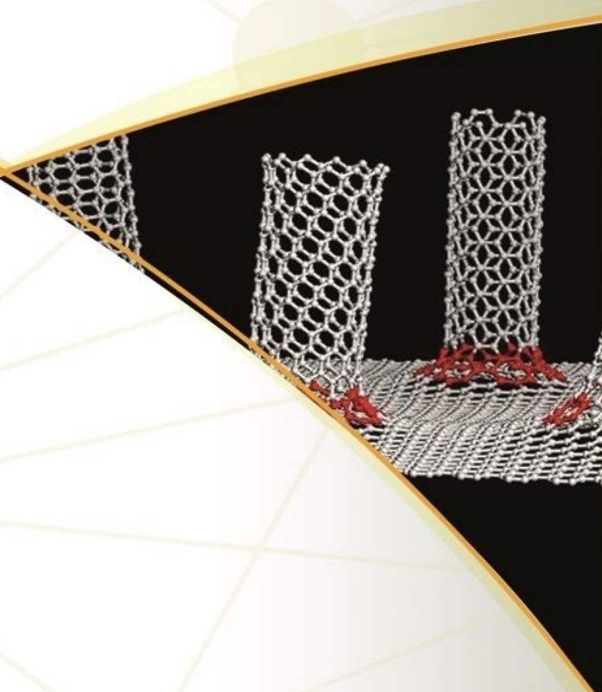
جامعة الجوف
Jouf University

ISSN: 1658 - 6670
Open Access Journal
Electronic ISSN:1658-9173
(1443/5074)

Jouf University Science and Engineering Journal

(JUSEJ)

Peer-Reviewed International Journal



No. 02
Vol. 09
http://vrgs.ju.edu.sa/jer.aspx
Dec. 2022
https://www.ju.edu.sa/en/jouf-university-science-and-engineering-journal-jusej/home/

JUSEJ ISSN: 1658-6670
Electronic ISSN:1658-9173

Jouf University Science and Engineering Journal

Peer-reviewed International Journal

Vol. 9(2)
Dec. 2022

Designed and Edited by Prof. Abdelazim M. Mebed

IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

Dear professional colleagues, researchers and fellow students:

We are pleased to present the second issue of Volume VIII of the Journal of Science and Engineering (JUSEJ). JUSEJ was established under the generous sponsorship of the former rector of Jouf University, Prof. Ismail Muhammad Al-Bishri, since 2014, and the continuous support of the current president of the University, Prof. Muhammad Al-Shaya. Its maturity is an outcome of the consistent support of high-performing authors, a supportive and professional dedicated reviewers, many vigorous and conscientious editorial boards and collective input from the editorial board members. Various researchers who are active in the above field have been enrolled for providing the necessary impetus for the new journal. We are quite hopeful and shall be grateful to the service that these eminent scientists shall provide to the growth of JUSEJ. We are certain that the renowned scientists and academicians both from the industry and academic institutions all over the world will be enriched by sharing their research experiences through JUSEJ. We are happy to invite you to submit your valuable research works in URP journals. We strongly believe that our journal will help to develop your own professional career.

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Jouf University Science and Engineering Journal (JUSEJ) 2022; 9(2): 01- 07
Published online: Dec. 2022 (https://www.ju.edu.sa/en/jouf-university-science-and-engineering-journal-jusej/home/)
Print ISSN: 1658-6670 ***Electronic ISSN:1658-9173 (1443/5074)***

TRIBOELECTRIFICATION PERFORMANCE OF CARBON FIBER REINFORCED EPOXY COMPOSITES FILLED WITH C_3N_4 NANOPARTICLES

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***Submission Date**: Sept. 024, 2022.*
***Accepted Date:** Dec. 24, 2022*

The Triboelectrification phenomenon was recently used (exploited) to be a source of clean energy. Triboelectric generators/ Triboelectric nano-generators (TEG/TENG) are used to produce an amount of electrical energy from a small motion. The generated energy from rubbing or contact between isolated layers can be used for a wide range of applications; self-charged devices, wearable devices, biomedical sensors, and other smart instruments are some examples of TEG/TENG applications. The amount of generated power that produced by this phenomenon depends on several factors. Some of the factors are related to; the rubbing materials and others are related to motion mechanism and frequency. The present work investigates the effect of adding C3N4 nanoparticles for epoxy composites reinforced by carbon fiber as well as the contact mechanism under different loads and speeds on the generated amount of electricity during contact or sliding of composites on Kapton film. The results show that there is a significant effect of C3N4 nanoparticles on the triboelectrification of carbon fiber reinforced epoxy, especially for contact separation mode with low frequency under high applied loads.

Keywords: *Carbon Fibre Reinforced Epoxy (CFRE); Triboelectrification modes; Triboelectric-generator TEG; Graphitic carbon nitride C3N4 nanoparticles bine*

1. INTRODUCTION

Triboelectricity of non-conductive materials employed by Wang's team since 2012, they have proposed a new generator for harvesting electrical energy called Triboelectric Generators TEG which was developed after that to Triboelectric Nano-Generators TENG. These generators are based on the Triboelectrification process and induction effect between rubbing or contact materials, which generate an amount of electric power on the surfaces of contact pair of non-conductive materials. The amount of generated energy depends on several factors; type of contact materials, location of contact materials in triboelectric series, contact mechanism, contact load, sliding velocity, contact frequency, and other environmental factors that affect the generated power [1-5]. Polymer composites used recently as a promising alternative for conventional materials in a lot of industrial applications because of their good mechanical and physical properties. Natural fillers, as well as metallic additives, were investigated as tribological performance enhancers of polymeric composites. It was concluded that; the friction coefficient and wear rates of HDPE and PP composites decrease with increasing copper content [6-9]. Static charges that generate because of rubbing between dissimilar surfaces were investigated in more than one research paper, the electric power produced by this phenomenon (Triboelectrification process) was proposed to be used in different applications like; self-charging devices, wearable devices, and sensors in form of triboelectric generators or triboelectric Nanogenerators. Aluminum mesh as a reinforcement phase in epoxy composites significantly affects the electrostatic charges (ESC) generated on the composite surface during sliding on rubber. Besides the composition of rubbing materials, the electrostatic charges also depend on the substrate layer that acts as an electrode in triboelectric generators, Ali et al. [10-12] conclude that copper substrate layers represented the lowest ESC values, while PP substrate displayed the highest values. Besides, grounding the metallic substrate caused significant ESC reduction, polyethylene fibers blended with PMMA yarns drastically decreased ESC regardless the material of the substrate. In addition to that, it was observed that increasing the ratio of PA yarns blending PE turf decreased ESC, while PA textiles in form of ribbons experienced more reduction in ESC because the flexibility of the turf enables for extra deformation of turf leading to an increase in the contact area. Finally, the value of ESC can be minimized by the control of the content of PA textiles [13-15]. It was confirmed that the value of ESC proportionally increased with the increase of the magnetism of the metallic films [16-19] It was concluded that, a small amount of mechanical movement between insulating surfaces can generate an electric power that can be used in low consumption devices or sensors. An increase of contact frequency or sliding velocity can increase the output Dc voltage of Kapton-PTFE TEG. It was recommended that the output electricity can be increased be using multiple layers of Kapton- PTFE TEG. Ibrahem et. al. [20]. Wang et al. expected that triboelectric is a dangerous industry effect because the electrostatic charge could lead to ignition, dirt explosions, dielectric breakdown, electronic damage, etc. But of the other hand, electrostatic charges incorporate a capacitive energy system. Feng-Ru Fan et al. concluded that triboelectric generators (TEGs) have the manageable of harvesting electricity from human activities, rotating tires, ocean waves, mechanical vibration, and more, with top-notch purposes in self-powered structures for personal electronics, environmental monitoring, clinical science, and even large-scale power. [21-30]. The triboelectric action was also proposed as a novel phenomenon to help in the medical care team's protection during the COVID-19 pandemic by means of a suitable selection of personal protection equipment PPE materials that helps in repel viruses away based on the surface charge of viruses. Ali et al. recommended that safety goggles that are used to provide personal protection from COVID-19 be made from negatively charged materials that lie on the bottom side of the triboelectric series. [31-35]. The present work investigates the effect of the composition of epoxy composites reinforced by carbon fiber filled with Graphitic carbon nitride (C_3N_4) nanoparticles as well as the contact mechanism on the generated amount of electricity as a result of contact and sliding on Kapton film.

2. MATERIALS AND METHODS

2.1 POLYMERIC MATRIX AND CARBON FIBRE

Epoxy resin $C_{21}H_{25}ClO_5$ (Easy Cast-Clear Epoxy) with its corresponding hardener - Tetrahydromethylphthalic anhydride - was used to prepare the matrix mixture of the proposed composite, the suitable ratio of resin to hardener is 1:1 as recommended by the supplier. Carbon fiber in form of plain textile was used as reinforcement by the ratio of 15%.

2.2 GRAPHITIC CARBON NITRIDE

Graphitic carbon nitride (C_3N_4) has become a new research hotspot and has drawn broad interdisciplinary attention as a metal-free and visible-light-responsive photocatalyst in the arena of energy conversion and environmental remediation. This is due to its appealing electronic band structure, high physicochemical stability, and "earth-abundant" nature. The construction and characteristics of each classification of the heterojunction system were critically reviewed. The band structures, electronic properties, optical absorption, and interfacial charge transfer of g-C_3N_4-based heterostructured nanohybrids theoretically discussed. [36-37]. CN-T/CN-U metal-free isotype heterojunction was constructed in situ with molecular composite precursors based on the band alignment between CN-T and CN-U.[38-39]. Polymeric graphitic carbon nitride (for simplicity, g-C_3N_4) is a layered material similar to graphene, being composed of only C, N, and some impurity H. Contrary to graphenes, g-C_3N_4 is a medium band gap semiconductor and an effective photocatalyst for a broad variety of reactions, and it possesses a high thermal and chemical stability[40]

2.3 PREPARING OF TEST SPECIMENS

Graphitic carbon nitride (C3N4) filler in form of nanoparticles (up to 100 nm) was added to the epoxy mixture with a ratio of 5% from the composite volume. The epoxy-hardener mixture and filler were blended by means of an electrical blender to provide a good distribution of particulates inside the test specimen. After well mixing of resin and powder, test specimens produced by hand-layup technique on carbon fiber that already adhered to a thin film of aluminum (as an electrode) which adhered on a rectangular wooden substrate (20 mm x 10 mm) to make a single layer (2 mm thickness) of triboelectric generator TEG. The other layer (2 mm thickness) of TEG is composed of Kapton film placed on a thin layer of an aluminum electrode.

2.4 EXPERIMENTAL AND MEASUREMENTS

After full drying of epoxy composites for two days, test specimens will be subjected to contact with Kapton film in two modes; contact - separation and lateral sliding under different conditions of dry contact, different sliding speeds, and contact frequency. Surface charges that are generated as a result of rubbing action between the two dissimilar layers will be detected by means of a surface DC voltmeter, and the generated charges collected by means of induction effect to the electrode layers can be measured by means of an Avometer. The effect of rubbing conditions as well as composite contents on the amount of generated charges will be discussed.

3. RESULTS AND DISCUSSION

3.1 TRIBOELECTRIFICATION OF EPOXY COMPOSITES UNDER SLIDING MODE

The sliding speed or rubbing velocity of the proposed contact layers ranged from 10 to 20 m/min. under constant contact pressure 2 N/mm2 or 10N/mm2. figures 1, and 2 show the effect of applied loads or contact pressure on the generated voltage over the time for sliding mode under low sliding speed.

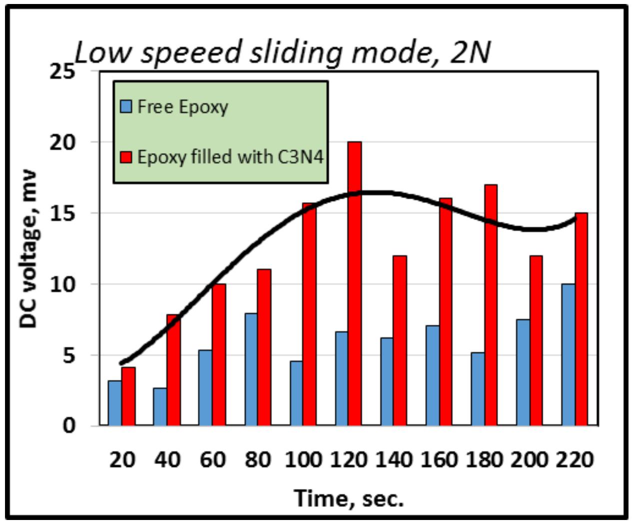

Fig. 1. Triboelectric discharge of epoxy composites under low sliding speed and low applied loads.

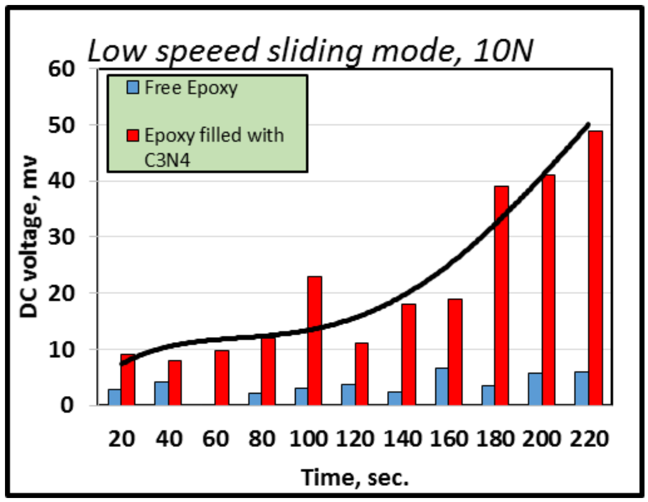

Fig. 2. Triboelectric discharge of epoxy composites under low sliding speed and high applied loads.

It seems that there is little effect on the generated electricity with an increase of applied pressure between contact layers of Kapton and epoxy composites free of fillers. But using Graphitic carbon nitride (C3N4) nano-particles significantly affects the generated voltage of epoxy composites, the amount of DC voltage of epoxy composites filled with Graphitic carbon nitride (C3N4) increases to 50 mv under high applied loads. This may be related to the increase of contact area under high contact pressure. Sliding of epoxy composites on Kapton film under high sliding speeds-figs. 3,4- shows drastic increases of dc voltage under low and high applied loads. The generated dc voltage reaches 70 mv under high loads and high sliding speed.

