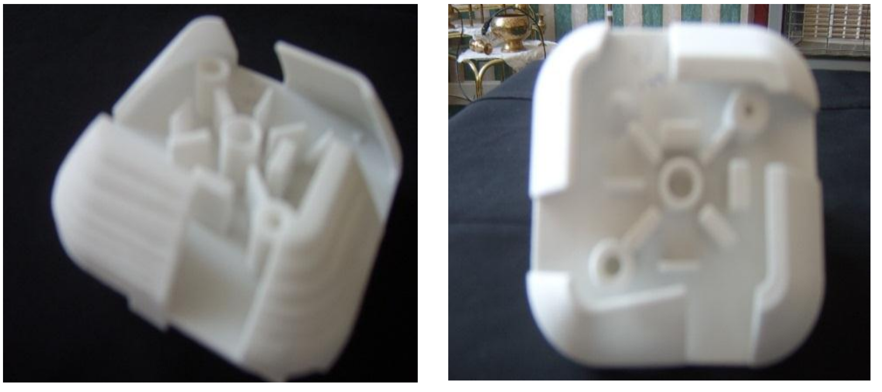

Figure 16. Orange peel texture for the part fabricated using old powder 144 hours.

9.5 Optimal processing parameter combination development

The limits of the parameters that were used for experiments of glass filled PA 3200 EOS; 28 hours exposure time and 26MFR in order to determine the optimal processing parameters, after the processing parameter window was then expanded to the high part bed temperature of 176 °C. The produced parts were examined by visual inspection and touching, which showed that all the benchmark has been improved and the orange peel disappeared and newly deposited powder layers were smooth and continuous using the combination parameter in the run 6. The part fabricated by combination parameters laser power15 Watt , scan spacing 0.15, laser speed 4000 mm/s, layer thickness 0.1mm and part bed temperature 176 °C was the best combination for this powder 28 hour exposure time 26 MFR as shown in Figure 17. At the substrate temperature with the highest energy density, the powder in the part build area began to cake severely and at the same temperature with the lower limit of energy density, the powder surrounding the part was more easily to remove.

Figure 17. Orange peel texture for the part fabricated using optimum parameters.

10. Conclusion

In this work, a HiQ sintersation 2000 machine was used for conducting experiments on old PA3200 EOS glass filled powder in case of orange peel phenomenon. The improvement for the quality of the powder by blend different ratio of old with new powder, and the surface quality of the parts was considered. It was evidence from the experiments the quality of 26 MFR glass filled powder can be improved with 50, 60 and 70% of virgin powder. A 60% virgin powder must be blended with 23 MFR and more. In case of 19MFR the experiments showed slightly improvement in the quality of powder with all the ratios. It was shown that an evidence of density parts processed in LS was influenced by the layer thickness and laser speed, as density of parts decreased with increasing of this factor.

The optimal processing parameters for selective laser sintering of the old powder 28 hours exposure time and 26MFR were determined by a systematic design of experiments which indicates that all the benchmark has been improved and the orange peel was disappeared, and the newly deposited powder layers were smooth and continuous using the combination parameter in the run 6. The part fabricated by combination parameters laser power15 Watt, scan spacing 0.15, laser speed 4000 mm/s, layer thickness 0.1mm and part bed temperature 176 °C was the best combination for this powder 28 hour exposure time 26 MFR. It can be concluded that the effect of laser power and layer thickness are largest and laser speed and scan spacing are smallest. Thus, the laser power, layer thickness and the part bed temperature are more critical than the others for achieving high surface quality that results in no orange peel occur.

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Speech Recognition Development using Magnitude-Squared Coherence (MSC).

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الملخص:

في السنوات الاخيرة بدأ الاهتمام بشكل كبير من قبل عدة مؤسسات و هيئات علمية عالمية بالبحث عن تطوير سبل تخاطب البشر مع الآلات و مر الباحثون في هذه المؤسسات بعدة محاولات باءت معظمها بالفشل و البعض الأخر ببعض النجاح ولو بشكل جزئي حيث تم تحقيق نتائج مرضية الى حد ما استفاد منها غيرهم من الباحثين للوصول الى مرحلة متقدمة من فهم الالة للإنسان و لو بشكل بسيط يتمثل في تنفيذ اوامر معينة. لذا و من هذا المنطلق رأينا أن نعرض في هذه الورقة ما توصلنا اليه من نتائج حول كيفية تمييز الالة لصوت بشري معين عن طريق مقارنة الطيف الترددي لذلك الصوت مع المكونات الترددية لأطياف الصوت المخزن في ذاكرة تلك الألة باستخدام دالة الاتصال التربيعي (The Magnitude-Squared Coherence) و بناء على ذلك التمييز يحدث استجابة من قبل الألة للأمر الصوتي.

الكلمات المفتاحية :التمييز ,مخاطبة الألة , الطيف الترددي.

Abstract:

In recent years, a great deal of attention has been paid by several international scientific institutions and organizations to search for the development of human communication to machines

(*machine learning*). Researchers in these institutions have gone through many attempts which most of them failed and others partially succeeded in some way that made other researchers to reach the stage of understanding the machine to human voice even if few command words to implement simple orders. Therefore, our propose in this paper is figuring out findings on machine recognition for a particular human voice by comparing the frequency spectrum of that voice with the frequency spectrum components of the voice stored in the memory of that machine using the magnitude-squared coherence function . Accordingly, a reaction is made by the machine to that command word.

Keywords: recognition, machine learning, frequency spectrum.

I. Introduction:

The frequency domain of the signal is the easiest way to process any signal, so conversion to the frequency domain has been made to facilitate handling it by using Fourier Transform, which helps study the frequency components of that signal, where many studies in this area have shown that the ratio of matching among frequency components of human voices is up to 75%, So it is made as a standard reference threshold to make sure for the matching process.

"Since frequency domain contains exactly the same information as the time domain, just in different form, so by knowing one domain, it's possible to calculate the other. Given the time domain signal, the processing for finding the frequency domain is called *decomposition analysis*; the forward *Discrete Fourier Transform (DFT)*. While the number of samples in the time domain is usually represented by some variable N (which is the number of samples in the message signal) can be a positive integer to the power of two chosen, i.e 128, 256, 512, 1024, etc. there are two reasons for this, the first one, digital data storage uses binary addressing, and the second, the most efficient algorithm for calculating the DFT usually operates with N that is a power of two. Typically, N is selected between 32 and 4096.Some way of calculating the DFT for any signal is called *convolution*. This is based on detecting a known wave form in another signal [1] ".

"Convolution is a formal mathematical operation just as multiplication, adding , and integration. It takes two signals to produce another signal so, convolution is used to describe the relationship between tree signals of interest: the input signal (the recorded), impulse response (the filter impulse response), and the output signal (the filtered signal).

Computer generation and recognition of speech are formidable problems; many approaches have been tried with only middle success. This is the active area of DSP research where we've been trying to figure out how to build speech synthesis and recognition system. Nearly all techniques synthesis and recognition are based on the model of human speech production which mostly contains sounds that can be classified as either *voiced* or *fricative*. Voiced sounds occur when air is forced from lungs, through the vocal cords, and out of the mouth and\or nose. This vocal cords vibrate at frequencies between 50 and 1000 Hz resulting in periodic puffs of air being injected into the throat. Since vowels are an example of voiced sounds combined with some other fricative. Propagation through this structure is a linear process that can be filtered by a linear filter with appropriately chosen impulse response. In most cases, a finite impulse response is used in this model, with the recursion coefficients specifying the filter's characteristics.

Getting a high-quality voice in terms of purity and not being affected by the jamming factors during recording is very important for the machine for recognition, so it is necessary to filter this signal using frequency response filters through which we get rid of the unwanted reciprocating components. Speech recognition algorithms take this matter a step further by trying to recognize patterns in some execrated parameters. This typically involves comparing the segment information with templates of previously stored voiced sounds in an attempt to identify the speaker voice [2]"

Most speech recognition algorithms rely on only the sound of the individual word, so they attempt to recognize the word, but not understanding it. We have tried in the process of comparing similarity between similar frequency spectrums for both instantly recorded and filtered stored voice as a template in the device using Matlab as shown in Fig(4) (the Recorded Signal in Time Domain) and Fig(5) which shows the Recorded Signal (Filtered using FIR filter) (where the word is created by recording a speech segment by the user " the word is (Hello) in Arabic (Marhaban)". Then the recorded speech samples are stored into .wav format in Matlab to get the best results by butting a mechanism for showing this similarity using the Magnitude-Squared Coherence (MSC).

The development of our speech recognition process system is divided in four stages. Fig(1) illustrates Speech recognition process system ,the first is filtering stage , estimating the power spectral density, using the magnitude-squared coherence and the recognizing stage where feature detection can be implemented by *correlation and limited threshold*:

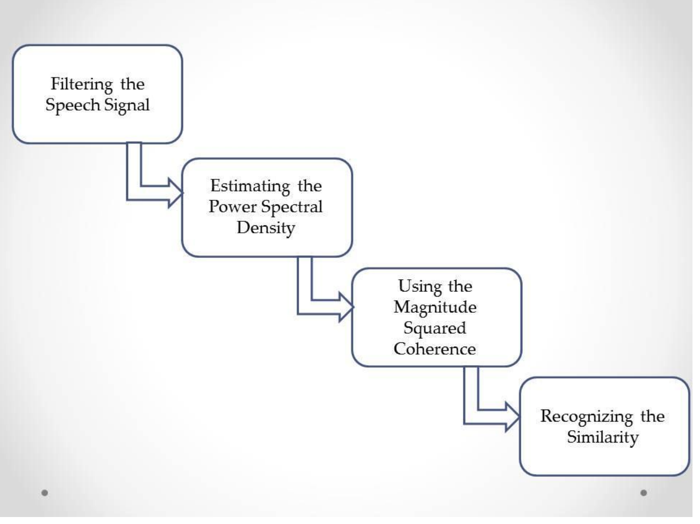


Fig (1): Speech recognition process system.

II. Filtering the Speech Signal:

"The purpose of obtaining a pure, uninterrupted speech voice is for the machine to compare it with the previously recorded voice in the device's memory. The process of selecting filters which pass only the desired frequencies, made us in need to study the human frequency component accurately, so that we came up with how to design filters for specific frequencies in a range of human voice of frequency ranging from approximately 85 to 185 Hz.