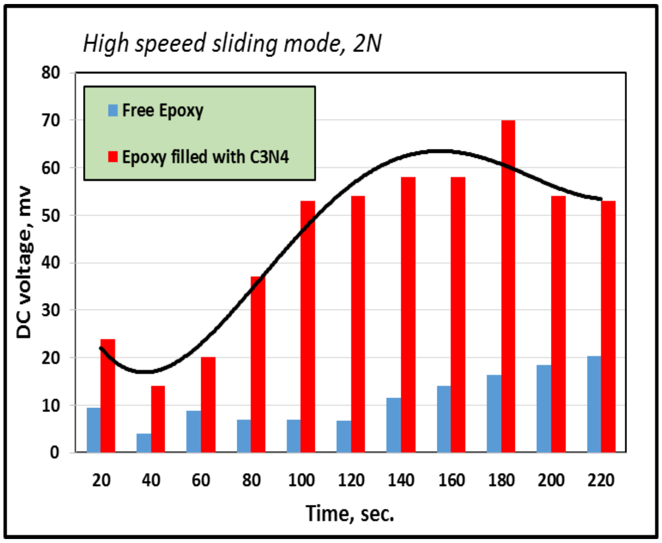

Fig. 3. Triboelectric discharge of epoxy composites under high sliding speed and low applied loads

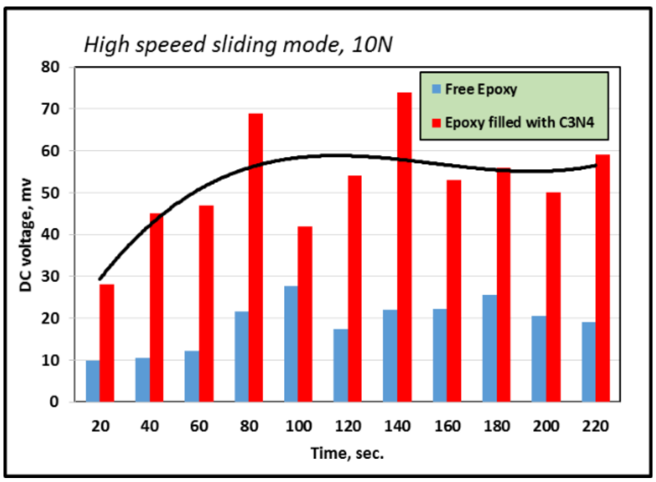

Fig. 4. Triboelectric discharge of epoxy composites under high sliding speed and high applied loads.

3.2 TRIBOELECTRIFICATION OF EPOXY COMPOSITES UNDER CONTACT-SEPARATION MODE

The other contact mode proposed for carbon fibre epoxy composites with Kapton film is contact-separation mode under low and high contact frequency 2hz and 5hz respectively, as well as low and high applied pressure. Figures 5,6 shows that using C3N4 fillers increases the charges of epoxy composites up to 200mv by means of the contact-separation mode under low frequency and high loads.

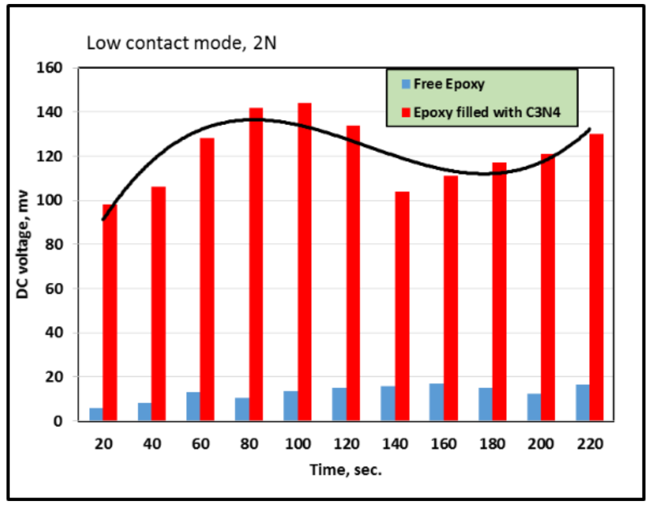

Fig. 5. Triboelectric discharge of epoxy composites under low-frequency contact separation and low loads.

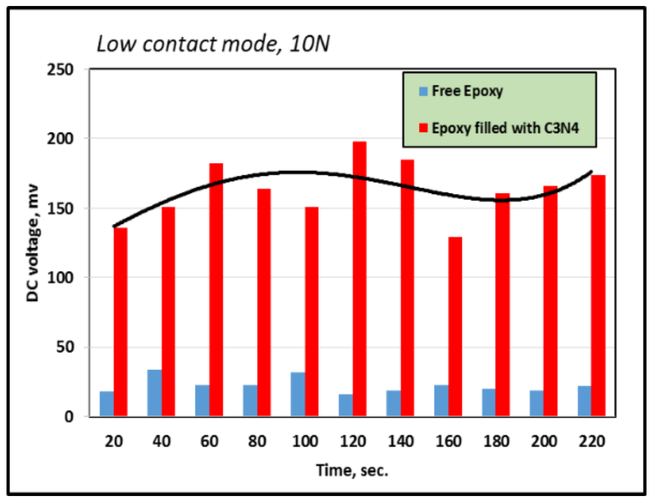

Fig. 6. Triboelectric discharge of epoxy composites under low frequency contact separation and high loads.

Figs. 7,8 shows the same trend of the presence of Graphitic carbon nitride which increases the amount of generated voltage under high contact separation mode. An increase in applied loads also increases the generated voltage to 160mv.

This behavior of epoxy composites under contact-separation mode for low frequency and high applied loads is clear evidence of increasing the contact area and contact time which directly increases the amount of generated dc voltage. It can conclude that the use of Graphitic carbon nitride as a nano-fillers for carbon fiber epoxy composites rubbing against Kapton generates high values of dc voltage while applying contact-separation mode under high loads and low contact frequency, these results recommended the proposed composites as a triboelectric generators TEG that can be used for generating an amount of electric power at traffic signs while the vehicles are slow and there are high applied loads.

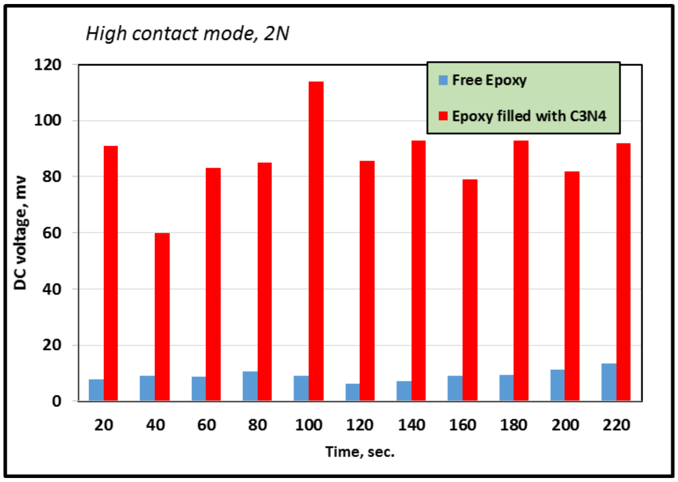

Fig.7. Triboelectric discharge of epoxy composites under high frequency contact separation and low loads.

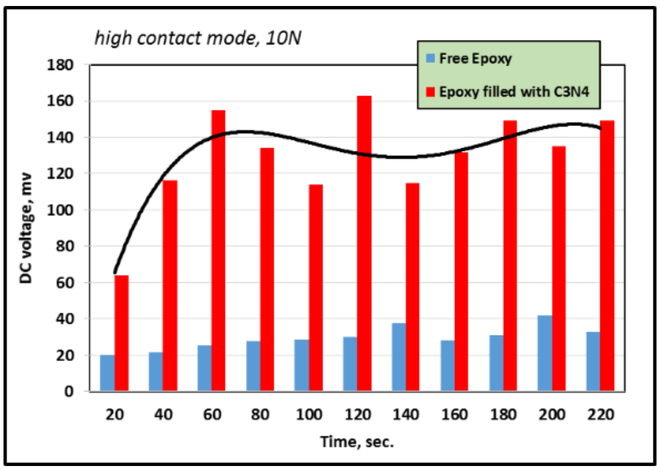

Fig.8. Triboelectric discharge of epoxy composites under high frequency contact separation and high loads.

4. CONCLUSION

Depending on the results of this work, it can be concluded that:

Epoxy composites reinforced with carbon fiber and filled with natural fillers can be used as an electrode layer triboelectric generators TEG.

Graphitic carbon nitride C3N4 nano-particles show promising additives for enhancing the triboelectrification behavior of epoxy composites.

Sliding speed and applied loads are important parameters for designing of lateral sliding TEG

Triboelectric generators TEG from contact-separation mode shows high generated dc voltage under low contact frequency and high applied pressure

Using of Graphitic carbon nitride C3N4 as a nano-fillers for carbon fiber epoxy composites rubbing against Kapton film generates high values of dc voltage, these results recommended the proposed composites as triboelectric generators TEG that can be used for generating an amount of electric power at traffic signs while the vehicles are slow and there are high applied loads.

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Jouf University Science and Engineering Journal (JUSEJ) 2022; 9(2): 08- 18
Published online: Dec. 2022 (https://www.ju.edu.sa/en/jouf-university-science-and-engineering-journal-jusej/home/)
Print ISSN: 1658-6670 ***Electronic ISSN:1658-9173 (1443/5074)***

EFFECT OF OPERATING CONDITIONS ON THE PERFORMANCE OF THE SOLAR TOWER-POWERED ORGANIC RANKINE CYCLE

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Submission Date: *Oct. 05, 2022.*
Accepted Date: *Dec. 21, 2022*

Scientists are turning to the practice of renewable energy in the face of a warming climate and environmental damage. The Organic Rankine Cycle (ORC) is the newest method for converting low or medium-temperature energy sources into electricity. A solar tower was designed and constructed for a purpose of producing steam from solar energy to power the ORC. Using the reheating process to enhance ORC efficiencies, and a solar pond as storage of heat that does not lose the heat because the middle layer of the salinity gradient in the pond does not allow heat to pass through it, are both new in the current work. The overall performance of the ORC system is evaluated using three-pointers: net output power, thermal efficiency, and evaporator temperature. The present article examined the ORC using different types of organic fluids of R116, Propane, R134a, R600 (n-butane), R124, R245fa, R123, R601(n-pentane), and R113 at boiling temperature from -78.2 to 47.6°C to verify fluid type or boiling temperature effects on ORC performance. The results showed that ORC employing R113 has the highest efficiency of all tested organic fluids. The boiling temperature of organic liquids has a major effect on ORC thermal efficiency. The ORC gave an efficiency estimated at 18.2% with the working fluid R113, compared to 8.3% with R116.

Keywords: *solar tower receiver; organic fluids; organic Rankine cycle; evaporator; steam turbine*

1. INTRODUCTION

Nowadays, use of renewable energies is an important goal to confront the rise in electricity prices, global warming, and environmental pollution [1]. From this point of view, countries have tended to build power plants that operate on solar energy to produce large amounts of electricity on a small to large scale [2]. Organic Rankine cycles (ORC) are thermodynamic cycles that use organic working fluid in generating electricity from geothermal power plants. Because purpose of ORC system is to generate power from low heat sources, water is not suitable in these mild conditions. Sylvain Quoilin [3] made a comparison between water and an organic working fluid and showed how the different working fluids are distributed in dry, equal and wet ranges, and stated that water has great deal of moisture while R134a has isotropic tendency, heptane is completely dry liquid. A wide range of organic working fluids can initiate the evaporation process at lower temperatures from waste thermal energy in plants and factories or from solar energy so these fluids fit well in an ORC system. Good selection of working fluid is very important in ORC performance [4, 5]. An advantage of using ORCs instead of Steam Rankine cycles in low-temperature electric power production to recover waste heat and improve efficiency in power plants is the use of organic fluids [6]. Examples of low-grade waste heat (80-

200 °C) are industrial waste streams, trapping solar heat in collectors, cooling water streams for stationary diesel engines, diesel engine exhaust [7], and biomass [8]. Various types of organic fluids have been used in ORC based on safety and technical feasibility [9], low toxicity, good material compatibility, limits to fluid stability [10], low flammability, corrosiveness, and anti-fouling properties [11].

The saturation vapor curve is a very significant distinguishing of the organic fluids due to its effects on efficiency of ORC [12]. The first and second-law analyses were presented of ORC using R134a, R113, and R123 [13]. Vijayaraghavan and Goswami [14] used propane and isobutane fluids for the combined power cycles, including combined first and second-law analysis. Different procedures to perform the second-law analysis of ORCs are in reference [15]. Also, ORC is the most popular energy cycle to combine with solar thermal collectors and is an ideal choice for low and medium temperature levels, typically up to 300°C [16, 17]. Liu et al. [18] used a two-stage ORC and obtained an ORC efficiency improvement of 8% to 12%. Soulis et al. [19] studied a two-stage solar-driven ORC and performed a geospatial analysis to properly evaluate this technology and found overall system performance ranged from 2.2% to 2.8% year-on-year. ORC is a cycle like the traditional water/steam Rankine cycle but works with organic fluids and is generally a less complex unit than the water/steam Rankine cycle [20, 21]. ORCs are widely used for power generation from medium to low-temperature solar energy sources [22, 23]. Recently, it has been noted that there is an increase in research related to use of ORC for electric power generation which has proven its technical value and ability to improve energy sustainability [24]. The ORC thermal efficiency increased with increasing evaporation temperature. The various areas in which ORC can be effectively applied while reducing the relevant cost and confirms that ORC can be used in down-cycle recovery or high-pressure gas turbines at a lower cost compared to other technologies. It is concluded that solar ORC is more cost-effective compared to power generation by other methods in addition to the ability to store energy in PCM storage. ORC is similar to steam cycle except for working fluid. Water in ORC is replaced by organic which has a lower boiling temperature than water, making the properties of ORC fluid suitable to take advantage of the low temperature of less than 400°C. ORC also has advantages over the steam cycle in that ORC working fluid has a higher molecular weight than water, increases the fluid mass flow rate for the same turbine volumes, and improves ORC efficiency.

Bellos et al. [25] have simulated ORC with reheat cyclopentane to enhance thermodynamic cycle efficiency. They concluded that according to the optimization procedure of cycle design, the proposed design increases power and financial performance compared to the usual design. An analysis of the solar-powered organic Rankine cycle using flat plate collectors was performed by Wang et al. [26], giving an improvement in the system efficiency by 7.8%. An ORC driven by flat plate solar collectors tested by Pinerez et al. [27] gives a maximum efficiency of 14.6%. Xu et al. [28] used ORC with equivalent solar collectors and they concluded that an investment payback period is close to nine years and the annual system efficiency is 15.1%, these results agree with the experimental data of Georgousis et al. [29]. Guangli et al. [30] have tested a two-stage ORC that is being proposed for the recovery and utilization of low-grade heat from single flash geothermal power plant exhaust flue fluids using working fluids R227ea and R116. Also, decreasing the fluid temperature at turbine exit leads to an increase in the thermal efficiency of solar-powered ORC and thus increases amount of electrical energy produced [31, 32].

Many researchers have used ORC to take advantage of wasted energy from factories or diesel engines for power tweaks. In the present work, first and second laws of thermodynamics were used to analyze the use of solar low heat sources with ORC. Various types of organic fluids such as R116, Propane, R134a, R600 (n-butane), R124, R245fa, R123, R601 (n-pentane), and R113 were tested to select the best working fluid for the highest efficiency of ORCs. The effect of fluid temperature and pressure at the entry and exit of the turbine on ORC performance was also studied.

2. EXPERIMENTAL WORK

Figure 1 shows the current test apparatus consisting of a tower with a 4.5-meter-high iron structure, and a receiver installed on the top of the tower to absorb the heat focused on it through 50 wooden panels covered with reflective mirrors installed around the tower. The absorption tank size is 1m x 0.7m x 0.3m and it is made of a black-coated galvanized iron sheet with a thickness of 0.003m, and it absorbs heat from 50 mirrors, the area of each of them is 1mx 1.2m with 60 m^2 of total area. The steam outlet from the solar tower receiver is connected to the heat exchanger of the organic Rankine cycle. Figure 2 displays the temperature rises over three days from 9 AM to 5 PM. The figure shows that the collector gives an average temperature of about 177°C from 10 AM until 3 PM with small differences between the six-day measurements. Data were recorded for many days every month throughout the year but only six days were represented because they have the same values of temperatures. The measurements were also carried out through different year months, and the results are shown in figure 3. The temperature increases from 110°C in January and increases to 177°C in June, July, and August, and then decreases gradually in December to 140°C. The estimated power output from the steam generator system of the solar collector, and a 50 Kw to 60 KW was obtained from the present system through a year.

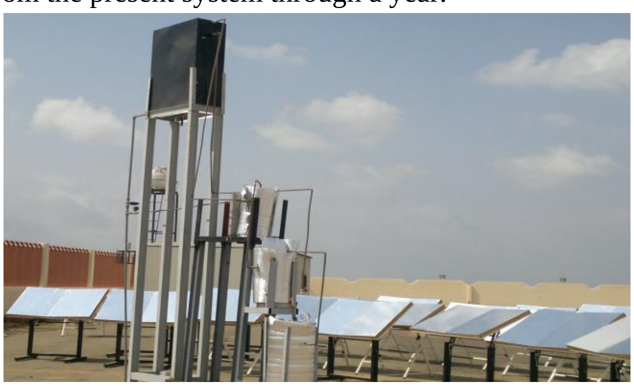

Fig. 1. A photo of the present test rig

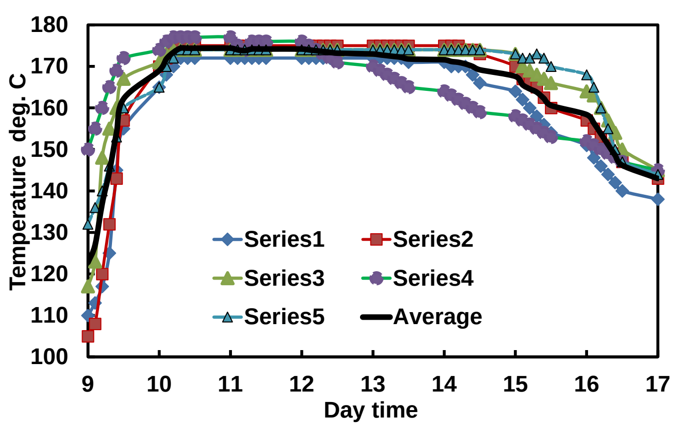

Fig. 2. Temperature gains from the solar system

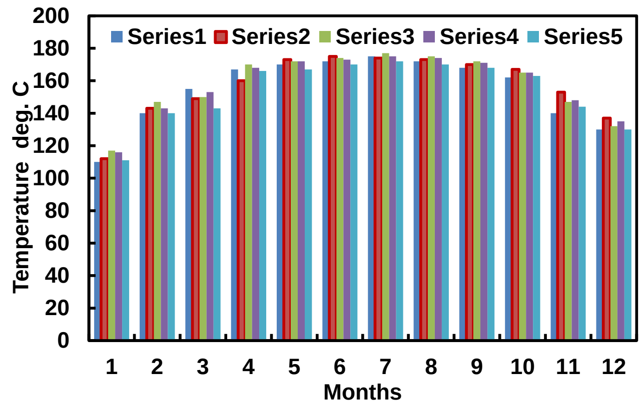

Fig. 3. The measurements through different year months

3. SOLAR ORGANIC RANKINE CYCLE MODEL

3.1. SOLAR CYCLE COMPONENT MODELS

A typical power tower plant, Fig. 4, consists of a solar field known as a heliostat, a tower, a solar receiver, a thermal energy storage unit (solar pond or evaporator), and an organic Rankine cycle (ORC). The reflective area of the solar field collects normal radiation directly into the solar receiver located on top of the solar power tower. The solar receiver absorbs the collected direct natural radiation and converts it into heat. The solar pond is used as a storage and heat permeable fluid consisting of layers of molten salt with gradient salinity to transfer heat to the solar tower receiver and then the organic Rankine cycle to produce electricity. The solar field reflective zone collects the natural radiation directly into the solar receiver located on the top of the solar power tower and converts it into heat. The solar pond consisting of gradient brine is used to store impermeable heat and transfer it to the solar tower receiver and then to the organic Rankine cycle to produce electricity. The current system operating temperature is up to 320°C where sunlight can be focused 1500-2500 times. The average temperature achieved by this system gives it the flexibility to operate the ORC [33]. Thus the flow of useful energy is calculated by the following formula [34]:

$$G_{on} = G_{sc}\,[1 + 0.033\cos(360 s/365)] \qquad (1)$$

Where G_{on} is solar constant value on a plane normal to the irradiation. The useful steady-state condition heat rate from the solar tower receiver, q_H, [35]:

$$q_H = A_C[I_g \tau\alpha - U_g(T_i - T_o)] = mCp(T_s - T_e) \qquad (2)$$

Where A_C is receiver area, m^2. According to Faye, et al. [36], the solar field size is determining the total reflecting area (A_T) of the heliostats. This area can be determined by following expression [37]:

$$A_T = E_p/(DNI\ \eta_{conv}\eta_{rec}\eta_{opt}) \quad (3)$$

where DNI is the direct natural radiation in the local area, the conversion yield efficiency, rec the efficiency of the solar energy receiver, and the efficiency of the photovoltaic helicopter. The optical efficiency (η_{opt}) of the sunshades reflects the amount of energy that reaches the receiver after solar radiation is reflected by heliostats [38]. It defines the set of field losses such as atmospheric attenuation (η_{aat}), cosine (η_{cos}), shading and blocking ($\eta_{sh\&bloc}$), reflection (η_{ref}), and spillage losses (η_{spil}) [39].

$$\eta_{opt} = \eta_{aat}\eta_{cos}\eta_{sh\&bloc}\eta_{ref}\eta_{spil} \quad (4)$$

Receiver efficiency (η_{rec}) is defined as a ratio of net heat power absorbed to total power intercepted at a receiver input. It includes absorption (η_{ab}) and conduction (η_{cond}) losses, convection (η_{conv}), and radiation losses (η_{rad}). The conversion product (η_{con}) of a unit of power consists of the electrical efficiency (η_T) of a steam turbine and generator efficiency (η_G).

$$\eta_{rec} = \eta_{ab}\eta_{Cond}\eta_{conv}\eta_{rad},\ and\ \eta_{con} = \eta_T\eta_G \quad (5)$$

Also Faye et al. [36] designed solar tower system with 175 heliostats with a total reflective area for solar canopies equal to 350 m^2, each of which is 2 m^2 and 1.5 meters high, produced 600 watts/ m^2 with an efficiency of 76.4% which confirmed experimentally by [40]. The useful heat that gains from the solar tower receiver and transferred into the ORC evaporator can be calculated using Equ. (2) as follows:

$$q_H = F_R A_C[I_g\tau\alpha - U_g(T_i - T_a)] \quad (6)$$

where F_R is the glassed plane sensor efficiency factor [41]. The energy in the direction of flow motion can calculated as:

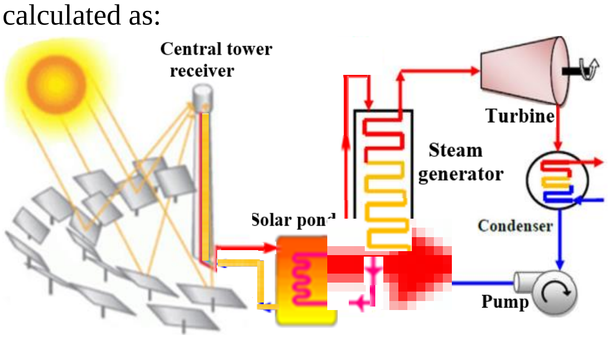

Fig. 4. Schematic diagram of a solar tower power plant

$$S\Delta x - U_g\Delta x(T - T_a) + [-k\delta(dy/dx)_{x+dx}] = 0 \quad (7)$$

Where S is the absorbed solar radiation. By dividing the terms of Equ. 7 by Δx and tending it to zero:

$$d^2T/dx^2 = (T - T_a - s/U_g)(U_g/k\delta) \quad (8)$$

On the other hand, the receiver thermal power, $\dot{Q}_{th,rec}$ is calculated [42] by:

$$\dot{Q}_{th,rec} = SM\cdot\dot{Q}_{th,pb}/\eta_{rec,guess} \quad (9)$$

Where $\dot{Q}_{th,pb}$ is the block thermal power required, $\eta_{rec,guess}$ is the receiver thermal efficiency, and SM is the solar multiple.

3.2. RECEIVER SURFACE TEMPERATURE AND MASS FLOW CALCULATION

The solar tower receiver surface average temperature, $T_{s,avg}$ can be obtained [43] by:

$$T_{s,avg} = Q_{fluid}\{[\ln(r_{o,tube}/r_{i,tube})/(2\pi\eta_{tube}H_{rec}k_{tube})] + [1/(\pi r_{i,tube}h_{inner}H_{rec}\eta_{tube})]\} + T_{htf,avg} \quad (10)$$

Where $T_{htf,avg}$ is the average temperature of receiver fluid, $\dot{Q}_{fluid}$ convection to receiver fluid, $r_{o,tube}$ radius of receiver outer tube, $r_{i,tube}$ radius of receiver inner tube, H receiver height, h_{tube} total number of tubes in the receiver, k thermal conductivity, h_{inner} internal convection heat transfer coefficient between tube wall and receiver, ($h_{inner}=0.023Re^{0.8}Pr^{0.4}\ k_{fluid}/L_c$), L_c characteristic length, $d_{i,tube}$ inner receiver tube diameter, and Pr Prandial number. The receiver mass flow rate is calculated with absorbed receiver thermal power energy [44] as:

$$\dot{m}_{htf} = \eta_{rec}Cp_{,htf,avg}\dot{Q}_{inc,rec}\ (T_{htf,hot} - T_{htf,cold}) \quad (11)$$

Where η_{rec} is the thermal efficiency of receiver, $C_{p,htf,avg}$ specific heat of fluid, $T_{htf,hot}$ outlet temperature of receiver fluid, and $T_{htf,cold}$ inlet temperature of receiver fluid. The correlation for calculating tower height for surround fields based on Falcone [44] is given below:

$$H_{tower,\ min} = 36.30075 + (0.3013896Q_{th,rec}) - (0.1004369 \times 10^{-3}Q^2_{th,rec}) \quad (12)$$

$$H_{tower,max} = 54.91579 + (0.3070526Q_{th,rec}) - (0.1039793 \times 10^{-3}\ Q^2_{th,rec}) \quad (13)$$

$$H_{tower} = (H_{tower,min} + H_{tower,max})/2 \quad (14)$$

where $Q_{th,rec}$ is the receiver thermal power, $H_{tower,min}$ is the minimum tower height, $H_{tower,max}$ is the maximum tower height, and H_{tower} is the tower height. The following correlation is developed using state-of-the-art commercial power plant data:

$$H_{tower} = 0.6806\dot{Q}_{th.rec} + 106.6 \quad (15)$$

Examination of Equs. (12-15) indicates that height of solar tower on which the central receiver is fixed has very important role in planning of heliostat field, but that it requires a considerable cost to install. Of course, not all helicopters are used to focus their reflected solar energy on tower at the same time or same focal point because extremely high temperatures can cause the receiver to overheat and melt. Figure 5 shows the effects of the total reflective area of heliostats reflective and receiver size on thermal capacity achieved from a solar tower. It appears that the energy gained from solar towers increases by increasing both the total reflecting area and receiving area for helicopters. These results are consistent with that the solar-generated energy increases by increasing heliostat areas.

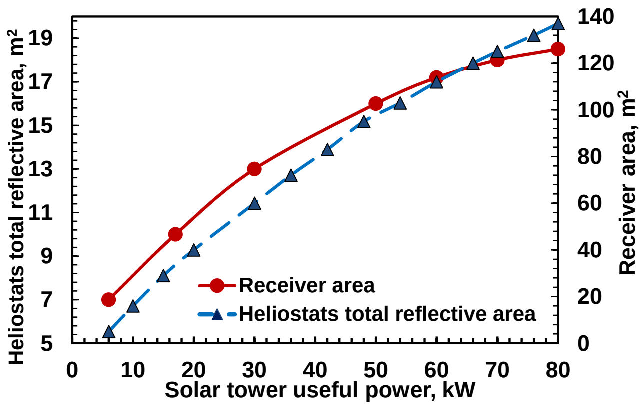

Fig. 5. Effect of heliostats total reflective area and receiver area

3.3. ORGANIC RANKINE CYCLE COMPONENT MODELS

Similar to the Rankine cycle, the ORC cycle shown in Fig. 5 has the same thermodynamic conditions and works in the same method but uses organic working fluid instead of water. The ORC operates at a low-temperature source of solar energy and consists of a pump, boiler (evaporator), turbine (expander), and condenser. This is because ability of organic working fluid has high molecular weight which makes a phase transition from saturated liquid to saturated vapor at the lower temperatures. Influences of different types of organic working fluids, turbine inlet, and exit temperature, and pressure and heat source temperature on ORC efficiency are verified. The simple derivation for analytical of the solar power tower receiver is presented similarly to [45]. To complete this work, it was assumed that, an isentropic turbine and pump efficiency, no pressure drop in the evaporator, condenser, or pipes, and steady-state flow conditions. The energy balances of any steady-state that are applied in the system components is expressed as:

$$\sum m_i = \sum m_e \qquad (16)$$

$$Q - w = \sum m_e h_e - \sum m_i h_i \qquad (17)$$

Where $\dot{Q}$ and $\dot{W}$ mean heat and work rate crossing the component boundaries, respectively. The subscripts i and e are the inlet and outlet conditions, $\dot{m}$ mass flow rate, and specific enthalpy of system stream working fluid. In the ORC shown in Fig. 4, there are four distinct processes, which are, in order, as follows: process 1-2 (pumping), process 2-3 (heat transfer at constant pressure), process 3-4 (expansion), and process 4-1 (Constant pressure heat transfer). The working fluids R116, Propane, R134a, R600 (n-butane), R124, R245fa, R123, R601 (n-pentane), and R113. The pump consumed power is:

$$W_P = \dot{m}(h_e - h_i)/\eta_{sp} = \dot{m}\,(h_2 - h_1)/\eta_{sp} = \dot{m}(P_2 - P_1)/\rho \qquad (18)$$