In the design of frequency-selective filters, the desired filter characteristics are specified in frequency domain in terms of the desired magnitude and phase response of the filter. In the filter design process, the coefficients of casual Finite Impulse Response (FIR) must be determined closely to approximate the desired frequency response specifications. However, as a general rule, a (FIR) filter has high side-lobes in a stop-band than an Infinite impulse Response (IIR) filter having the same number of parameters.

- **Characteristics of Practical Frequency-Selective Filters:**
  Casualty implies that the frequency response characteristic $H(f)$ of the filter cannot be zero except at a finite set of points in the frequency range (*the same condition needed for our implementation*) also $H(f)$ cannot have an infinitive sharp cut-off from pass-band to stop-band so, $H(f)$ cannot drop from unity to zero abruptly.
  The transition of the frequency response from pass-band to stop-band defines the range of frequencies allowed to pass through this filter (*also known as Transition Band*) is illustrated in Fig(2) (magnitude characteristic of physically realizable filters) . The band-edge frequency ω_p defines the edge of the pass-band while the frequency ω_s denotes the beginning of the stop-band [6] ":

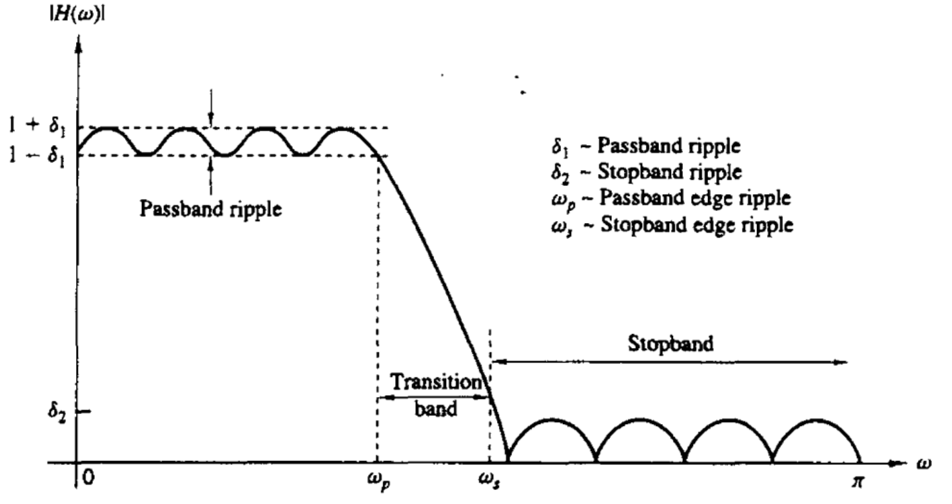


Fig (2): magnitude characteristic of physically realizable filters.

Since:

$$H(\omega) = \frac{\sum_{k=0}^{M} b_k \, e^{-i\omega k}}{1+\sum_{k=0}^{N} a_k \, e^{-i\omega k}} \qquad (1)$$

In any filter design, we must specify the following:

1. The maximum tolerable pass-band ripple (δ_1).
2. The maximum tolerable stop-band ripple (δ_2).
3. The pass-band edge frequency (ω_p).
4. The stop-band edge frequency (ω_s).

The parameters a_k , b_k , M and N are selected according to the input signal and output of the filter.

After designing a FIR filter using Matlab, the impulse response is showed in the Fig(3) (the impulse response for the designed FIR filter (Matlab R2016a)) :

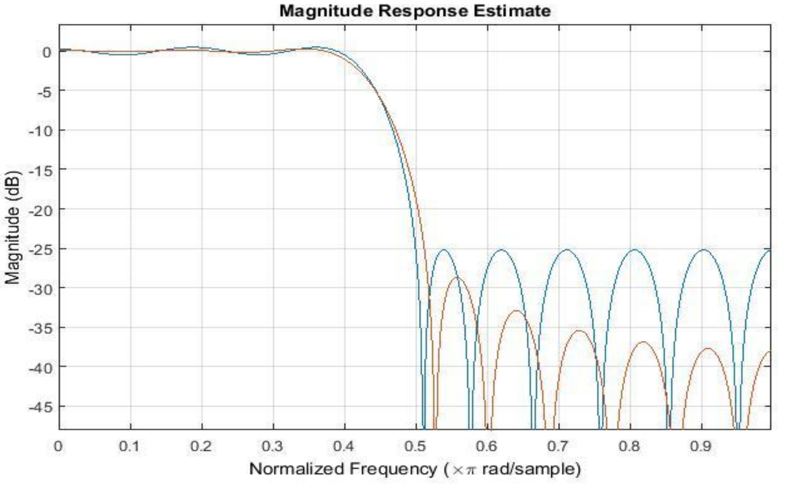
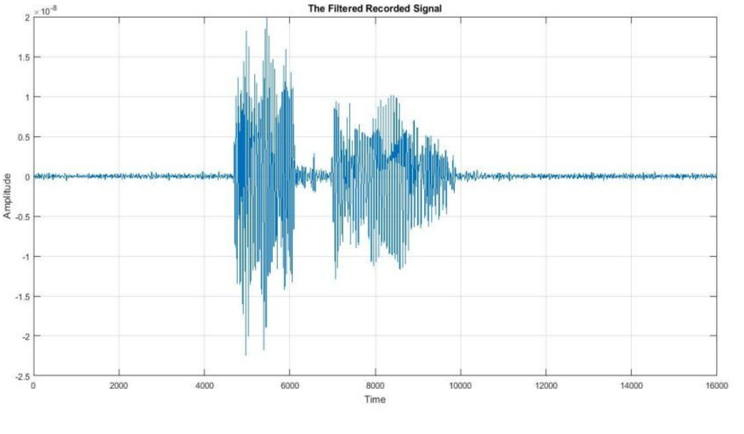
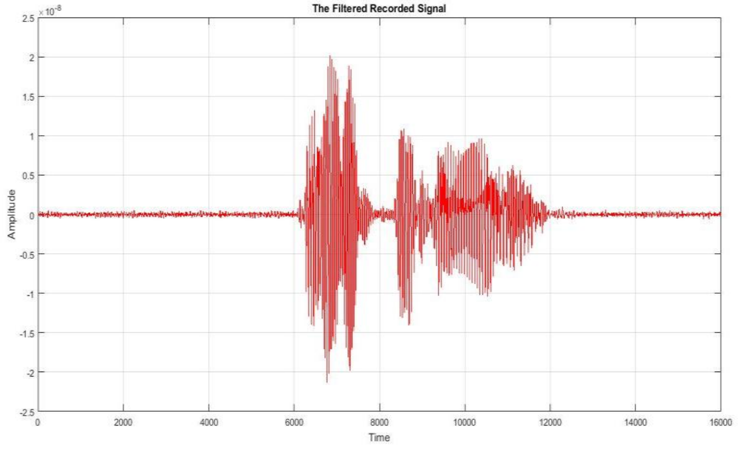


Fig (3): the impulse response for the designed FIR filter (Matlab R2016a).



Fig(4): the Recorded Signal in Time Domain.



Fig(5): the Recorded Signal (Filtered using FIR filter).

III. The Power Spectral Density Estimation Discrete Fourier Transform (DFT):

"The power spectral density (or simply power spectrum) of a random signal can be estimated using the DFT. There are two basic approaches: the first is called *periodogram* analysis and the second is an indirect approach based on the autocorrelation sequence. While computing the DFT of a signal is generally easy (requiring no more than the execution of a simple program such " *periodogram*") the interpretation of these computations can be difficult because the DFT only provides a complete representation of finite-duration signals.

It is not in general possible to compute the discrete-time Fourier transform of a signal because this would require an infinite number of operations. However, it is always possible to compute a finite number of frequency samples of the DTFT in the hope that, if the spacing between samples is sufficiently small, this will provide a good representation of the spectrum. Simple results are obtained by sampling in frequency at regular intervals. Therefore, defined the N-point discrete Fourier transform $x[k]$ of a signal $x[n]$ as samples of its transform $X(f)$ taken at intervals of $1/N$:

$$X[k] \triangleq X\left[\frac{k}{N}\right] = \sum_{n=-\infty}^{\infty} x[n]\, e^{-i2\pi kn/N} \text{ for } 0 \leq k \leq N-1 \qquad (1)$$

Because $X(f)$ is periodic with period 1, $x[k]$ is periodic with period N, which justifies only considering the values of $x[k]$ over the interval $[0, N - 1]$ [7] ".

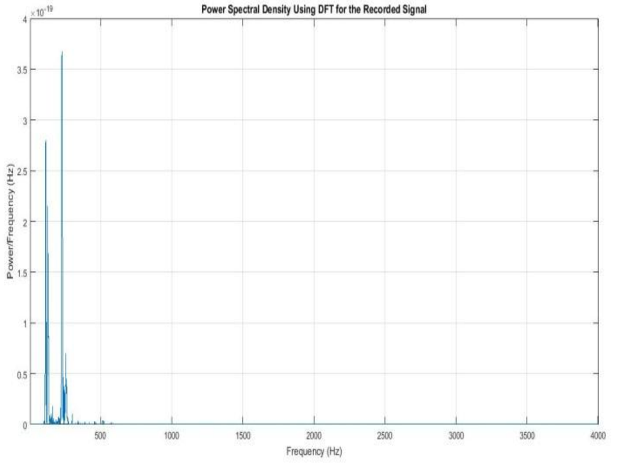
Rhetorically, by applying $x_1[k]$ as a filtered recorded speech signal and $x_2[k]$ as a filtered stored speech signal on Matlab:

$$X_1[f] = \sum_{k=-\infty}^{\infty} x_1[k]\, \delta\left(f - \frac{k}{N}\right) \qquad (2)$$

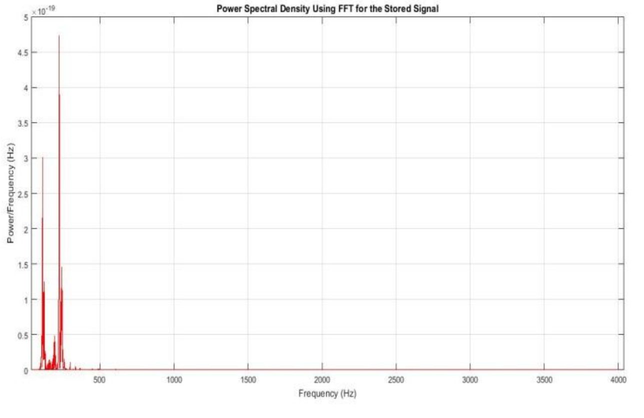
$$X_2[f] = \sum_{k=-\infty}^{\infty} x_2[k]\, \delta\left(f - \frac{k}{N}\right) \qquad (3)$$

The preceding results show that a linear estimation can be realized by means of the DFT provided where the two signals to be convolved must have finite durations. In many applications, however،one needs to convolve a relatively short unit sample response (say a few tens to a few hundred points) with a signal of indefinite duration.