Where P_e, P_i are the pump exit and inlet pressure, $\dot{m}$, ρ mass flow rate and density of working fluid, η_p pump efficiency respectively. The actual specific enthalpy of working fluid at the pump outlet is:

$$h_2 = h_1 + \dot{W}_P/\dot{m} \qquad (19)$$

The main governing equation for development of evaporator (heat exchanger) model is:

$$\dot{Q}_{eva} = \dot{m}\,(h_e - hi) = \dot{m}\,(h_3 - h_2) \qquad (20)$$

where the exit enthalpy from the evaporator, $h_3 = h_g(T_s)$. Turbine work can be deduced as:

$$\dot{W}_T = \dot{m}\,(h_i - h_e) = \dot{m}\,(h_3 - h_4) \qquad (21)$$

where h_i and h_e are the enthalpy at the turbine inlet and exit, respectively. The condenser heat loss is:

$$\dot{Q}_{con} = \dot{m}\,(h_e - h_i) = \dot{m}\,(h_4 - h_1) \qquad (22)$$

The irreversibility of cycle components is obtained using exergy analysis by the following relations:

$$\sum Ex_i = \sum Ex_e + \sum Ex_D \qquad (23)$$

$$i \sum m_i e\,x_i + Ex_Q = e \sum m\,ex_e + Ex_W + Ex_D \qquad (24)$$

Where the subscript i, e, is the inlet and exit exergy flow from the control volume around the solar pond (storage of energy), $\acute{E}x_i$ and $\acute{E}x_e$ are exergy transfer by work and heat, respectively, and $\acute{E}x_D$ is exergy destruction. For a uniform flow, the irreversibility rate is:

$$I = T_o \frac{dS}{dt} = T_o \dot{m}_{ORC} [\sum S_e - \sum S_i + \frac{ds_{ORC}}{dt} + \sum_j \frac{q_j}{T_j}$$

Where the subscript j represents heat transfer, and the term (ds_{ORC}/dt) =0 for steady-state conditions. The solar fraction is defined as the ratio of amount of solar energy received to total energy required by the system:

$$SF = Q_{solar}/(Q_{solar} + Q_{sux} + Q_{boiler}) \quad (25)$$

where Q_{solar} is the solar useful energy, Q_{sux} auxiliary energy in the solar cycle and Q_{boiler} boiler energy required for the organic Rankine cycle. The organic working fluid in liquid state at maximum operating pressure (state 2) enters heat exchanger. In the evaporator, heat is transferred from high-temperature heat transfer fluid, heated through solar collector field, to organic working fluid. The turbine isentropic work, $\acute{W}_{Ts}$, is:

$$\acute{W}_{Ts} = \dot{m}\,(h_3 - h_{4s})\,\eta_{sT} \quad (26)$$

where η_{sT} is the isentropic efficiency of the turbine. The isentropic exit enthalpy from the turbine (state 4) can be calculated using following equations; $x_{4s} = (s_{4s} - s_f)/s_{fg}$, [where, $s_{4s} = s_3 = s_g\,(T_s)$] as*:*

$$h_{4s} = h_f + x_{4s}\, h_{fg} \quad (27)$$

while turbine exit enthalpy (actual) can be written using the turbine isentropic efficiency as:

$$h_4 = h_3 - \eta_T (h_3 - h_{4s}) \quad (28)$$

where η_T is the isentropic efficiency of the steam turbine and *s* denotes the isentropic. The power output from the ORC is calculated from [17, 20]:

$$\acute{W}_{net} = \acute{W}_T - \acute{W}_p \quad (29)$$

The overall exergy efficiency of ORC can be defined as:

$$\eta_{ORC} = \acute{W}_{net} / Q_{re}, \text{ and } \varepsilon_{ORC} = \acute{W}_{net} / \acute{E}x_i \quad (30)$$

Energy efficiency for the overall system can be calculated by ratio of net power output from ORC and the cooling capacity of the evaporator to the total heat energy entering the overall system [46]:

$$\eta_{ORC} = (\acute{W}_{net} + Q_{eva}) / (Q_{geo} + Q_{solar}) \quad (31)$$

The expression of exergy efficiency for the combined system [47] is:

$$\varepsilon_{overall} = [\acute{W}_{net} + Q_{eva}((T_o/T_E) - 1)] / (\acute{E}x_{geo} + \acute{E}x_{solar}) \quad (32)$$

Figure 6 illustrates effect of increasing turbine inlet working fluids temperatures from saturated to critical on thermal efficiency of organic Rankine cycle. These results are under assumption that turbine and pump efficiency is 85% and 80%, turbine inlet pressure is 1.4 MPa, and turbine outlet temperature is 25 °C. This figure shows that the resident organic fluid cycle efficiency is a poor function of turbine inlet temperature because it remains nearly constant or decreases slightly by increasing temperature at inlet of turbine. That is organic fluids do not need to increase heating to improve ORC efficiency, in contrast to water, which increases efficiency of thermal Rankine cycle by increasing water temperature at the turbine inlet.

Table 1 shows various working fluid boiling temperatures used in this research. Figure 7, deduced from Fig. 6, shows effect of working fluid boiling points on ORC thermal efficiency. It is shown in this figure that R113 has the highest boiling point among selected fluids (47.6°C), gives best thermal efficiency (about 18.2%), whereas fluid R116, that has the lowest temperature of -78.2°C, shows lowest ORC thermal efficiency (3.8). All the other organic working fluids were tested, and gave similar trend. And this concluded that ORC efficiency increases with increasing working fluid boiling temperature. Figure 8 shows effect of turbine inlet pressure on ORC thermal efficiency. Confirmation of the results shown in Figure 6, with all tested organic working fluids, is that ORC thermal efficiency increases by increasing turbine inlet pressure due to increase in net work and evaporator temperature.

Figure 8 shows that ORC with using R113 as working fluid has the best performance among the other tested fluids. Figure 9 shows effect of both organic working fluid type and turbine outlet temperature (condenser temperature) on ORC overall thermal efficiency. The figure shows increasing ORC efficiency by decreasing temperature at turbine exit (condenser temperature). Means that using ORC in locations at lower ambient temperatures will be more effective than in hot climates. Figure 9 concluded that dry organic fluids such as R113, R601, R123, R245fa, and R124 give better performance than wet liquids such as R600, 134a, propane, and R116. That is because dry fluids do not condense after fluid has passed through turbine, unlike wet fluids, which condense right after the turbine. It can be summarized that organic fluid has a higher boiling temperature among the tested fluids, gives higher ORC thermal efficiency, and has a low boiling point, achieving lower ORC thermal efficiency. Thus the general rule is that higher boiling temperature organic fluid achieves better ORC thermal efficiency, and vice versa. That is the highest efficiency of ORCs by using R113, and the lowest is with using propane and R116.

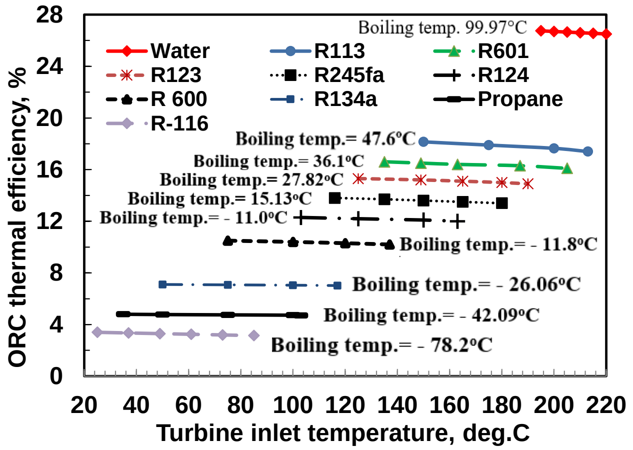

Fig.6. Effect of turbine inlet temperature on ORC thermal efficiency (P_3 = 1.4 M Pa, and T_4 =15°C

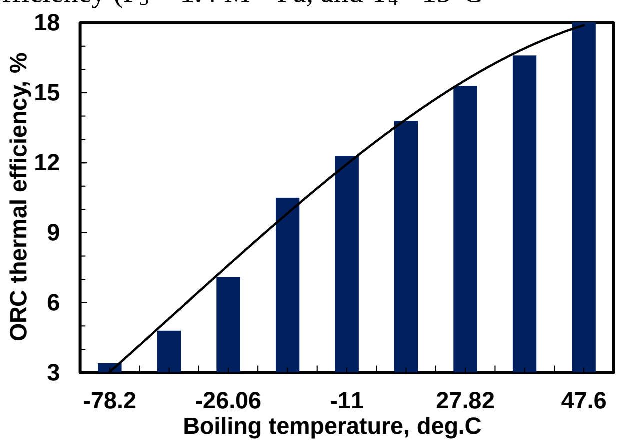

Fig. 7. Effect of working fluid boiling on the ORC efficiency

Table-1: *Basic properties of the selected organic working fluids*

Working fluid	*Molecular weight g/mole*	*Normal boiling point °C*	*Critical temperature °C*	*Critical pressure kPa*	*Density kg/m³*
R116	242	−78.2	19.9	3050	613.3
Propane	44.1	-42.09	96.7	4248	220.5
R134a	102.03	–26.06	101.06	4060	515,3
R600 (n-utane)	58.12	- 11.8	152	3796	228
Isobutane	58.12	-11.6	134.7	3640	224.4
R124	136.5	-11.0	122.3	3634	560
R245fa	134.03	15.13	154.01	3651	517
R123	152.9	27.82	183.68	3662	550
R245ca	134.05	35.13	174.432	3925	523
R601 (n-entane)	7215	36.1	196.5	3364	624.82
R113	187.38	47.6	214.06	3392	560
Water	18	99.96	273.	22000	1000

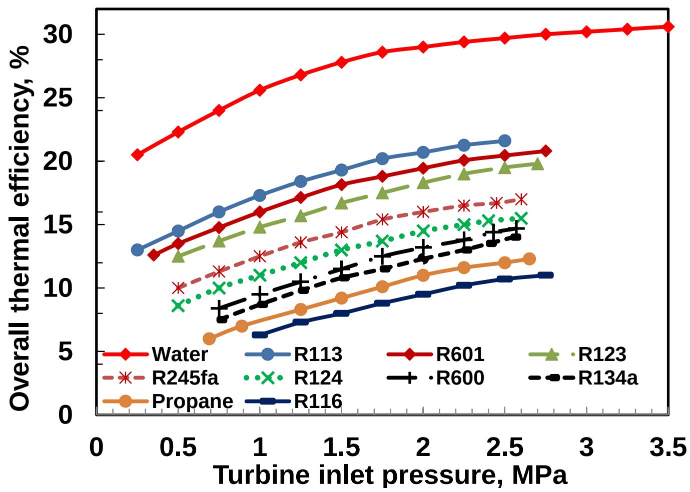

Fig. 8. Effect of working fluid boiling and turbine inlet pressure on the ORC efficiency

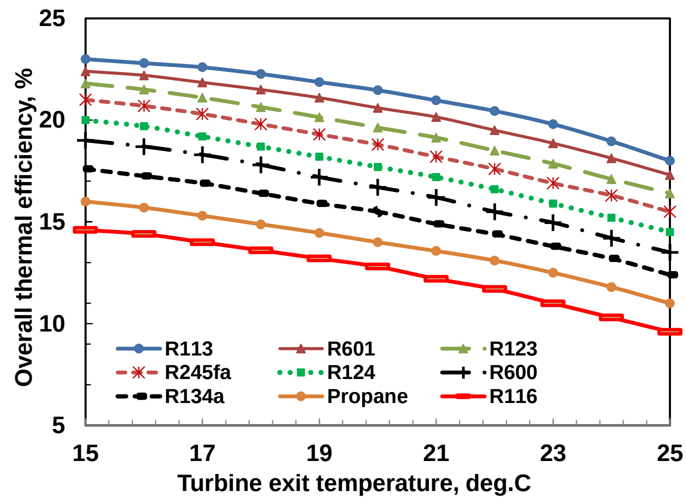

Fig. 9. Effect of working fuel and turbine exit temperature on ORC efficiency

Figure 10 shows that decreases required mass flow rate with increasing turbine inlet pressure for all fluids due to increases net cycle power. These results agree with the results presented in Fig. 6 because the increase in net power leads to increase ORC thermal efficiency. In Fig. 10, the fluid R113 requires the lowest discharge flow among the organic working fluids at pressures smaller than 1.65 MPa, while for pressures higher than 1.65 MPa, R600 needs less flow. The fluid R601 requires acceptable flow rates for all different turbine inlet pressures compared to other fluids. But fluid R116 requires the highest quantity of discharge among organic working fluids at pressures higher than 1.35 MPa, while pressure less than 1.35 MPa R124 requires more flow. The present result agrees with that of Daniarta et al. [48]. Figure 11 extracted from results in Figure 10. It gives a relationship between quantity of liquid required to achieve 50 kilowatts of energy from organic materials with different boiling points. This figure summarizes and confirms the results shown in Fig. 8, which is increase fluid boiling temperature increase ORC output power.

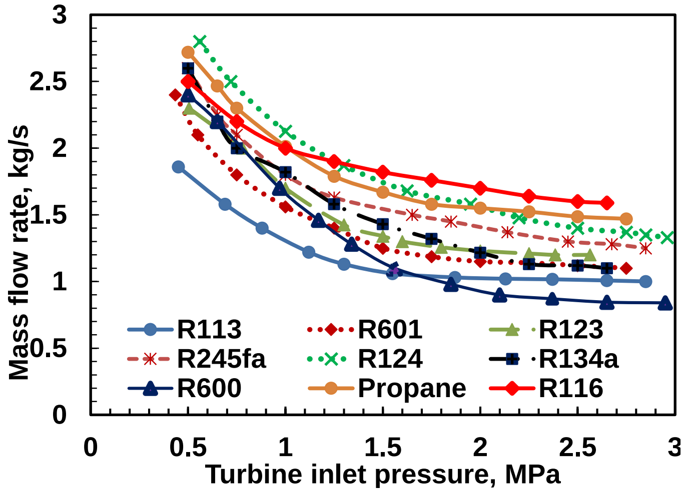

Fig.10. Effect of turbine inlet pressure and working fluid on ORC performance

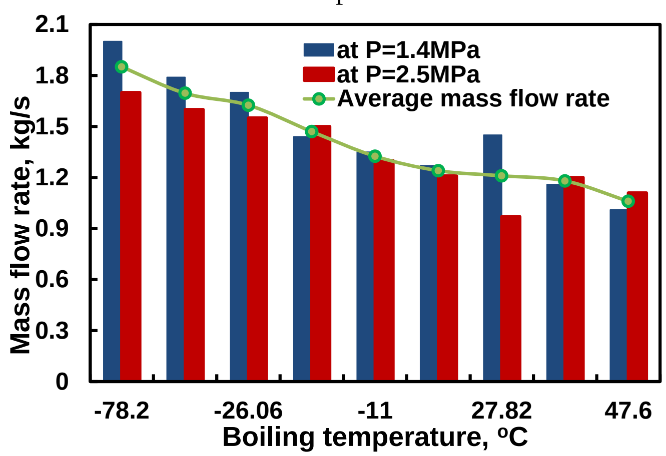

Fig.11. Effect of working fluid on ORC mass flow rate

4. CONCLUSION

Integrating solar energy systems with organic Rankine cycle delivers higher energy and efficiency to electricity generation system from low-temperature thermal sources. It is a way to reduce global warming and environmental pollution. A heat generation solar tower was constructed to feed organic Rankine cycle, with solar pond as a heat storage for steam extraction to feed ORC with the aim of studying effect of working fluid type, turbine inlet and exit conditions on ORC overall efficiency. The current article examined ORC using different types of organic liquids R116, Propane, R134a, R600 (n-butane), R124, R245fa, R123, R601 (n-pentane) and R113 at boiling temperature from -78.2 to 47.6°C to verify effect of fluid type or boiling temperature on ORC performance.

The results show that the collector gives an average temperature of about 177oC from 10 AM until 3 PM with small differences between the six-day measurements. The temperature increases from 110oC in January and increases to 177oC in June, July, and August, and then decreases gradually in December to 140oC. The estimated power output from the steam generator system of the solar collector, and a 50 Kw to 60 KW was obtained from the present system through a year.

The ORC gave highest thermal efficiency with R113 working fluid, while lowest when R116. The higher the boiling temperature of the working fluid of the ORC, the higher the total heat capacity of the system. A significant improvement in ORC efficiency with the increasing pressure and temperature of fluid entering turbine and their decrease in the outlet. The organic Rankine cycle requires a lower mass rate of fluid flow R113 than other types of working fluids for the same capacity produced at pressures less than 1.65 MPa, while for pressures greater than 1.65 MPa the cycle of R600 requires a lower fluid flow rate. A cycle with fluid R601 requires acceptable flow rates for all different turbine inlet pressures compared to other fluids. But if the cycle operating liquid is of type R116, the cycle requires the highest flow rate among the organic working fluids at pressures higher than 1.35 MPa, while at pressures less than 1.35 MPa with working fluid R124, the cycle needs a maximum discharge rate. Compared to many other organic fluids, R113 has the best ability to make full use of low-grade solar heat. This suggests that reasonable choice of ORC working fluid is a very important issue that deserves careful consideration in practice.

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Jouf University Science and Engineering Journal (JUSEJ) 2022; 9(2): 19- 30
Published online: Dec. 2022 (https://www.ju.edu.sa/en/jouf-university-science-and-engineering-journal-jusej/home/)
Print ISSN: 1658-6670 ***Electronic ISSN:1658-9173 (1443/5074)***

STUDY EFFECT OF THE DESIGN ON THE PRODUCTS AND RELATIONSHIP BETWEEN THE DESIGNS AND ADVANCED MANUFACTURING STAGES - LASER TECHNOLOGY

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***Submission Date**: Nov. 07, 2022.*
***Accepted Date:** Dec. 20, 2022*

The design of any product depends on the shapes and elements, and how they are distributed on the surface and its shapes, and the use of suitable materials for the product's function. This research aims to study the design foundations of products and their relationship with advanced manufacturing methods, such as laser technology, and to show the stages of product manufacture from the beginning of design to final product, and to explain the importance of the design for using laser technologies in manufacturing products and its impact on product quality. The importance of this research depends on using digital technologies in the areas of product design and manufacturing. We focus on the standard quality of the product and also the effects of using the programming for advanced machines during manufacturing processes. We make some hypotheses based on the following

- The relationship between designed products and manufacturing methods
- Using digital control in the design and manufacturing processes increases the quality of the final product.
- The final product is related to using the methods and using the materials.

Keywords: *Advanced technologies—programming machines—numeric control—evaluation*

1 INTRODUCTION

There is no doubt that there is a relationship between the design stage of products and the stage of manufacturing for any product, where the shape of the design is affected, which contains forms consisting of elements, whether these elements are geometric, vegetal, written letters, personal images or heritage elements, it may be affected by the way they are manufactured, whether it is a traditional method. Or non-traditional, sophisticated, and talking about design does not mean only talking about the shape alone, but it must also include talking about how to implement the required design using modern advanced methods, where the point represents an element of design, "and through the design and plastic qualities of the products, the materials have been affected by the digital revolution [1] Modern, which led to the development of the process of formation and design with one material in one space, which allowed the designer to design freely.

To learn about digital control, we find "digital systems that control the operation of mechanisms instead of analog control, whether automatic or manual.

This field of manufacturing includes making use of computer technologies in directing types of machines digitally or automatically to produce products that are characterized by accuracy at high speed. The computer is used as an assistant for CAM manufacturing, not only in controlling operating machines of all kinds, but also in planning and controlling production processes.

1 Statement of the problem

Shedding light on the design quality of products with their different materials and their relationship to their advanced manufacturing methods.

2 Objectives

• Studying the design principles of products and their relationship to manufacturing methods.

• Show the stages of product quality from the beginning of design to implementation.

3 Research importance:

- Show the importance of using digital technologies in the areas of product design and its impact on manufacturing.
- Highlight the criteria for evaluating the quality of product design.
- Shed light on how to program advanced machines during manufacturing processes.

4 Research hypotheses:

• There is a strong relationship between product design standards and manufacturing methods.

• The use of digital control in the design and manufacturing processes increases the quality of the final product.

• The shape of the final product is affected by the methods used in manufacturing according to the different materials used.

5 Search limits:

Studying the impact of advanced technologies, such as (three-dimensional printing technology for stereoscopic models, engraving and laser cutting technology on different materials) and its impact on digital design technology in the stages of product implementation.

6 Previous studies:

7 First study

Doaa Hamed - PhD thesis - Technological foundations in design and application - laser engraving in glass using a computer - 2009.

Target: Reaching to build an influential scientific system in achieving diversity in shape design،

In order to suit the requirements of the various applied fields of laser engraving Technology in glass and apply the technological foundations in design for laser engraving in glass using a computer.

8 Results:

Establishing an information base that will benefit the designer in developing the various innovative aspects in a way that suits the development of technical production for laser engraving in the glass.

The study showed that engraving complex organic and geometric shapes accurately and in multiple silhouette degrees by dividing the shape into layers, where each layer is drilled separately, provided that drilling is carried out from the maximum shape to the bottom (so that the laser beam does not hit a drilling point in its path, and the beam is scattered in the direction of perpendicular to the flat layer.).

9 Second study

Dalia Mahmoud Ibrahim Khalil [2] - The effect of digital production on the design of metal furniture products - Master's thesis - Faculty of Applied Arts - Helwan University - 2009.

10 Purpose of the study

Attention to the production process in manufacturing processes based on machines that control digital systems that affect the design of metal furniture

The similarities are the study of some fast-cutting techniques that control the digital system.

Differences: A comparative study was conducted between some techniques, as well as a study of the effect of the cutting tool on the surface of the metal after the cutting process, which also affected the design of the metal product, according to the different metal materials and thickness.

11 The third study

Jihan Muhammad Abdul Azim Al-Jamal - Laser engraving technology to enrich the printing of wooden molds - Journal of Science and Arts, Volume Twenty-four - Issue - Third - July 2012.

12 Purpose of the study

Updating and developing the method of engraving the printing dies using the laser engraving technology, determining the steps for implementing the printing dies, using the laser engraving technique to engraving the printing dies easily to raise the level of technical performance for the users of printing with the dies.

13 Study methodology and its methodological procedures

The study depends on the descriptive analytical method in the research.

14 Theoretical framework :

In this research, there are two axes:

The first axis

It is based on the study of the characteristics of the design elements affecting the design of the product, which are related to the processes of laser cutting and engraving, where the shape of the design is affected, which contains forms consisting of elements, whether these elements are geometric, vegetal, written letters, personal images or heritage elements) maybe affected by the way they are manufactured. The design may also be associated with Arabic calligraphy sometimes in many designs for product design, which requires us to study some linear shapes and their relationship to the cutting path with laser machines. Then we also talked about the characteristics of the formal value in the design ،It clarifies how to judge the quality of the design, which is related to the manufacturing differences of the product and its competitiveness in the market. Therefore, the standards and evaluation of the quality of the product design were studied, showing the effect of advanced laser cutting processes on the product's quality.

The second axis

In this axis, the relationship of CAM means and how to control them in the speed of cutting affecting the quality of the product, which includes taking advantage of computer techniques in directing types of digital machines to produce products characterized by accuracy and high speed, and studying the relationship of advanced methods of rapid cutting operations and how they affect the design In this way, the integration between the three stages is a necessary process in the unification and development of capabilities, as well as achieving high flexibility in the design and manufacturing stages, which helps to achieve a better response to the market. Design programs may be able to deal with a huge amount of data and information, provide a huge amount of vocabulary, and design alternatives in order to achieve an assistant system for decision-making, which means a shift from the individual case of the designer to a system of integrated experiences. It also clarified how to quickly cut the product using machines. Digital, which takes advantage of computer numerical control to produce the required jobs in large numbers. Cutting machines for fast cutting machines, where the user faces the task of converting the data that is provided by the designer in the form of drawings on paper, so it is converted into coordinate points (x. y) or files represented by AutoCAD programs.

15 Study procedures:

Study the characteristics affecting the design

That is through the elements associated with the foundations of design whose shape is affected by the processes and advanced methods in the design stages until the implementation stages, which, as Christopher mentioned [3], is represented in:

Strong Boundaries - Thick

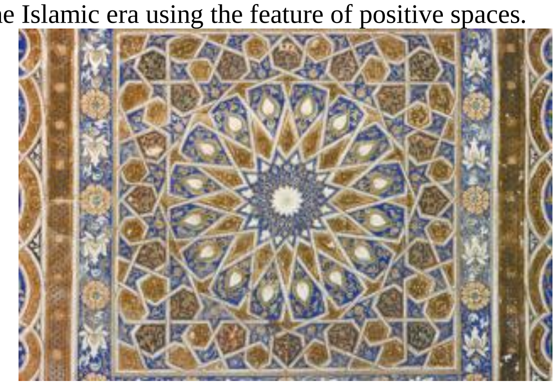
It is a type of transition or exchange between spaces when the juxtaposition between them is great and the sharp distances are not sufficient to separate them and usually aims to control the degree of interaction between spaces.

And that these breaks may be made in the shape through cutting operations, so there is no doubt that we want a good cut to connect the lines with each other to form the specific shape within the design as shown in the picture.

Picture (1) Demarcating the spaces between the spaces as one of the designs.

16 Positive space

It is the most difficult characteristic to perceive, and it is a deep embodiment of the totality. Just as each shape has a strong center, every void also has a strong center. This is illustrated by picture No. (2) Showing one of the ceramic tiles used the non-Islamic decorations on one of the mosque walls in the Islamic era using the feature of positive spaces.



Picture (2) Shows the geometric Islamic decorations

Voids: the void

The voids are what show the shapes, achieve calmness, emphasize the strength of some parts from others, and create the energy of the center, and since the shape has a language, so is the void.

Picture (3) shows the voids on the surfaces of the products.

17 Arabic calligraphy in design and its relationship to advanced methods of rapid cutting.

The research will be presented on Arabic calligraphy in particular and show the characteristics of its formation in flexibility, rotation, and overlap, where its expressions lie about its relationship with the arts and "the extent to which it is related to arts and architecture because of its decorative pattern, smoothness of its lines, the strength of composition and balance [4]. Also, "Arabic calligraphy letters are decorative elements with irregular shapes and endless diversity, which allows the practical application of the practice of some aspects of innovation in terms of employing their multiple potentials to offer plastic solutions with a renewed and innovative aesthetic value [5]

The Arabic calligraphy is one of the most prominent formal elements used by the Muslim artist in his various subjects, so that many of the artworks contain the calligraphy in which his prominent position lies, to reflect this on the products used by the different methods in the rapid cutting operations in the product manufacturing processes and also in the different materials.

That is why the designer did not stop at mere writing according to the rules followed in each font but began to excel in producing these fonts in a beautiful picture, adding to it from his imagination and creative designs. It also has its own elements and basics and the elements of Arabic calligraphy.

18 The components and plastic methods of Arabic calligraphy affecting the design of the product:

"It is the set of plastic characteristics and qualities that distinguish Arabic calligraphy from other inscriptions [6] which have an impact on the design of some Islamic products, such as Islamic lighting units, incense burners, candlesticks, and wall hangings.

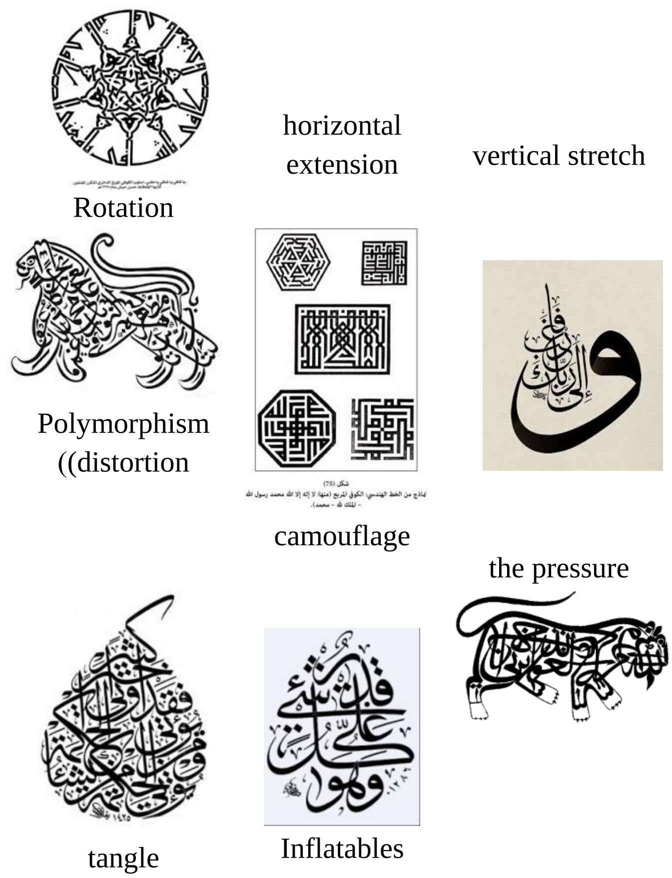


Fig. 1. expresses the different types of fonts affecting the design [6].

In terms of formation methods for Arabic calligraphy, the incorporation of the design idea into Arabic calligraphy: "It is the organization of the mental elements in the imagination of the calligrapher or the designer and transforming them from a visual reality into a concrete reality capable of inventing new ideas characterized by modernity and being the basis for building linear composition [7] depending on the characteristics of the line Arabic, which includes repetition, contrast, overlap, overlap, bifurcation, and combination of various lines in the form of different shapes.