After applying DFT on both signals for estimating the power spectral density as shown in Fig(6) the Power Spectral Density using DFT for the Recorded Signal and Fig(7) the Power Spectral Density using DFT for the Stored Signal, in such cases, the method outlined above may no longer be applicable because the signals $x_1[k]$ & $x_2[k]$ might be too long to fit in the computer memory.



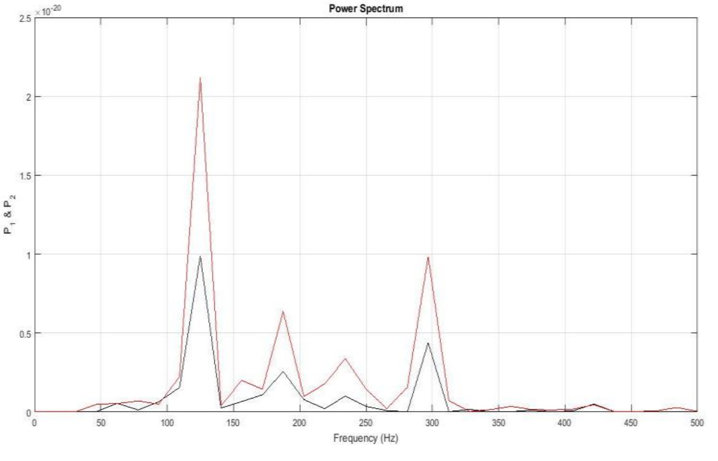
Fig(6): the Power Spectral Density using DFT for the Recorded Signal.



Fig(7): the Power Spectral Density using DFT for the Stored Signal.

By applying periodgram for both spectrums as in Fig(8), it's noticeable that there are similarities between the frequencies representing spectrums which contains hundreds of components needed to be compared.

Even if sufficient memory were available, computational times might be too long depending on the computer properties, and inaccuracies resulting from finite-precision arithmetic might be too great to make the DFT method useful.



Fig(8): Periodgram for both spectrums.

IV. The Magnitude-Squared Coherence (MSC) :

"The coherence function is a frequency domain scaling of the "similarity" of two functions or signals. Basically, it is a correlation coefficient against frequency, although the equivalence should not be followed in any strict sense. The correlation coefficient is a normalized covariance, while the coherence function is a normalized cross-power spectrum. The correlation coefficient is a scalar measure of the similarity of the overall shapes of two functions; the coherence function is a vector measure of the similarity in frequency content of two signals. For two identical signals, the correlation coefficient is harmony and the coherence function is unity. Two random uncorrelated signals yield a correlation coefficient and coherence function of zero. However, unlike the coherence function, the correlation coefficient is sensitive to phase. Two sinusoids at the same frequency have a correlation coefficient that varies from -1 to +1 as the relative phase of the sinusoids varies from zero to π. but, the coherence function is insensitive to phase and it is amplitude normalized, but the coherence is sensitive to uncorrelated noise and system nonlinearities because both introduce disparities between the two signal spectra. Within a frequency band, coherence is reduced by additive noise that is uncorrelated in the two signals, and thus it can be a useful vector measure of signal-to-noise ratio. For example, the coherence of input and output of a linear system can show the frequency bands where signal-to-noise ratio is sufficiently high for useful calculations in system identification [3]".

The frequency convolution theorem states that the multiplication of two functions in time domain is equivalent to convolution of their spectra in frequency domain. Mathematically, if:

$x_1[n] \leftrightarrow X_1[f]$ and $x_2[n] \leftrightarrow X_2[f]$ (by applying DFT) (4)

$$x_1(n)x_2(n) \leftrightarrow \frac{1}{2\pi}\{X_1[f] * X_2[f]\} \text{ (Convolution)} \tag{5}$$

Then $F[x_1(n)\, x_2(n)] = X_1(f) * X_2(f)$ (6)

And here for sufficiently large values of parameter N for a period of T:

$$X_1[f] = X_1\left[\frac{k}{NT}\right] = \sum_{n=-\infty}^{\infty} x_N[n]\, e^{-i2\pi kn/N} \tag{7}$$

Where x_N is a periodic summation :

$$x_N[n] \triangleq \sum_{m=-\infty}^{\infty} x[n - mN] \tag{8}$$

So, evaluation for all integers, k, between 0 and N-1, the array for both signals:

$$S_{x1x2}\left(\frac{k}{NT}\right) = \left|\sum_{n=-\infty}^{\infty} x_N[n]\, e^{-i2\pi kn/N}\right|^2 \tag{9}$$

So ,$S_{x1x1}(f) = S_{x1x1}\left(\frac{k}{NT}\right) = \sum_{n=-\infty}^{\infty} x_N[n]\, e^{-i2\pi kn/N}$ (10)

And $S_{x2x2}(f) = S_{x2x2}\left(\frac{k}{NT}\right) = \sum_{n=-\infty}^{\infty} x_N[n]\, e^{-i2\pi kn/N}$ (11)

The coherence function of two signals x1[t] and x2[t] is defined by:

$$C^2_{x1x2} = \frac{|S_{x1x2}(f)|^2}{S_{x1x1}(f).S_{x2x2}(f)} \tag{12}$$

The coherence function can also be expressed in terms of the system transfer function. In general, the transfer function is:

$$H[f] = \frac{X_1[f]}{X_2[f]} \qquad (13)$$

By multiplying numerator and denominator by the complex conjugate of X[f], Equation (13) becomes:

$$H[f] = \frac{X_1[f].X_1[f]^*}{X_2[f].X_1[f]^*} = \frac{S_{x1x1}(f)}{S_{x1x2}(f)} \qquad (14)$$

The squared magnitude of the transfer function is:

$$|H[f]|^2 = \left|\frac{X_1[f].X_1[f]^*}{X_2[f].X_1[f]^*}\right|^2 = \frac{|S_{x1x1}(f)|^2}{\left(S_{x1x2}(f)\right)^2} \qquad (15)$$

This method is based on the discrete Fourier transform representation of a finite-duration discrete-time series and has the advantage that can be applied to a relatively shorter discrete-time series than that required by nonlinear dynamical methods.

The estimated the coherence function as given by:

$$MSC(f) = \frac{S_{x1x2}\left(\frac{k}{NT}\right)}{X_1\left[\frac{k}{NT}\right].X_2\left[\frac{k}{NT}\right]} = \frac{S_{x1x2}(f)}{X_1[f].X_2[f]}$$
(16)

They defined the magnitude-squared coherence (MSC) as a frequency domain measure of the phase consistency between two signals, x1[n] and x2[n], as given by:

$$MSC_{x1x2}(f) = \frac{|S_{x1x2}(f)|^2}{S_{x1x1}(f).\,S_{x2x2}(f)} \qquad (17)$$

"MSC is dimensionless and can vary from 0 to 1. A MSC value of 1 at some frequency would indicate a linear relationship or perfect coherence between the two signals at that frequency, while a value of 0 would indicate no relationship or perfect incoherence between the two signals at that frequency. MSC is sensitive to noise and interference, whereas uncorrelated noise in either of the two signals decreases MSC, and correlated interference increases MSC [4] ".

Based on this information, and by calculating the matching ratio using MSC (in threshold of 85 %) for plotting coherence ratio for the chosen threshold in Fig (9) (Coherence ratio showing chosen threshold) for proportion of ability to highlight the desired voice by the computer.

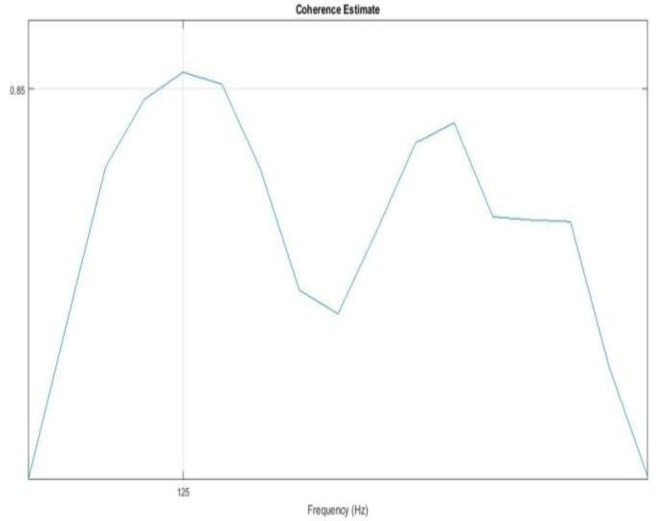


Fig (9): Coherence ratio showing chosen threshold.

In this research, several experiments were conducted to compare the voice of a specific person with his recorded voice in the first fifteen attempts and other attempts assisted by other fifteen people to compare their voices with the recorded voice. The table (1) showing these attempts and the matching ratio:

Table (1): Number of attempts and the matching ratio

Number of attempts and the matching ratio			
Attempt No.	MSC ratio %	Attempt No.	MSC ratio %
1	75	16	28
2	74	17	44
3	71	18	25
4	72	19	5
5	81	20	12
6	79	21	27
7	76	22	58
8	77	23	14
9	72	24	10
10	75	25	23
11	73	26	8
12	84	27	21
13	80	28	40
14	70	29	12
15	73	30	34

Here is a chart in Fig (10): the relationship between the number of attempts and the ratio of matching to the recorded voice. This chart is showing the relationship between the number of attempts made by the person whose the computer is trying to recognize his voice (with the same pronunciation) and the ratio of matching to the recorded voice:

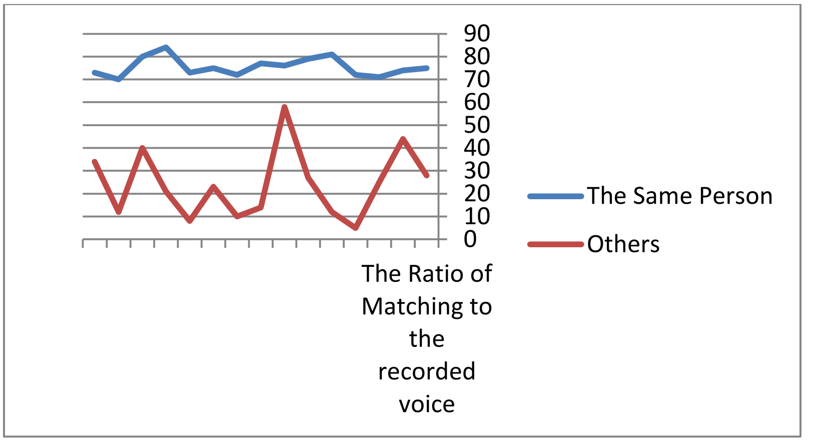


Fig (10): the relationship between the number of attempts and the ratio of matching to the recorded voice.