If we link those components and methods that characterize Arabic calligraphy with the design and rapid cutting techniques with advanced techniques associated with laser machines, we may find the emptying resulting from the cutting operations are designs based on the characteristics of the Arabic calligraphy resulting from interlacing, bifurcation or distortion of lines in the form of design in the product. How to implement these shapes in a literal and elaborate manner in every different method of implementation, using the latest programs on the computer attached to the laser cutting machines.

19 Features formality of value in design:

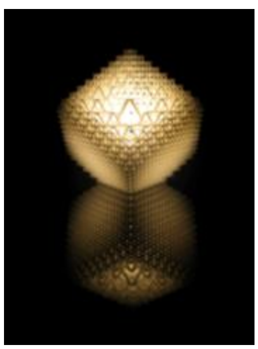
The features of the formal value in product design are "formal values that characterize it and make it completely different from other products with one or different functions, and these features include the type of material, the structure, the aesthetic form, the dimensions of the design and the treatment of surfaces when implementing the product [8]

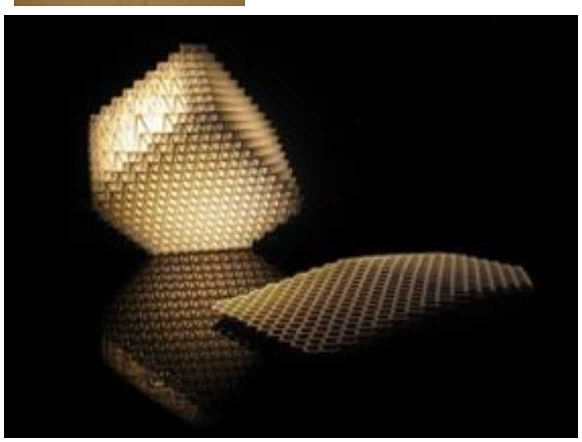
It also takes into account the design of products with three-dimensional shapes that depend on cutting or drilling inside the model, which we must know the systems of forming models that express what three-dimensional shapes are known as shapes of size and expressed in the projection in the three dimensions of space." Figures are geometrically parts of space defined by surfaces, either flat or curved, and they are called faces, so they are called letters, while the points where these letters meet are called vertices [9] and "The three-dimensional figure consists of mass and internal spaces, and through them establishes an expressive relationship between the surrounding spaces [10].

20 Figures can be generally divided into three types:

Regular figures:-

"They are solid objects with a similar structure in their composition, so there are no changes in the proportions of their constituent elements [11].





Pictures (4), (5), (6) illustrate the impact of advanced laser cutting processes on plastic and metal materials, and the clarity and innovation of the idea using advanced technologies.

Semi-regular figures:-

They include prismatic, pyramidal, cylinder, and conical solids, the solid formed by the rotation of the semicircle of an ellipse around its axis, and the solid formed by the rotation of a curved line around an axis.

(7):www.derwentlasercrafts.co.uk

(8):www.pinterest.com

Pictures (7), and (8): show the rapid cutting processes and their impact on the quality of design and implementation of the metal product.

Irregular shapes:

They are the ones whose composition is not subject to the geometrical rule by the usual methods, as these shapes cannot show the composition according to the customary system.

A group of pictures (9), (10), (11)) www.google .images.com/cutting of laser products

showing the final shape of a 3D product based on the idea of anatomy by laser technology as rapid cutting operations with more than one material.

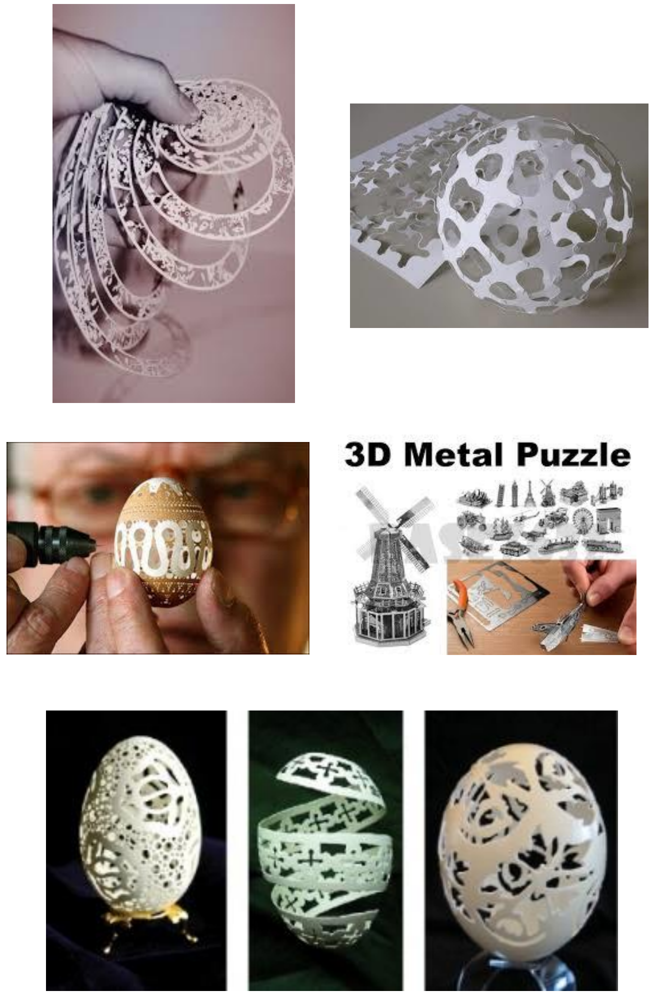


Fig. 2. Illustrating the laser cutting processes with paper and plastic materials

Through the research, the study may be exposed to advanced cutting and engraving techniques that depend on digital control using computers with laser machines, as “technical development led to a transformation that changed the shape, characteristics, and colors of the material and created new materials. This development was reflected in the structure of the product, which had a role in performance. Career [11] which helped the designers to unleash their ideas without being restricted in how to implement the product.

For this reason, many programs are used to draw the design such as AutoCAD, Coral Draw, 3ds Max, Art Cam, and many others through which you can convert the drawing file to DXF so that the machine can identify the coordinates of each point separately at the beginning of the cutting or drilling process.

After using modern technology by computer in design and manufacturing, cutting or engraving accurate Islamic motifs has become easy and accessible using advanced cutting methods on different materials, which are represented by laser cutting technology.

Pictures (12,13,14) [www.pinterest.com] show the advanced cutting processes in product design from metallic materials.

21 The relationship between differences manufactures and product quality.

The manufacturing differences in the manufacturing process negatively affect the quality of the product. The greater the percentage of these differences and the larger their scope, the worse the To distance the characteristics of this product from the specifications required for the quality level specifications of the product specially designed in order to satisfy the consumer, and improve the level of quality means (Quality). Improvement falls within the manufacturing differences, as this means reducing the number of defective units.

So we will starting to define the quality of the product:

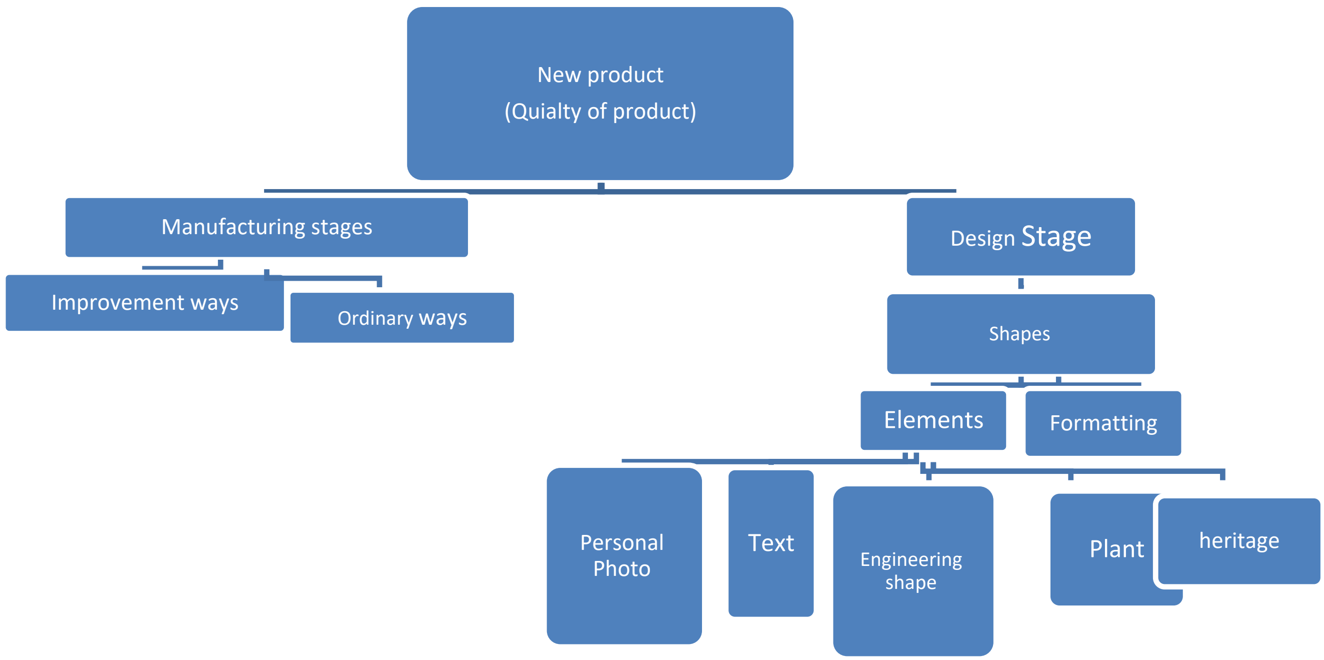
“Attributes or characteristics that can be measured and quantified [12]. These qualities may be represented, for example, in the degree of hardness, endurance, and the degree of reliability.

Quality is standard specifications and fixed standards that factories are committed to, keeping pace with consumer satisfaction and maintaining them. It is also linked to other important dimensions related to the quality of the industrial product, including:

Conformity:" It is the extent to which the design of the product and its manufacturing characteristics conform to well-known specifications. **Durability**: It is the amount of durability before the product deteriorate ،**Beauty**: It is related to appearance and impressions [13]

That is, in order to reach a good product that conforms to the internationally accepted quality control standards, which is ISO)), the design specifications must match what it contains elements within the specified shape, so it is choose the most appropriate method of manufacturing the product that is proportional to the material used to reach the highest possible quality of the product". necessary to

"The product designer needs to know the secrets of marketing and knowledge of the aesthetics of the product, human engineering and integration between them to make the product easy to use and at the same time its appearance is pleasing to the eye [14].



The corresponding figure (3) shows a relationship between the elements of the design of the metal product and the advanced technologies of the product implementation processes.

22 Criteria for evaluating the quality of a metal product design:

Quality is the determination of the value inherent in a product and the success and alignment of product design outputs with various design aspects and their main inputs. Quality is often associated with function, material, and weight in design،The function is often viewed through sight, touch, and direct interaction, showing movement, shape, and size appropriate to its formation. The choice of materials and body weight also support the elements of quality with the knowledge and use of strong and durable material, and then "overall confidence in the design that is found in effectiveness and purpose behind the use and how to work with it, creating a response to a large number of sensory elements depending on the product itself [15]

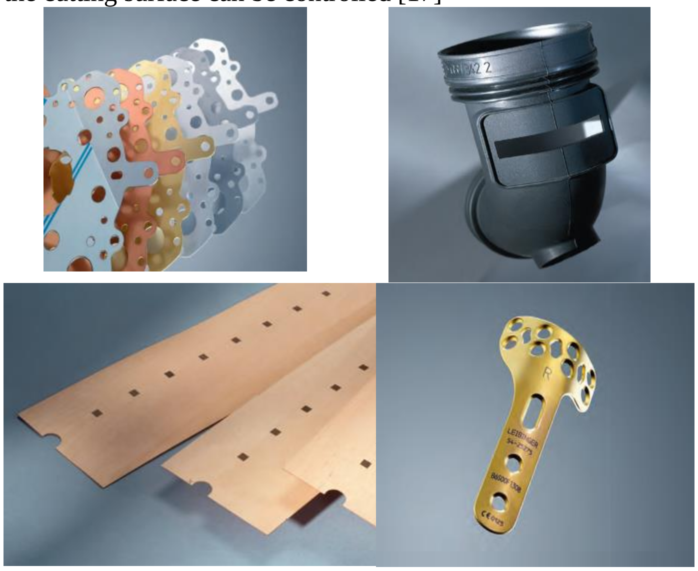
"In order to achieve the high quality of any industrial product, there must be integration between the design and the manufacturing process, which is related to the following criteria

- Product feasibility
- Product design aesthetics
- product cost
- The executive function of the product
- Product Productivity
- Safety
- Product sustainability

23 Studying the process of cutting decorations with laser technology and its impact on product quality

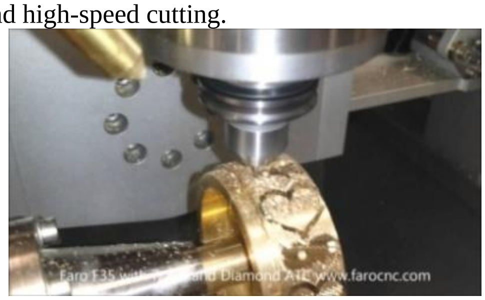
"A laser is a high-energy light beam produced in special equipment through optical resonance, either in a gas or in solid crystals [16] emitted light is focused on a very small area of the workpiece surface. Melting or evaporation of the material occurs in the area of the laser beam and the cutting products are removed through the flow of the accompanying inert gas (purple or nitrogen) to the beam.

The laser is used for cutting and engraving all kinds of materials from steel, aluminum alloys, plastics, and ceramics. The cut thickness is 15 mm in the case of steel, and plastic foils with a thickness of 1 mm can be cut. The cutting speed is 6 m / min when cutting steel and 90 m / min, when cutting plastic," The laser is also one of the most common methods of rapid cutting in which the cutting speed and the quality of the cutting surface can be controlled [17]



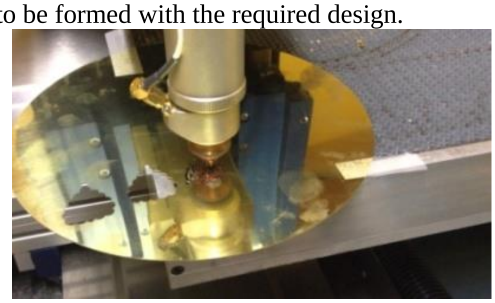
Picture (15) [18]:

The operation is characterized by the ability to cut all materials and produce high-quality cutting edges (without thermal effect on them), smoothness and straightness free of excess, as well as the possibility of executing small diameter holes and high-speed cutting.



www.pinterest.com

Pictures (16) show the feasibility criterion and the esthetics criterion using laser technology on 5 axes (stereotypes) using a movable table on which the product (golden bracelet) is based, to be formed with the required design.



https://www.google.com.eg/images

Picture (17) shows the standard of the feasibility of implementation using laser technology on two axes 2d using a fixed table on which the surface of the material (gold metal) to be cut is based on the required design.

24 Using CAM to control product's quality:

In our current era and with the tremendous development of technology affecting our daily lives in all the products surrounding us, whose basis is based on computer programming, "With the introduction of computers, engineers felt the need to take advantage of the advantages of computers in the field of hardware through the digital control system [19]

Through the use of a digital controller, the controller "receives measurements from the system, processes them, and then sends control signals to the operator that influence the control procedure in nearly all applications. Both the plant and the operator are analog systems [20].

The CAM programs give paths for the movement of the machine Tool Path, which are the lines that follow the operation, and most of the CAM programs can represent mechanical movement on those paths, giving the expected time to complete that process. The designer has to specify the size, material, tool used, shape, and diameter in order to fully assimilate the pieces to be executed. The CAD/CAM system generates the path of the cutting tool in CNC machines in the form of a CNC program converted to the DXF system, which leads to the realization of coordinate systems and the selection of the cutting tool, its speed, and feeding rates, as most CAD/CAM programs contain speed and feed data automatically.

25 The relationship of advanced methods of cutting operations with laser technology and how they affect the design and production of the product:

It is tangible before us the impact of development in the field of software and specialized machines, which "significantly affected the possibility of using the computer as a tool and technology for product design [21].

The process of rapid cutting in the product using digitally controlled machines, the machine receives various orders through" In the process of rapid cutting in the product using digitally controlled machines, the machine receives various commands through [6]

reading the holes through mechanical means, compressed air or light beam, and thus the occurrence of connection and closing of circuits of electric motors, and with the development of computers it was possible to achieve a direct link between the machine and the computer."

And that is the CNC-Computer-Numerical control. The use of digital control has spread in the rapid cutting operations on the product, which are included in the operation and shaping operations, and the digital computer control may be used to produce the required jobs in large numbers or to produce the spare parts required for the continuous maintenance of work tools.

Hence, we find that advanced methods systems such as laser technologies are designed to achieve the integration of design, engineering, and production, as "Integration is a great advantage in achieving the efficient use of the available data to reach an appropriate design for manufacturing [3], and there is no doubt that this integration leads to addressing a fundamental problem represented in the design variation in determining Shapes and dimensions, so CAM/CAD integrated systems achieve this feature, which leads to the best utilization of design, engineering, and manufacturing expertise and skills.

As computer-aided engineering (CAE) is an important part of an important system of the CAM / CAD system, the basic characteristics of manufacturing make it an important part of the integration process. Using the engineering database about the product, its technical composition, product parts, and characteristics.

It can also simulate field conditions to reach the best evaluation of the product and parts at the design stage, while the CAM system in this integration transfers the final design of the CAD system to the manufacturing or assembly stage, where CAM helps in scheduling production, material handling, operating machines and programming them to perform the required process in a way that achieves Accuracy, speed, reliability and appropriate timing in the production of parts and sub-assemblies.

26 The importance of using a scanner in rapid cutting operations

A 3D scanner is a tool that analyzes models into data about their shape and measures their dimensions ،This data is used to create three-dimensional digital models that are used in many applications called 3D printers, which have many types, according to the hologram to be printed, and its advantages are accuracy in data and speed of data capture and obtaining data of the scanned body without contact With it, and this is an important feature in case of difficulty in reaching the body

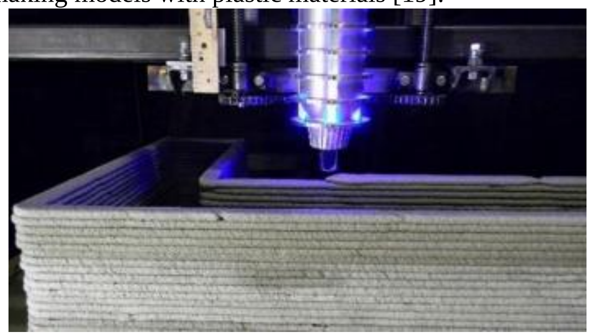
.

Picture (18) shows the relationship of the scanner with the product and the computer

There are three types of 3D printers" optical printers such as SLA and DLP printers, and laser printers such as SLS, and SLM printers, Thermoplastic or fused deposition printers, which are the most prevalent, are FDM [18].

They are single-color plastic printers that use plastic coils and press inside the machine and fuse to come out of the machine head according to the axes and coordinates given by the 3D designer program.

Picture (19) An image showing this FDM-type printer for making models with plastic materials [19].



Pictures (20) showing how to build stereoscopic models by building micro-layers

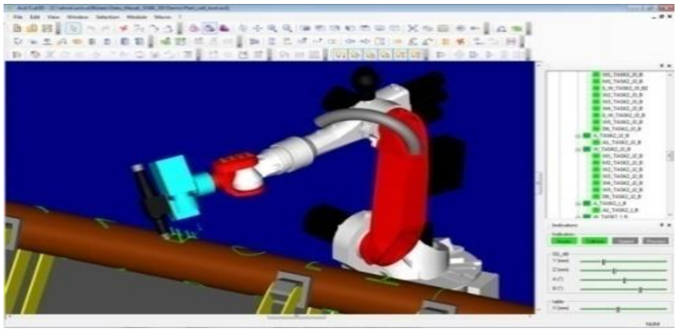
https://blog.educationalgate.com/uploads/images/image.

27 Software

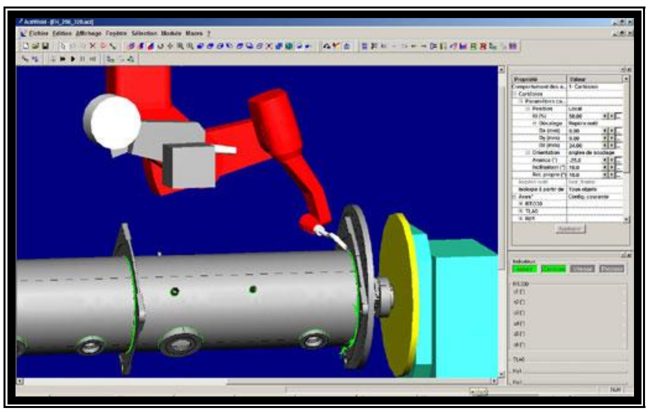
In fact, the program plays a major role in shaping the cutting tool, through the drawing programs that are characterized by accuracy and are linked to the movement of the cutting tool of jet machines. The developments in this industry are the development in the field of software because it is much less than the cost resulting from the development of the machines themselves.

How to program fast-cutting machines: -

Programming is "controlling the movement of the cutting tool through the numbers and symbols associated with each machine, and it begins with a special study between the computer and the machine, focusing in a way on the tolerances for some special operations and on choosing the cutting tool and the type of machine [3].



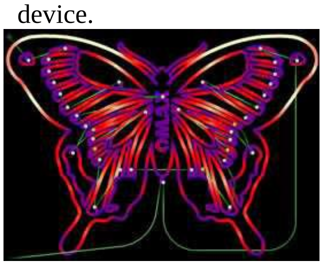
Picture (21) shows a simulation of programming the robot arm for a laser machine using AutoCAD programs and how to calculate the cutting path.[21].



Picture (22) shows how to calculate the cutting path on the program before actually starting the cutting process to avoid errors and follow the required accuracy.

28 Relationship the fast cutting machines CAD and CAM programming:-

"The design programming of any product and laser machines, whether engraving or cutting, is greatly affected, which shows its impact on the aesthetic units that characterize the design [22] Therefore, the user of fast-cutting machines faces the task of converting the data that is provided by the designer in the form of drawing on paper, which is converted into coordinate points. (x ,y) or files represented in AutoCAD, Art cam, or CAD programs by converting the CAD to" file name .dxf" that is run on the device.



Picture (23) [23] shows the shape of the design on the computer, and Picture (24) [23] shows the shape of the previous design in the final stage after performing rapid cutting operations on the desired metal, which is characterized by the use of the computer as an assistant for drawing and design, with a tremendous ability to implement two- and three-dimensional graphics, and to perform enlargement, reduction and repetition operations, and seeing Shapes at different angles and preparing layers to draw parts with multiple components, such as controllers, with the help of symbols.

29 Some of the products used with laser technologies in different materials

https://www.ulsinc.com/ar

http://lasercut-group.ae/textile-and-garment.html

https://www.google.com/url

2. RESULTS AND DISCUSSION

- The connection of digitally controlled machines to the design helps the designer to design and create, and the initial idea reaches implementation and good manufacturing.
- Easy to implement decorative and engineering designs in an accurate and high-quality repetitive manner

Advanced technology capable of reproducing products

- Ease of tracking the path of cutting or drilling and calculating the time of each work separately.

A technology that has the capabilities that make it able to develop the quality of production for the better, periodically and recursively.

- Preparation of samples or identical small batches of products, especially complex ones, which cannot be completed and finished with the normal formation easily.
- Preparation of large production in a short time and with the same accuracy.

- A technology characterized by saving human effort and labor. Only two workers can be used to produce a huge amount of cutting operations within the facility.

3. RECOMMENDATIONS.

-The necessity of keeping pace with the rapid scientific development in the technology of the devices used and assisting in the design and manufacturing processes in the stages of product design.

- Shed light on how to simulate cutting operations on advanced computer programs and how to track the calculation of the cutting path and avoid errors

- Studying cutting processes using advanced technologies on the three-dimensional shapes of different products.

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Jouf University Science and Engineering Journal (JUSEJ) 2022; 9(2): 31- 49
Published online: Dec. 2022 (https://www.ju.edu.sa/en/jouf-university-science-and-engineering-journal-jusej/home/)
Print ISSN: 1658-6670 ***Electronic ISSN:1658-9173 (1443/5074)***

OPTIMIZATION AREA, SIMULATION, AND PRODUCTION OF BIODIESEL FUEL OF JATROPHA IN JAZAN MUNICIPALITIES, KSA

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Submission Date: *Sept. 26, 2022.*
Accepted Date: *Dec. 22, 2022*

The main objective of this paper is to select an optimum site for the Jatropha plant farm, according to the requirement of site selection and a scientific approach to the integration of spatial analysis methods and hydrological study programs to analyze the data in the criteria used with Geographical Information Systems (GIS). Therefore, based on spatial analysis shows groups selected the flat farm, and then select the best location for the Jatropha plant farm. The second aim of this paper is to simulate the design of producing Biodiesel fuel from the Jatropha plants, to solve the impacts of environmental problems leading to health problems such as respiratory diseases caused by the harmful byproducts of burning petroleum-based for producing fuels in the distillation operation of oil, and apply the output of this simulation in the real world after verification of it. Produce Biodiesel fuel from the Jatropha plant is very timely because represents renewable energy. In this paper, the application of GIS optimum site selection for Jatropha plant farm will solve the problems of shortage of diesel fuel, the treatments, and chemical operations is carried out to produce the biodiesel from Jatropha plants, Jatropha is an oil-bearing plant. By using GIS for optimum site selection, the decision makers prepare good plans for future needs and management of data types. The software's used were ArcGIS10.4 for vectorization, editing, transformation, Topology, adding attribute database, and performing the spatial analysis. The open Source Process Simulator (DWSIM) software has been used to simulate biodiesel production and is employed in power plants. Jazan Municipalities was selected as a study area. The total area of the study in the Jazan Municipalities equals (1128.20) km^2. A simulation of biodiesel production was successfully built to process 1.62 Jatropha oil to produce 1.53 kg/s biodiesel

Keywords: *Geographic Information Systems (GIS), Jatropha plant, Jazan city, Optimum site selection, ArcGIS10.1*

1. INTRODUCTION

According to the study carried by (Mahmoud and Gar Alnabi, 2014), the optimum site selection of Jatropha plant farm helps the planners to develop the techniques of agricultural areas of Jatropha in order to use it for producing of biodiesel fuel. Besides the use of GIS tools for optimum site selection to save time and money, GIS becomes the software of feasibility studies in investment projects, a lot of companies and investors use the software to manage these projects by being highly professional. GIS analysts always help the planning ministers to select the optimum site selection for each investment project by using the integration of all data layers. Recently, GIS analysis techniques for site selection processes are developed to save time and cost.

The climate of Jazan city and the characteristics of the Jatropha both have played an important role and would be selected the Jatropha as an alternative for future biofuels production due to their low cost for their life span (W.-C. Wang,et al,2016). For example, Jatropha endured climate conditions and distinguish by a big resistance to the effects of pests, low precipitation, dehydration in the soil, and diseases thus, it requires the minimal cost of growing from the growth stage to seed production (R.N. Singh, et al,2008). The Jatropha fruits from the tree represent non-edible toxic fruits. The Jatropha tree is useful for erosion and minimizing dessert crawl. Also growing Jatropha trees represents a source of protection around agricultural projects(N.S. Tomar, et al, 2014).

In most world countries, increased demand for renewable energy and alternative fuels for diesel engines and factories due to declining petroleum crude oil reserves and the harmful effects of carbon dioxide resulting from burning crude oil on humans, animals, and plants. Biodiesel represents an alternative source of energy, renewable and clean fuel because is manufactured from to save recourses of energy. The physical properties of biodiesel are similar to those of petroleum diesel.

Biodiesel is defined as one diesel fuel derived from natural resources such as plants or animals. Biodiesel has consisted of long-chain fatty acid esters. The extraction process is the process of converting oil into biofuels (Singh, 2010).

The extracting process of biofuels from the Jatropha plant, starts after heating both the Jatropha oil and sodium methoxide to 60 °C, and mixed for 45 minutes using a magnetic mixer. The mixture is left for 24 hours. Then extract and filtered the Glycerin from the mixture. Biodiesel is a suitable alternative to petroleum because it generated from natural sources (Mustafa Balat, 2010). The Fatty acid esters which include biodiesel determine many important fuel physical and chemical properties of biodiesel (Knothe,2017). The industrial method for the trade production of biodiesel from plant oils and fats is a base-catalyzed transesterification process using potassium hydroxide (KOH) or sodium hydroxide (NaOH) as the homogeneous catalyst and methanol($CH3OH$) .

In this paper, the catalyst used for producing biodiesel potassium hydroxide (KOH) (Knothe, 2017). The impacts of using diesel fuel are:

1. Lower diesel quality
2. Poor combustion
3. Contaminants

Using diesel is caused effects by the increased amount of Greenhouse Gases in the atmosphere, and the reason represents of the emission of carbon dioxide coming from incomplete combustion of diesel fuel in the different means of transportation.

The paper focused on the GIS spatial analysis technology of site selection stages of the farm Jatropha plant to save time and cost after all integrating the database layers related to the site selection of the farm and simulating the process of producing fuel from Jatropha oil. Also, the paper focuses to achieve these objectives

- To Select the optimum farm in the study area according to the requirements of the selection using GIS analysis techniques
- To use jatropha to biodiesel as a new energy source.
- To build a flow chart (biodiesel plant).
- To operate different conditions to study plant performance.
- To using the open source simulator software(DWSIM) simulate biodiesel production.