It is noted in the previous figure that there is a difference in the level of ratios because the ratios of the first person is between 70 and 85% while other people, the ratios do not correspond at the best to 50%.

V. The Conclusion:

As a result of what has been achieved, it can be said that the process of recognizing the machine to a certain human voice (by uttering a certain word) has been in some way successful. Despite the different methods had made by researchers in this field (voice recognition), almost all methods reached a certain level of success. The method we used (using MSC) as a function to calculate the rate of similarity and convergence between frequency spectra of different voices may be more efficient in terms of work mechanism . Using MATLAB placed a given value for each frequency in the spectrum as an element within a matrix that is compared to elements in other matrices for reaching the best matching between the two matrices. And through our study of this process, we found that increasing in the number of matching frequency spectrums with each other as the proportion of similarity, the ability of the device to distinguish between these voices reduces. Depending on this, We determined a certain number of spectrums that must match, (our choice was three different frequencies), one of them is the most required voice frequency. This is the basis on which we relied on the threshold of the matching ratio. We also found that if the word spoken by the same person whose voice was previously recorded differs from the word to match, this function gives us a ratio of less than the required ratio, but at the same time, this ratio is higher than the matching ratio if it matches the voices of others.

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The relationship between HbA_{1C} and hypertension in newly & old type-II diabetes mellitus

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الملخص:

الهدف: ارتفاع ضغط الدم وداء السكري من الأمراض التي ترتبط مع بعضها بشكل وثيق. هناك أبحاث تدرس العلاقة بين ضغط الدم (BP) ومستوى الهيموجلوبين السكري (HbA1c) المصابين حديثًا والمصابين من فترة زمنية طويلة بمرض السكري. كان الهدف من الدراسة الحالية هو التحقيق في الإرتباط بين إرتفاع BP ومستوى HbA1c .

المواد وطريقة التحليل :

تم اختيار 48 مريضا بالسكري في (مركز السكري والغدد الصم طرابلس – ليبيا) .تم قياس ضغط الدم باستخدام مقياس ضغط الدم الزئبقي ، وتم قياس مصل الدم HbA1c والدهون بالطريقة الأنزيمية. COBAS INTEGRA تم قياس HbA1c بواسطة COBAS INTEGRA immunoturbidimetrically تم استخدام تحليل الارتباط (بيرسون) لاستكشاف العلاقة بين ارتفاع ضغط الدم وارتفاع السكر في الدم .تم تحليل عوامل الخطر المستقلة ل BP الانقباضي والانبساطي باستخدام الارتباط.

النتائج:

عينات HbA1c المصابين حديثًا من النوع الثاني من داء السكري كان عددها (ن = 24) و المصابين من فترة زمنية طويلة بمرض السكري (ن = 24) ، مقارنةً بعينات HbA1c الاصحاء (ن = 24) .كان هناك ارتباط كبير بين الهيموغلوبين السكري (HbA1c)وضغط الدم الانقباضي ,(r=0.308*, P=0.033) (SBP)
ضغط الدم الانبساطي ,(r=0.137, P=0.353) (DBP)، ولكن كانت هناك علاقات معنوية قوية بين الهيموغلوبين السكري (HbA1c) وضغط الدم الانقباضي (SBP) (r=0.607**, P=0.001),
ضغط الدم الانبساطي ,(r=0.203, P=0.166) (DBP) كان لديه خطر كبير أكبر لارتفاع ضغط الدم ، على التوالي .وكشف تحليل الارتباط كان HbA1c عاملا مستقلا من BP الانقباضي والانبساطي.

الاستنتاجات: في الدراسة الموجودة بين أيدينا العلاقة بين ارتفاع السكر في الدم وارتفاع ضغط الدم في مرض السكري من النوع الثاني، تشير النتائج التي توصلنا إليها إلى أن ارتفاع السكر في الدم وكذلك ارتفاع HbA1c ضمن نطاق السكري المصابين من فترة زمنية طويلة بمرض السكري يرتبط بارتفاع معدل انتشار ارتفاع ضغط الدم بغض النظر عن مخاطر القلب والأوعية الدموية الأخرى.

Abstract

Objective: Hypertension and diabetes are closely related morbidities. There is a researches examining the relationship between blood pressure (BP) and HbA_{1c} level newly and among older diabetes mellitus. The objective of the current study was to investigate the association of high BP and HbA_{1c} level.

Materials and methods: A cross-sectional study, 48 diabetic patients in (Diabetes & Endocrinology Center Tripoli – Libya) were chosen. Blood pressure was measured using a mercury sphygmomanometer, Serum HbA_{1c} and Lipids were measured by enzymatic method COBAS INTEGRA. HbA_{1c} was measured by immunoturbidimetrically COBAS INTEGRA. Correlation (Pearson) analysis was used to explore the association between hypertension and hyperglycemia. Independent risk factors for systolic and diastolic BP were analyzed using correlation.

Results: Subjects in HbA_{1c} group newly type-II diabetes mellitus (n = 24) and old type-II diabetes mellitus (n = 24), as compared with normal HbA_{1c} (n = 24). There was significant correlation between glycated haemoglobin (HbA_{1c}) and Systolic blood pressure (SBP) ($r=0.308^{*}$, P=0.033), Diastolic blood pressure (DBP) (r=0.137, P=0.353), but there were strong significant correlations between glycated haemoglobin (HbA_{1c}) and Systolic blood pressure (SBP) ($r=0.607^{**}$, P=0.001), Diastolic blood pressure (DBP) (r=0.203, P=0.166), had a significant higher risk for hypertension, respectively. correlation analysis revealed HbA_{1c} was an independent factor of systolic and diastolic BP.

Conclusions: in study present a relationship between hyperglycemia and hypertension in a type-II diabetes**,** our findings suggest that hyperglycemia as well as higher HbA_{1c} within the old type-II diabetes range is associated with a higher prevalence of hypertension independent of other cardiovascular risk.

Keywords: diabetes mellitus, glycated haemoglobin HbA_{1c},
diabetes, hypertension.

Introduction

Hypertension (HTN or HT), also known as high blood pressure (HBP), is a long-term medical condition in which the blood pressure in the arteries is persistently elevated.[1] High blood pressure typically does not cause symptoms.[2] Long-term high blood pressure, however, is a major risk factor for coronary artery disease, stroke, heart failure, atrial fibrillation, peripheral vascular disease, vision loss, chronic kidney disease, and dementia.[3][4][5][6]

High blood pressure is classified as either primary (essential) high blood pressure or secondary high blood pressure.[7] About 90–95% of cases are primary, defined as high blood pressure due to nonspecific lifestyle and genetic factors.[7][8] Lifestyle factors that increase the risk include excess salt in the diet, excess body weight, smoking, and alcohol use.[2][7] The remaining 5 – 10% of cases are categorized as secondary high blood pressure, defined as high blood pressure due to an identifiable cause, such as chronic kidney disease, narrowing of the kidney arteries, an endocrine disorder, or the use of birth control pills.[7]

Blood pressure is expressed by two measurements, the systolic and diastolic pressures, which are the maximum and minimum pressures, respectively.[2] For most adults, normal blood pressure at rest is within the range of 100–130 millimeters mercury (mmHg) systolic and 60–80 mmHg diastolic.[9][10] For most adults, high blood pressure is present if the resting blood pressure is persistently at or above 130/80 or 140/90 mmHg.[7][9] Different numbers apply to children.[11] Ambulatory blood pressure monitoring over a 24-hour period appears more accurate than office-based blood pressure measurement.[7][1]

Lifestyle changes and medications can lower blood pressure and decrease the risk of health complications.[12] Lifestyle changes include weight loss, physical exercise, decreased salt intake, reducing alcohol intake and a healthy diet.[7] If lifestyle changes are not sufficient then blood pressure medications are used.[12] Up to three medications can control blood pressure in 90% of people.[7] The treatment of moderately high arterial blood pressure (defined as >160/100 mmHg) with medications is associated with an improved life expectancy.[13] The effect of treatment of blood pressure between 130/80 mmHg and 160/100 mmHg is less clear, with some reviews finding benefit[9][14][15] and others finding unclear benefit.[16][17][18] High blood pressure affects between 16 and 37% of the population globally.[7] In 2010 hypertension was believed to have been a factor in 18% of all deaths (9.4 million globally).[11]

Type-II diabetes mellitus (DM) and Hypertension (HT) are among the most common chronic non-communicable diseases and multifactorial disorders affecting both developed and developing countries and occur at a higher prevalence in the older age group and result from both genetic and environmental etiological factors[19] [20].

They are the main preventable risk factors for coronary heart disease, stroke, end-stage renal failure, disability and increased health-care costs. Although DM and HT are not among the top leading causes of death, such as cancer and stroke, these two diseases draw attention from the public due to their increasing trends, while cancer and stroke are declining [21].

Epidemiological and clinical studies have shown that these diseases often cluster in individuals and in families, and are collectively known as Syndrome X [22].

The term DM describes a metabolic disorder of multiple etiologies characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion or insulin action or both. It continues to increase in numbers and significance, as changing lifestyles lead to reduced physical activity, and increased obesity [23] [24].

A patient who suffers from type-II DM has a 2 – 4 times greater risk of death from cardiovascular causes than the patient without DM. The most common cause of death in the diabetic patient is heart disease. In addition, peripheral vascular disease, end-stage renal disease, blindness and amputations are common co-morbidities in diabetic patients [25].

Similarly, HT is considered to be one of the most common causes of morbidity and mortality affecting mankind. HT is a common health problem in developed countries and a major risk factor for cardiovascular diseases (CVD) [26].

HT exhibits an iceberg phenomenon where unknown morbidity exceeds the known morbidity. The prevalence of HT is rapidly increasing in developing countries and is said to be one of the leading causes of death and disability among the elderly [27].

Its prevalence is probably on the increase in developing countries where adoption of western lifestyles and the stress of urbanization both of which are expected to increase the morbidity associated with unhealthy lifestyles unfortunately are not on the decline [26].

Genetic and environmental factors are also reported to play a key role in HT, 90% of which are better classified as idiopathic. High blood pressure in adults has a high impact on the economy and on the quality of life of individuals with important implications for resource expenditures [28].

Several studies conducted in different ethnic groups show a close association between HT and DM, where the prevalence of HT is significantly higher in the patients with non insulin-dependent DM (NIDDM or type-II DM).

Both systolic and diastolic HT has been reported, and conclusive evidence indicates that the link between DM and essential HT is hyperinsulinemia [29]. The prevalence of HT is 1.5 – 2.0 times more in those with DM than in those without DM, whereas almost one-third of the patients with HT develop DM later [30].

The presence of hypertension in diabetic patients substantially increases the risks of coronary heart disease, stroke, nephropathy and retinopathy. When HT coexists with DM, the risk of CVD is increased by 75%, which further contributes to the overall morbidity and mortality of already high risk population. Generally, HT in type-II diabetic persons clusters with other CVD risk factors such as microalbuminuria, central obesity, insulin resistance, dyslipidaemia, hypercoagulation, increased inflammation and left ventricular hypertrophy [31].

This clustering risk factor in diabetic patients ultimately results in the development of CVD, which is the major cause of premature mortality in patients with type-IIDM.

DM and HT are interrelated diseases that strongly predispose people to atherosclerotic cardiovascular disease, and hence have been referred to as “the bad companions” [32].

The objective of the present study is to determine the prevalence rate and risk factor associated with DM and HT it populations of Libya as till date very little information exist about the prevalence of DM and HT from Libya.

Material and methods

Blood samples were collected from 48 type-II diabetic patients and 24 controls. Patients and controls were matched for age. The aged

30- 84 years from diabetes and endocrinology centers in Tripoli - Libya. Fasting overnight venous blood sample (about10 ml) were drawn by the researcher himself into vacutainer plane tubes from all individuals. The blood was left for a while without anticoagulant to allow blood to clot. Then, serum samples were obtained by centrifugation at room temperature at 5000 rpm/ 5 minutes.

Determination of serum Glucose, HbA_{1c}, lipid profile by COBAS Integra 400 plus

The Roche Cobas Integra 400 plus

The Roche Cobas Integra 400 plus chemistry analyzer is used for diagnostic clinical chemistry testing. Classic chemistry, electrolytes, specific proteins, therapeutic drug monitoring, drugs of abuse, and thyroid hormone testing are consolidated into one system with one reagent cassette design.

BP Measurements: BP was measured using a mercury sphygmomanometer by an experienced physician. Subjects were in a seated position with an arm flexed at the level of the heart. After the cuff was wrapped around the upper arm with the cuff 's lower edge one inch above the antecubital fossa, the cuff was rapidly inflated to 180 mmHg, then air was released from the cuff at a rate of 3 mm/s. During this period, the physician listened carefully with a stethoscope while simultaneously observing the sphygmomanometer. The first knocking sound (Korotkoff) was the subject's systolic pressure. When the knocking sound disappeared, that was the diastolic pressure. BP was measured in either the right upper or left upper arm after each subject had been seated for at least 10 min. [39]

The arm with the higher blood pressure would be measured twice. The average was used for analysis. If the difference of SBP or DBP between the twice was over 5 mmHg, it would be measured for the third time, and then the average of three times was used for analysis. [39]
Hypertension was defined as systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg or reported receiving antihypertensive medication. [39]

Results

Total (72) subjects comprising of 24 newly diabetic, 24 old diabetic and 24 controls were included in the present study. Measurement of blood pressure and HbA_{1c}, blood glucose, lipid profile was done in all the groups. Who attended (Diabetes & Endocrinology Center Tripoli – Libya).

Table-1. Sample characteristics of group A, group B and group C.

Characteristics	Group A	Group B	Group C
N (72)	24	24	24
Age (years)	47.58 ± 12.9	56.29 ± 14.99	55.79 ± 15.22
Gender (Male/Female)	14/10	14/10	14/10

Group A: non- diabetic, Group B: newly diabetic, Group: C old diabetic

Serum analysis:

Table 2: Comparison of mean values of variables in newly & old Type-II Diabetes Mellitus (T2DM) and healthy control groups

Sl. No.	Parameter mg/dl	Group	N	Mean ±SD	t	*P*-Value
1.	FBS	Group A	24	90.77±14.25		
		Group B	24	192.20±74.32	6.56	0.001
		Group C	24	263.16±111.90	7.48	0.001
2.	HbA_{1c}	Group A	24	5.35±0.37		
		Group B	24	9.30±1.67	11.27	0.001
		Group C	24	10.33±2.0	11.44	0.001
3.	Systolic blood pressure	Group A	24	119.16±9.28		
		Group B	24	131.29±19.40	2.76	0.025
		Group C	24	140.83±18.39	5.15	0.003
4.	Diastolic blood pressure	Group A	24	77.91±7.21		
		Group B	24	83.12±13.33	1.68	0.13
		Group C	24	82.75±9.63	1.96	0.20
5.	LDL–cholesterol	Group A	24	128.13±32.14		
		Group B	24	117.16±31.67	1.19	0.68
		Group C	24	104.91±30.87	2.55	0.72
6.	Triglyceride	Group A	24	156.79±84.88		
		Group B	24	153.75±77.84	0.129	0.86
		Group C	24	117.40±55.67	1.90	0.18
7.	Cholesterol	Group A	24	182.08±29.15		
		Group B	24	181.54±33.71	0.06	0.90
		Group C	24	142.33±44.98	3.63	0.10

(Reference range of FBS =70-110 mg/dl. Reference range of HbA_{1c} = 4-6 mg/dl. Reference range of Cholesterol = 50-200mg/dl. Reference range of Triglycerides = 50-200 mg/dl. Reference range of LDL-C = 10-100 mg/dl. Group A: non- diabetic, Group B: newly diabetic, Group: C old diabetic

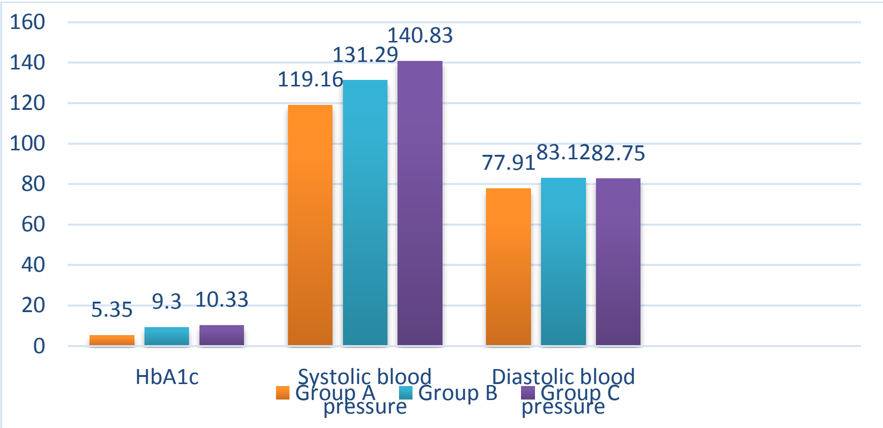

Figure 1: Comparisons of HbA_{1c} level & blood pressure in newly diabetic, old diabetic and non- diabetic

Table 3: Correlation of HbA_{1c} values with blood pressure parameters in group B and group C Type-II Diabetes Mellitus

Sl. No.	Parameter mg/dl	Group B HbA_{1c}		Group C HbA_{1c}	
		Pearson correlation(r)	*P*-value	Pearson correlation(r)	*P*-value
	Systolic blood pressure	0.308*	0.033	0.607**	0.001
	Diastolic blood pressure	0.137	0.353	0.203	0.166
	LDL-C	-0.143	0.331	-0.220	0.133
	Triglyceride	0.050	0.738	-0.269	0.065
	Cholesterol	0.040	0.789	-0.270	0.063

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

The age and gender wise distribution of the study subjects is given as shown in Table 1. They were in the age group of 30 - 84 years. The mean age of newly diabetic subjects was 56.29 ± 14.99 years, old diabetic subjects was 55.79 ± 15.22 years whereas the controls were in the age group of 30 - 84 and mean age was 47.58 ± 12.9 years. Out of 24 newly diabetic 14 were males and 10 were females, 24 old diabetics were males and 10 were females and in case of 24 controls 24 were males and 10 were females.

The blood pressure was measured separately as systolic blood pressure and diastolic blood pressure. The results of blood pressure measurement are shown in Table 2. and Figure 1. The mean systolic blood pressure (SBP) of newly diabetic subjects was 131.29 ± 19.40 mmHg, old diabetic subjects was 140.83 ± 18.39 mmHg and that of controls was 119.16 ± 9.28 mmHg. The mean systolic blood pressure was found to be higher significant in old diabetic subjects than controls ($p < 0.05$) and found to be significant in newly diabetic subjects than controls ($p<0.05$). Mean diastolic blood pressure (DBP) of newly diabetic was 83.12±13.33 mmHg, old diabetic subjects were 82.75 ± 9.63 mmHg and that of controls was 77.91 ± 7.21 mmHg. The mean diastolic blood pressure of old diabetic was not found significant than controls ($p>0.05$). and not found significant in newly diabetic subjects than controls ($p > 0.05$).

The mean HbA_{1c} in newly diabetic was 9.30 ± 1.67 %, old diabetic was 10.33 ± 2.0 % and that of among normal healthy controls was 5.35 ± 0.37 %. The mean HbA_{1c} in old diabetic was higher than newly diabetic and normal healthy controls and the difference between the three groups was found to be statistically higher significant ($p < 0.001$) in old diabetic subjects and found to be higher significant in newly diabetic subjects than controls ($p < 0.05$). The results of HbA_{1c} levels are shown in Table 2 and Figure.1.

this study showed strong significant (0.308) correlation between HbA_{1c} with Systolic blood pressure in newly type-II diabetic subjects. and The present study in old type-II diabetic subjects shows a highly positive significant (0.607) correlation of HbA_{1c} levels with Systolic blood pressure.

This study showed observed a highly positive significant correlation between HbA_{1c} and Systolic blood pressure in old type-II diabetic subjects; but, in there was week correlation between HbA_{1c} and Systolic blood pressure in newly type-II diabetic subjects.

Conclusion

The result of This case study presents a relationship between type II DM in patients with of blood pressure. There is a positive significant correlation between the levels of HbA_{1c} concentration and blood pressure of newly type-II diabetes, a highly positive significant correlation between the levels of HbA_{1c} concentration and blood pressure of old type-II diabetes individuals.

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Study the Effect of Autogeneous Semiautomatic TIG Welding Process Parameters on Mechanical Properties of AISI304L Austenitic Stainless Steel Joints Using Taguchi Method

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الملخص

يتم استخدام لحام قوس التنجستن الكهربائي – ذو الغاز الخامل ذاتي التوليف (بدون اضافة معدن حشو) في لحام مقاطع الحواف المربعة الرفيعة التي يصل سمكها إلى 2 مم ، بينما في لحام المقاطع الأكثر سمكًا (أكثر من 2 مم) يلزم تحضير الحواف وإضافة معدن حشو. تعرض هذه الورقة تأثير عوامل ومتغيرات عملية اللحام المختلفة مثل تيار اللحام وسرعة اللحام ومعدل تدفق غاز اللحام على قيمة مقاومة الشد القصوى وقيمة الصلادة للفولاذ الصلب المقاوم للصدأ الأوستنايتي ذي الدرجة 304 ل باستخدام عملية لحام قوس التنجستن الكهربائي –ذو الغاز الخامل ذاتي التوليف. تم استخدام الواح من معدن الفولاذ السابق و بسماكة 3 مم كمادة أساسية لإعداد الوصلات الملحومة بالتناكب وبشكل افقي وبخط لحام واحد فقط. كانت متغيرات الإدخال الثلاثة المختارة مختلفة عند ثلاثة مستويات. تم استخدام تصميم تاغوتشي المؤلف من ثلاثة مستويات وثلاثة متغيرات (L9) كمفهوم لتصميم التجربة. تم استخدام نسبة الإشارة إلى الضوضاء (S/N) وتحليل التباين (ANOVA) لتحديد مستويات مدى تأثير وأهمية

متغيرات الإدخال. من خلال النتائج تبين ان سرعة اللحام لها اقوى تأثير على خصائص الوصلات الملحومة. يمكن استخدام عملية لحام قوس التنجستن الكهربائي – ذو الغاز الخامل ذاتي التوليف مع الواح الفولاذ المقاوم للصدأ الأوستانيتي بسماكة 3 ملم دون أي إعداد للحافة أو إضافة معدن حشو عند استخدام غاز الأرجون كغاز للحماية.

ABSTRACT

Autogeneous TIG welding (without filler metal) is used in thin square edges section up to 2 mm, while in thicker sections (more than 2 mm) edge preparation and filler metal are needed. This paper presents the influence of different input parameters of TIG welding process like welding current, welding speed, and gas flow rate on ultimate tensile strength and micro-hardness of AISI304L austenitic stainless steel using autogeneous TIG welding process. Sheet plate of 3 mm thickness have been used as the base material for preparing single pass butt welded joints. The selected three input parameters were varied at three levels. Taguchi (L9) orthogonal array design was used as a design of experiment approach to conduct the experiments. Signal to noise (S/N) ratio and analysis of variance (ANOVA) were employed to designate the levels of significance contributions of input parameters. Welding speed has stronger effect on the output characteristics of welded joints. Autogeneous TIG welding process has validation in sheet plates of austenitic stainless steel with thickness 3 mm without any edge preparation or filler metal addition when using argon as shielding gas.

Keywords: Autogenous TIG Welding, Austenitic Stainless Steel, Mechanical Properties, Taguchi.

1. INTRODUCTION

Tungsten Inert Gas (TIG) welding, which is also known as Gas Tungsten Arc Welding (GTAW) uses a non consumable tungsten electrode and an inert gas for arc shielding to produce the weld [1]. Austenitic stainless steels form the major class of materials used in the industry today. TIG welding process is one of important process for fabrication of the various components of stainless steel in the industry whenever quality, productivity, and cost are concerned. The principle disadvantaged of TIG welding lie in the limited thickness of material which can be welded in a single pass. TIG welding parameters are the most important factors affecting the quality, productivity, and cost of welding. The input process parameters play a very significant role in determining the quality requirements. The joint quality can be defined in terms of properties such as tensile strength, micro-hardness, and many others [2]. While the productivity and the cost of welded joints are related to the welding speed factor, edge preparation, and filler metal addition needed to the welding process. Autogeneous semi-automatic TIG welding process produce a welded joints at high productivity and low cost. For proper welding and control on TIG welding parameters a semi-automatic welding setup has been developed in-house. Semi-automatic TIG machine is very easy to set up and can be customized by using conventional TIG welding equipment as shown in Figure (1).

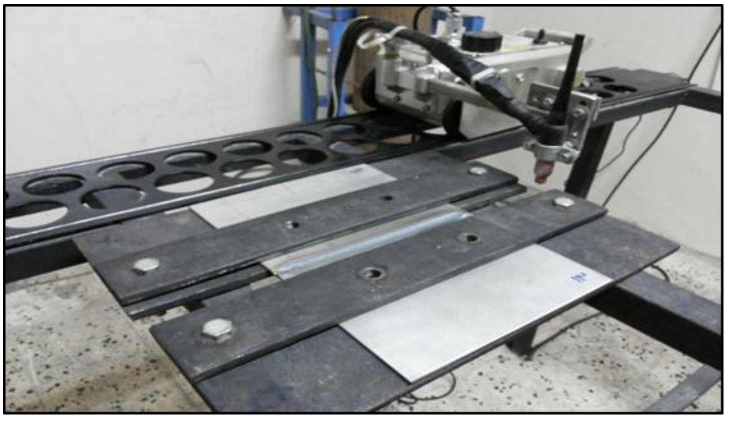

Figure (1). Experimental set-up for TIG welding

2. LITERATURE REVIEW

Many researchers have studied in the field of TIG welding process for different alloys by using conventional, semi-automatic, and full automatic TIG machine.

A.A. Shirali and K. C. Mills [3] investigated the effect of various welding parameters on the penetration of SS304 and SS316 plates with 6mm thickness using GTA welding process. From experimental results, they were concluded that weld penetration was found to decrease with increasing welding speed for low, medium, and high sulfur casts. Increased welding current was found to increase the weld penetration in high sulfur casts, but decreased penetration in low sulfur casts. Increasing linear energy (which is dependent upon both welding speed and current) was found to cause increases in penetration for low and medium sulfur casts, but had little effect on penetration in low sulfur steels. Increases in arc length were found to decrease weld penetration. This is in agreement with the observations of other workers. Weld penetration was found to increase with increasing vertex angle of the electrode for medium and low sulfur casts. The use of frustum electrodes was found to reduce the differences in weld penetration for casts with different sulfur contents.

Juang and Tarng [1] adopted a modified Taguchi method to analyze the effect of each TIG welding process parameters such as gas flow rate, arc gap, welding current and welding speed on the weld pool geometry, i.e. front height, back height, front width, back width and then to determine optimal combination of the process parameters associated with the optimal weld pool geometry. The base metal was AISI 304 stainless steel plates with a thickness of 1.5 mm. Experimental results showed that the front height, front width, back height, back width of the weld pool in the TIG welding of AISI 304 stainless steel were greatly improved by using this approach.

Mukesh and Sharma [4] studied the influence of different input parameters such as welding current, gas flow rate and welding speed on the mechanical properties during the gas tungsten arc welding of austenitic stainless steel 202 grade. In this study, they investigated the microstructure, hardness and tensile strength of weld specimen using nine experiments were performed based on L9 orthogonal array of Taguchi's methodology. From the experimental results, it was found that the current had the maximum influence on the output characteristics. Microstructure of weld metal structure showed the delta ferrite in matrix of austenite.

Raghuvir Singh et al. [5] investigated the effect of TIG welding parameters like welding speed, current, and flux on depth of penetration and width in welding of AISI304L stainless steel has been studied. From the study, it was observed that flux used has the most significant effect on depth of penetration followed by welding current. However, SiO_2 flux has more significant effect on depth. Optimization was done to maximize penetration and having less bead width.

Oyetunji et al. [6] studied the Effects of welding speed and power input on the hardness property of Type 304L Austenitic Stainless Steel (ASS) Heat Affected Zone (HAZ) welded with Gas Tungsten Arc Welding (GTAW) process. The authors used standard approaches to find hardness, tensile, and impact measurements. From experiment and investigation, results obtained from the HAZ micrographs showed that the hardness property of the HAZ was influenced at varying degrees at the range of welding speeds and power inputs. Microstructure of the HAZ was a mixture of austenite and ferrite, also variation in volume fraction and grain size of the phases was observed. Chromium carbide formation and precipitation due to sensitization was seen at the grain boundaries. Optimum hardness property was obtained at fast welding speed of 9.5 m/min and 9.20 kW power input.

Sudhakaran et al. [7] studied the effect of welding process parameters, namely welding current, welding speed, shielding gas flow rate, and welding gun angle on the microstructure of AISI202 grade chromium manganese stainless steel plates, welded by TIG welding. The authors were used method to keep one parameter at the minimum and maximum levels and other parameters kept constant. Also, they were studied the metallographic concentrated on the grain structure, presence of carbides and formation of ferrite, austenite and martensite in the weldment. From the investigation, they obtained results helped in selecting quickly the required process parameters to achieve the desired weld quality.

Anawa et al. [8] investigated the weldability of austenitic stainless steel AISI 316, welded by automatic TIG welding under various welding conditions, and studied the effect of input welding parameters, like welding current and gas flow rate on impact and tensile strength of prepared welding joints used statistical approach. From experimental results, they showed that impact energy was increased when gas flow rate of (CO_2) was increased, also increasing of welding current caused to increasing of impact energy up to (1200 Ampere) then decreased. While the tensile strength results showed that as welding current was increased the tensile fracture load was decreased, while increasing of gas flow rate caused to increase of tensile fracture load up to 12 L/min. then reduced.

3. METHODOLOGY OF STUDY

3. 1 Taguchi Design method

Genichi Taguchi has developed a method based on "Orthogonal Array" to study the control parameters with a small number of experiments. The experimental results are then transformed into a signal-to-noise (S/N) ratio. There are three Signal-to-Noise ratios of common interest for optimization: the nominal is better, smaller is better, and the higher-the-better. Regardless of the category of the objective function for optimization, a larger *S/N* ratio corresponds to better performance characteristic. Therefore, the optimal level of the process parameters is the level with the highest *S/N* ratio.

$$MSD = \frac{(Y_1 - \bar{Y})^2 + (Y_2 - \bar{Y}^2) + \ldots (Y_n - \bar{Y}^2)}{n} \text{ for nominal is better.} \qquad (1)$$

$$MSD = \frac{(Y_1^2 + Y_2^2 + \cdots + Y_n^2)}{n} \text{ for smaller is better.} \qquad (2)$$

$$MSD = \frac{\left(\frac{1}{Y_1^2} + \frac{1}{Y_2^2} + \ldots\ldots + \frac{1}{Y_n^2}\right)}{n} \text{ for bigger is better.} \qquad (3)$$

$$\mathrm{S/N} = -10\log\ (MSD) \text{ for all characteristic.} \qquad (4)$$

3. 2 Work Material and Experimental Parameters

In this experimental works, 3mm thick of AISI304L austenitic stainless steel was used. The dimensions of the work piece, length 150mm, width 150mm with autogenous single pass square edge butt joints. The workpiece is welded at three different levels of welding parameters, i.e. welding current, welding speed, and gas flow rate as shown in Table (1). The welding conditions which have been kept constant in this experiment are shown in Table (2). The chemical composition of Stainless Steel 304L sheet using for this study is shown in Table (3).

Table (1). Welding parameters and their levels

Process Parameters	Level 1	Level 2	Level 3
A: Welding Current (Amp.)	130	135	140
B: Welding Speed (mm/min)	180	190	200
C: Gas Flow Rate (Liter/min)	4	6	8

Table (2). Fixed welding conditions

Polarity	DCEN (Direct Current Electrode Negative)
Power Supply	230 V
Shielding Gas	Argon (99.99%)
Electrode Diameter	1.6 mm
Tungsten Electrode Characteristics	2% Thorated, Red color code
Torch Nozzle Material	Ceramic
Nozzle Size	4
Torch Position (Gun Angle)	Vertical (zero deg.)
Electrode to plate distance (Arc gap)	3 mm

Table (3). Composition of the base material

Type	%Cr	%Ni	%C	%Si	%Mn	%P	%S
304L	18.0-20.0	8.0-12.0	0.03	1.00	2.00	0.045	0.03

3. 3 L9 Level Taguchi Orthogonal Array

L9 orthogonal array has been selected with considering three factors and three levels for each factor. The input parameters considered in the study are: welding current, welding speed, and gas flow rate. Nine butt welded samples have been made using different levels of welding current, welding speed, and gas flow rate. Real values of the factors are shown in the experimental design matrix in Table (4).

Table (4). Experimental design matrix as per L9 orthogonal array

S. No.	A: Welding Current	B: Welding Speed	C: Gas Flow Rate
1	130	180	4
2	130	190	6
3	130	200	8
4	135	180	6
5	135	190	8
6	135	200	4
7	140	180	8
8	140	190	4
9	140	200	6

4. EXPERIMENTAL WORK

4.1 Experimental Procedure

In the present study, AISI304L austenitic stainless steel material has been selected. Welding set-up has been prepared. Welding process has been carried out in TIG welding machine. Experiments were conducted based on Taguchi L9 orthogonal array. Photos of welded specimen before and after welding are shown in Figure (2).

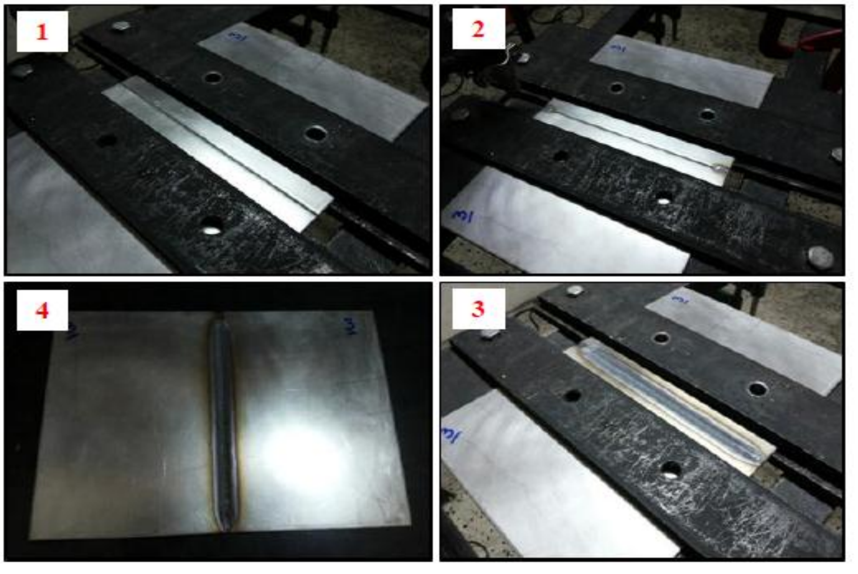

Figure (2). Photographic view of welded specimen before and after welding

4.2 Ultimate Tensile Strength (UTS) Test

The ultimate tensile strength (UTS) of the machined specimens were tested on Zwick universal tester machine. Tensile test carried out according to ASTM standards. The dimensions of each of the tensile test specimen is shown in Figure (3).

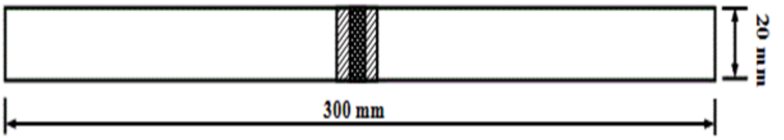

Figure (3). Dimensions of the specimen prepared for tensile test

Test specimens prepared according to ASTM standards (three sample for each specimen) are shown in Figure (4).

The tensile test was carried out on Zwick universal tester machine with 1000KN load capacity. Nine specimens were tested at each condition, three samples for each specimen as shown in Figure (5). The results of average ultimate tensile strength are given in Table (5).

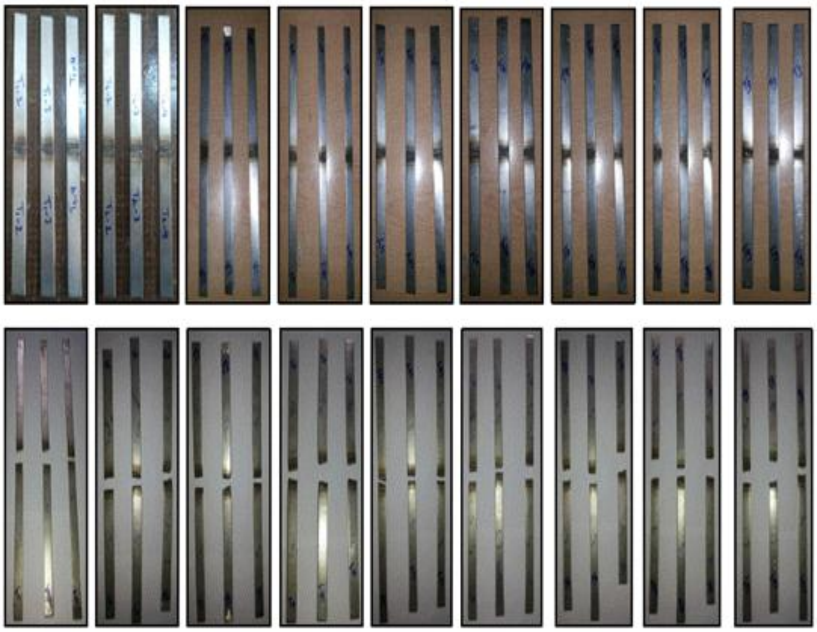

Figure (5). Specimens after tensile test

4.3 Micro-hardness Test

For micro-hardness test, the base metal is cut out from the specimens and placed in the mounting press as shown in Figure (6) in below. After placing, the samples are first rubbed with emery papers and then cleaned with acetone solution. In the present study, Vickers hardness tests are used to measure the hardness by MVK-E micro-hardness tester with magnification X400 and 200g indentation load. Vickers indenter made of diamond in the form of square based pyramid was used for indenting purpose. The results of micro-hardness test are given in Table (5).

Figure (6). Specimens for micro-hardness test

5. RESULTS AND DISCUSSION

5.1 Effect of process parameters on UTS.

Based on the experimental results data in Table 5, main effect plots for UTS have been obtained. From these plots the nature of the relationship between UTS and input parameters has been predicted. In Figure (7), inconsistent trend of UTS with welding current and welding speed can be observed. With increase in welding current from 130 to 140 Amp., UTS first increases from 549.223 to 580.556 MPa and then decreases from 580.556 to 541.78 MPa beyond the 2nd level of welding current. While with increase in welding speed from 180 to 200 mm/min, UTS first increases from 580 to 620 MPa and then decreases to 471.556 MPa beyond the 2nd level of welding speed because of less penetration depth at high level of speed. As gas flow rate increases from 4 to 8 l/min, UTS decreases from 598.556 to 533.89 MPa.

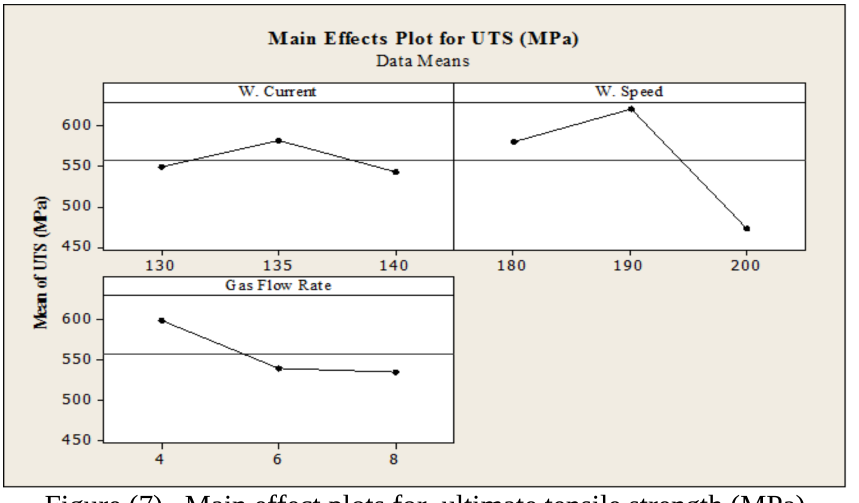

Figure (7). Main effect plots for ultimate tensile strength (MPa)

5.2 Effect of process parameters on micro-hardness

Based on the experimental results data in Table 5, main effect plots for micro-hardness have been obtained as shown in Figure (8). Main effect plot shows that micro-hardness increases from 176 to 184.34 HVN when welding current increases from 130 to 140 Amp. Micro-hardness first increases from 180.83 to 188.5 HVN and then decreases from 188.5 to 173.5 HVN when welding speed increases from 180 to 200 mm/min. While, micro-hardness decreases from 188.67 to 178.5 HVN when gas flow rate increases from 4 to 8 l/min.

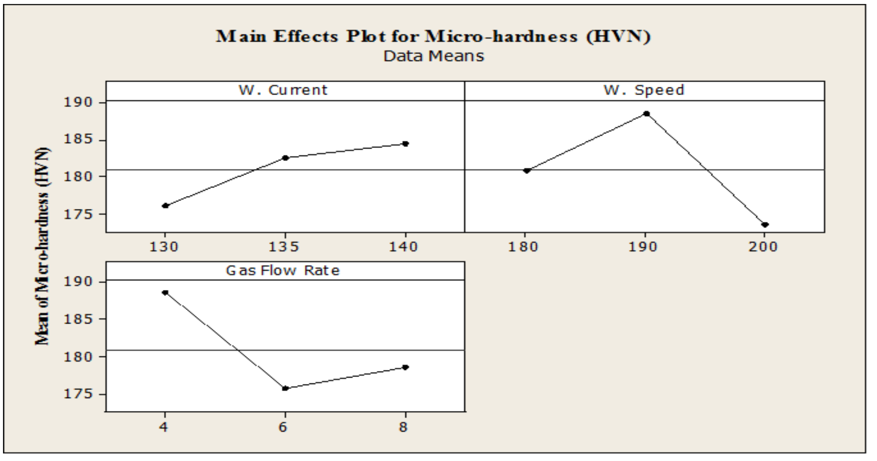

Figure (8). Main effect plots for micro-hardness (HVN)

5.3 Analysis of S/N ratio for UTS

In the Taguchi Method the term 'signal' represents the desirable value (Mean) for the output characteristic and the term 'noise' represents the undesirable value (Standard Deviation) for the output characteristic. Therefore, the S/N ratio used to measure the quality characteristic deviating from the desired value. The S/N ratio of the output characteristic (ultimate tensile strength) was analyzed in accordance to the criterion of the bigger is better, in order to maximize the response. The S/N ratio for the bigger is better target for the response can be expressed as:

$$MSD = \frac{\left(\frac{1}{Y_1^2} + \frac{1}{Y_2^2} + \ldots\ldots + \frac{1}{Y_n^2}\right)}{n} \qquad (3)$$

$$S/N = -10\log\ (MSD) \qquad (4)$$

where, M.S.D. is the Mean Square Deviation for the output characteristic, Yi is the value of ultimate tensile strength.

Table (5). Experimental results and S/N ratios for ultimate tensile strength and micro-hardness.

Sample number	Average of ultimate tensile strength (MPa)	S/N Ratio of UTS (dB)	Micro-hardness (HVN)	S/N Ratio of Micro-hardness (dB)
1	630.00	55.9868	186.5	45.4136
2	581.67	55.2935	172.5	44.7358
3	436.00	52.7897	169.0	44.5577
4	581.00	55.2835	180.0	45.1055
5	636.67	56.0782	190.5	45.5979
6	524.00	54.3866	177.0	44.9595
7	529.00	54.4691	176.0	44.9103
8	641.67	56.1462	202.5	46.1285
9	454.67	53.1539	174.5	44.8359

Regardless of the category of the quality characteristic, a greater S/N ratio corresponds to better quality characteristics. The S/N response table for ultimate tensile strength is shown in Table (6) and presented in Figure (9) as shown in below.

Table (6). Mean S/N ratio table for ultimate tensile strength

Level	A: Welding Current (Amp.)	B: Welding Speed (mm/min)	C: Gas Flow Rate (Liter/min)
1	54.69	55.25	55.51
2	55.25	55.84	54.58
3	54.59	53.44	54.45
Delta	0.66	2.40	1.06
Rank	3	1	2

The rank (1) in Table 6 indicates that welding speed parameter has stronger effect on the process followed by rank (2) gas flow rate parameter which has less effect, while rank (3) welding current parameter has the minimum effect on the process.

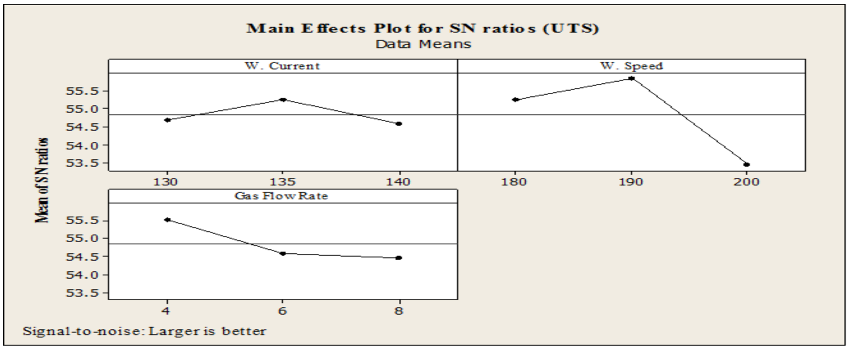

Figure (9). Main effect plots for S/N ratio of ultimate tensile strength (MPa)

5.4 Analysis of S/N ratio for micro-hardness

The S/N ratio of the output characteristic (micro-hardness) was analyzed in accordance to the criterion of the bigger is better, in order to maximize the response. Regardless of the category of the quality characteristic, a greater S/N ratio corresponds to better quality characteristics. The S/N response table for micro-hardness is shown in Table (7) and presented in Figure (10) as shown in below.

The rank (1) in Table (7) indicates that welding speed parameter has stronger effect on the process followed by rank (2) gas flow rate parameter which has less effect, while rank (3) welding current parameter has the minimum effect on the process.

Table (7). Mean S/N ratio table for micro-hardness

Level	A: Welding Current (Amp.)	B: Welding Speed (mm/min)	C: Gas Flow Rate (Liter/min)
1	44.90	45.14	45.50
2	45.22	45.49	44.89
3	45.29	44.78	45.02
Delta	0.39	0.70	0.61
Rank	3	1	2

5.5 Analysis of variance (ANOVA) for UTS

Analysis of variance for S/N ratio and mean data for ultimate tensile strength are summarized in Table (8) and (9) respectively at 95% confidence level and it is observed that welding speed is the most prominent factors which affected on ultimate tensile strength with percent contribution of 75.70% followed by gas flow rate with percent contribution 16.25% then welding current with percent contribution 6.15%.

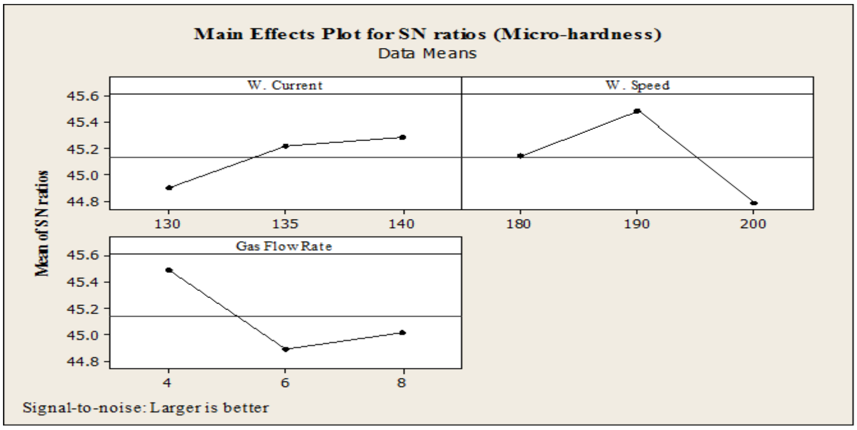

Figure (10). Main effect plots for S/N ratio of micro-hardness (VHN)

Table (8). Analysis of variance for S/N ratio of ultimate tensile strength

Source	df	Seq. SS	Adj. MS	F	Cont. (%)
A: W. Current	2	0.7583	0.3791	3.18	6.15
B: W. Speed	2	9.3430	4.6715	39.14	75.70
C: Gas Flow Rate	2	2.0067	1.0034	8.41	16.25
Residual Error	2	0.2387	0.1194		1.90
Total	8	12.3467	6.1734		

Table (9). Analysis of variance for means of ultimate tensile strength

Source	df	Seq. SS	Adj. MS	F	Cont. (%)
A: W. Current	2	2541	1270.4	1.90	5.40
B: W. Speed	2	35397	17698.3	26.51	75.30
C: Gas Flow Rate	2	7743	3871.3	5.80	16.50
Residual Error	2	1335	667.5		2.80
Total	8	47015	23507.5		

5.6 Analysis of variance (ANOVA) for micro-hardness

Analysis of variance for S/N ratio and mean data for micro-hardness are summarized in Table (10) and (11) respectively at 95% confidence level and it is observed that welding speed is also the most prominent factors which affected on micro-hardness with percent contribution of 38.15% followed by gas flow rate with percent contribution 31.70% then welding current with percent contribution 13.25%.

Table (10). Analysis of variance for S/N ratio of micro-hardness

Source	df	Seq. SS	Adj. MS	F	Cont. (%)
A: W. Current	2	0.2579	0.1290	0.79	13.25
B: W. Speed	2	0.7415	0.3707	2.26	38.15
C: Gas Flow Rate	2	0.6156	0.3078	1.88	31.70
Residual Error	2	0.3280	0.1640	-	16.9
Total	8	1.9431	0.9715	-	-

Table (11). Analysis of variance for means of micro-hardness

Source	df	Seq. SS	Adj. MS	F	Cont. (%)
A: W. Current	2	115.1	57.53	0.77	13.0
B: W. Speed	2	337.6	168.78	2.25	38.25
C: Gas Flow Rate	2	280.4	140.19	1.87	31.75
Residual Error	2	150.2	75.11	-	17.0
Total	8	883.2	441.61	-	-

6. CONCLUSION

In the present study, autogenous single pass butt welding of austenitic stainless steel AISI 304L has been done using semi-automatic tungsten inert gas welding machine, at varied levels of welding current, welding speed, and gas flow rate. The L9 orthogonal has been used to assign the identified parameters.

ANOVA analysis was performed for the analysis purpose which shows that welding speed is the most significant parameters that influenced on ultimate tensile strength and micro-hardness of the weld. The highest ultimate tensile strength and maximum micro-hardness obtained in the research is 641.67 MPa and 202.5 HVN respectively at the same level of a welding current of 140 amp, welding speed of 190 mm/min, and gas flow rate of 4 l/min. Autogeneous TIG welding process has validation in sheet plates of austenitic stainless steel with thickness 3mm without any edge preparation or filler metal addition when using argon as shielding gas.

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