2. METHODOLOGY

2.1 THE BASE MAP

The base map used for selecting the optimum site of jatropha farm in Jazan, the Kingdom of Saudi Arabia(KSA) and includes Jazan city Municipality, a part of Hakamiah Municipality, a part of Wadi Jazan municipality, a part of Sebia Municipality, Damad Municipality, Abu Arish Municipality, and a part of the

Red Sea. The total area of the study in the Jazan city area equals (1128.20) km^2. The source data of the satellite image, the base map, and the Digital Elevation Model (DEM) are classified in Table 1.

Table 1: *The information of the two sources of the base maps*

No.	Data	Source	Data notes
1	Projection	Universal Transverse Mercator (UTM)	UTM Projection is used to transfer the latitude and longitude coordinates to metric (Easting and northing)
2	False Easting	500000.000 meter	False Easting is the East- coordinates related to the origin. For UTM =500000 m
3	False Northing	0.00000000 meter	False Northing depends on whether the point is in the hemisphere. If the point in the northern hemisphere, the false northing =0 m
4	Central Meridian	45 Degree E	Central meridian of zone 38= 45^{0}E
5	Scale Factor	0.99960000	The Scale factor of Central Meridian
6	Latitude of Origin	0.0000000	Latitude of Origin is the origin of north- coordinates
7	Linear Unit	Meter	Metric system in (IS) units.
8	Geographic Coordinate System (GCS)	GCS_Ain_el_Abd_1970	Metric (GCS) in the local datum
9	Datum	D_Ain_el_Abd_1970	Local Datum of KSA
10	Angular Unit	Degree	Angular unit(deg. Min. Sec.) in UTM

The geo-databases of the study are established of three components of the following:

a) Satellite image Landsat7 (with three bands: red, green, and blue) (Fig. 1).

b) The base map of Jazan Municipalities (Fig. 2).

c) Digital Elevation Model (DEM) of Jazan Municipalities (Fig. 3).

Fig. 1. The Satellite Image of Jazan, KSA (Output from ArcGIS10.4).

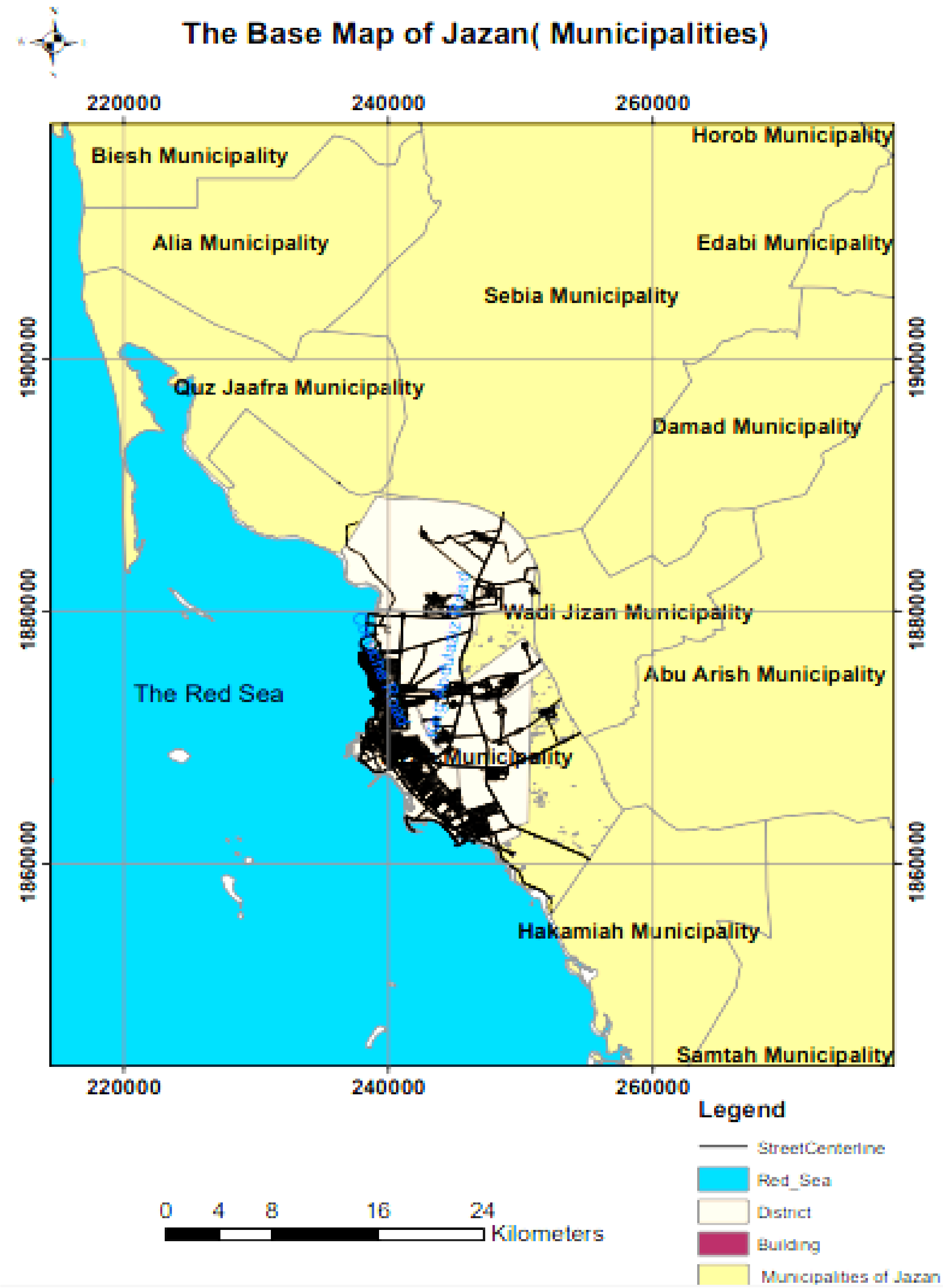

Fig. 2. Jazan Municipalities (Output from ArcGIS10.4).

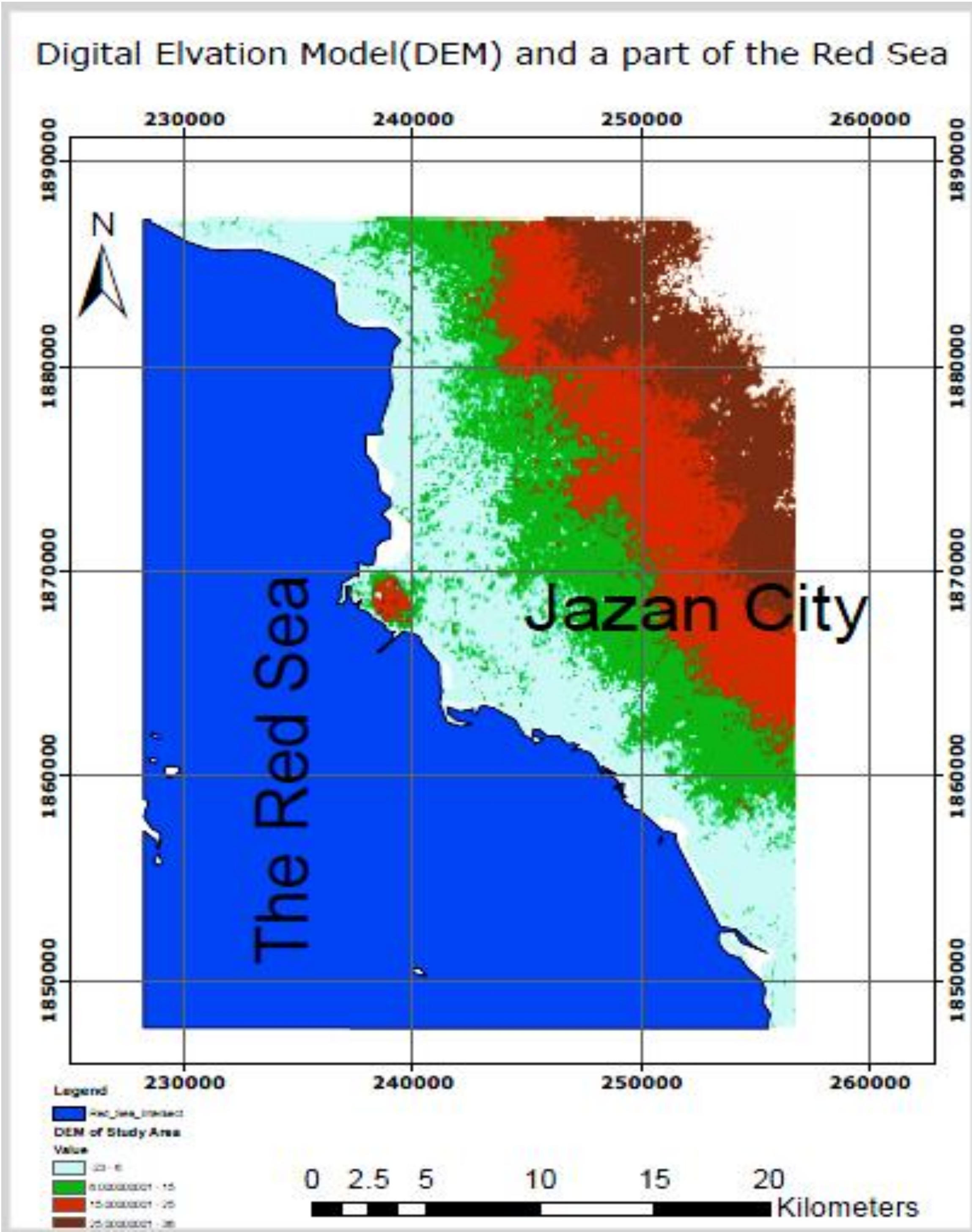

Fig. 3. The Digital Elevation Model of Jazan Municipalities (Output from ArcGIS10.4).

2.2 SOFTWARE USED

The software packages used include (ArcGIS Version 10.4 and Arc Hydro Version 9) for processing and analysis of the paper results. ArcGIS10.1 software packages (Arc Catalog10.4, Arc Map10.4, and Arc Toolbox 10.4).The software's were used for performing this paper tasks are:

1. Modeling of geo-database and displaying (Is carried out using the software Arc Catalog10.4).
2. Preparing the layout of the model maps and performing the model tasks (using Arc Map10.4 software).
3. Establishing a digital model of the study area and carrying out the spatial analysis of optimum site selection (using Arc Map10.4 software).
4. Performing a hydrology analysis to select the watershed and basin of rainwater harvesting(using Arc Hydro 9 software)

2.3 STEPS OF METHODOLOGY

In this paper, the methodology adopted consists of four steps. Firstly, spatial analysis was carried out, after spatial and attribute data had been added properly to the GIS model. Also, the information of the required analysis of the area is interred into ArcGIS10.4 software Secondly, carried out the spatial analysis of the input data of the study area is performed. Thirdly, the conclusions and recommendations did after checking to the second step. Finally, the optimum area of the Jatropha farm is selected and according the results of the software's analysis Arc Hydro9 and ArcGIS10.4. The most important data used in this paper are:

- ❖ The topographic map of Jazan Municipalities.
- ❖ The elevations on contouring are derived from the Digital Elevation Model (DEM) of Jazan Municipalities.
- ❖ The information of the land use map of Jazan Municipalities.
- ❖ The Rain falls data of Jazan Municipalities.
- ❖ The soil classifications data of Jazan Municipalities.

In ArcGIS10.4, the mathematical method of spatial analysis used to select the optimum site of the Jatropha plant farm was the intersection method based on the sets theory in linear algebra.

2.3.1 PROCESSING OF DATA

Practically, the GIS model data (spatial and attributes) is arranged and transformed to shape files with the extension (shp.), this extension represents the basic of GIS data. Moreover, the possibility of data exchange depends on it. however, Modern GIS technology can complete this process fully for the land use topographic maps which include tourist areas, agricultural areas, industrial areas, and residential area by using scanning technology and

Digitizing manually by on-screen digitizing to obtain the required accuracy of the GIS model. The data can be observed from the field by total station and GPS instruments are loaded directly into a GIS. In this paper, ArcGIS10.4used to transfer the study area base maps from Raster to Vector data, built a geo-database, and performed the spatial analysis. Different layers are established directly after digitizing the image and scaning topographic maps of Jazan Municipalities by using a line command manually layer by layer. Errors occur in the process of scanning and tracing raster data solved before the spatial analysis to select the optimum site for the Jatropha plant farm.

The above-mentioned errors should be corrected before the spatial analysis process is carried out.

And also the simulation process is established.

3. RESULTS AND DISCUSSION

The application of GIS for the selection of the suitable site for the Jatropha plant farm is based on the overlaying of all datasets of the GIS model and areas that satisfy specific suitability criteria. in this paper, the spatial analysis consists of two methods of analysis, firstly, selection by attribute according to the required selection. Secondly, using the method of intersection in which the optimum site selection of the Jatropha plant farm is based on the intersection between different geographic layers. The buffer areas are created according to the requirements of the project. An agricultural Project used in the investigation is the Jatropha plant farm in Jazan Municipalities is chosen according to the following criteria:

1. The Jatropha plant farm is at least 20000 hectares (200 km^2).
2. The distance of the Jatropha plant farm from the Mahlia generation station is ≤ 200 m.
3. The soil of Jatropha plant farm should be suitable for agriculture.

4. The distance from the center of Jazan city should ≤ 10 kilometers.
5. The distance should not be ≥ 8 kilometers away from the largest watershed of rainwater harvesting.
6. The distance of the Jatropha plant farm from the main existing roads is ≤ 200 m.

In this paper, to obtain the results of analysis, two parts are discussed

1. Steps of analysis for selection the optimum farm of Jatropha.
2. Built a simulation of biodiesel production.

These parts are detailed in the following:

3.1 STEPS OF ANALYSIS

Fig. 4 represents a flowchart processing of selecting the best farm for cultivating Jatropha trees. This method includes data collection, scanning the Jazan base map, performing digitization, correcting the errors, performing topology, integrating of spatial data to attribute data , carrying out analysis, and selecting the best area for planting Jatropha.

Fig. 5 illustrates the area (228.5 km^2) in Jazan City, KSA which was calculated by ArcGIS10.4. The area is located in the case study location.

A report by the Federation of Oils, Seeds and Fats Associations Ltd (FOSFA) stated that the yield of oil per hectare is around 2.2-2.7 tons (Ashwani Kumar et al., 2008). In the case study of this research, the available area for cultivation of Jatropha is about 228.5 km^2. Thus the yield of the oil from this area will be 51,412.500 tons/year (1.63 Kg/s).

Jatropha seeds include about 27-40% of oil (Achten,et al,2008) this oil is produced biodiesel fuel that is usable in a standard diesel engine, and electricity plants generation.

Fig. 6 shows the Jazan city soil map established by ArcGIS10.4. The soil of Jazan city can be described as silt, clay, and sandy. The soil classification used in the current study is based on the soil investigation carried out by (Ali and Mahmoud, 2020). The characteristics of the soil showed that the sandy soil is suitable for planting Jatropha. It is worth mentioning that such sandy soil can be ideal for planting Jatropha (Gour, 2006).

To achieve the aim of selecting an optimum site for the Jatropha farm, the analysis commands are carried out. These commands and their results are mentioned in the following:

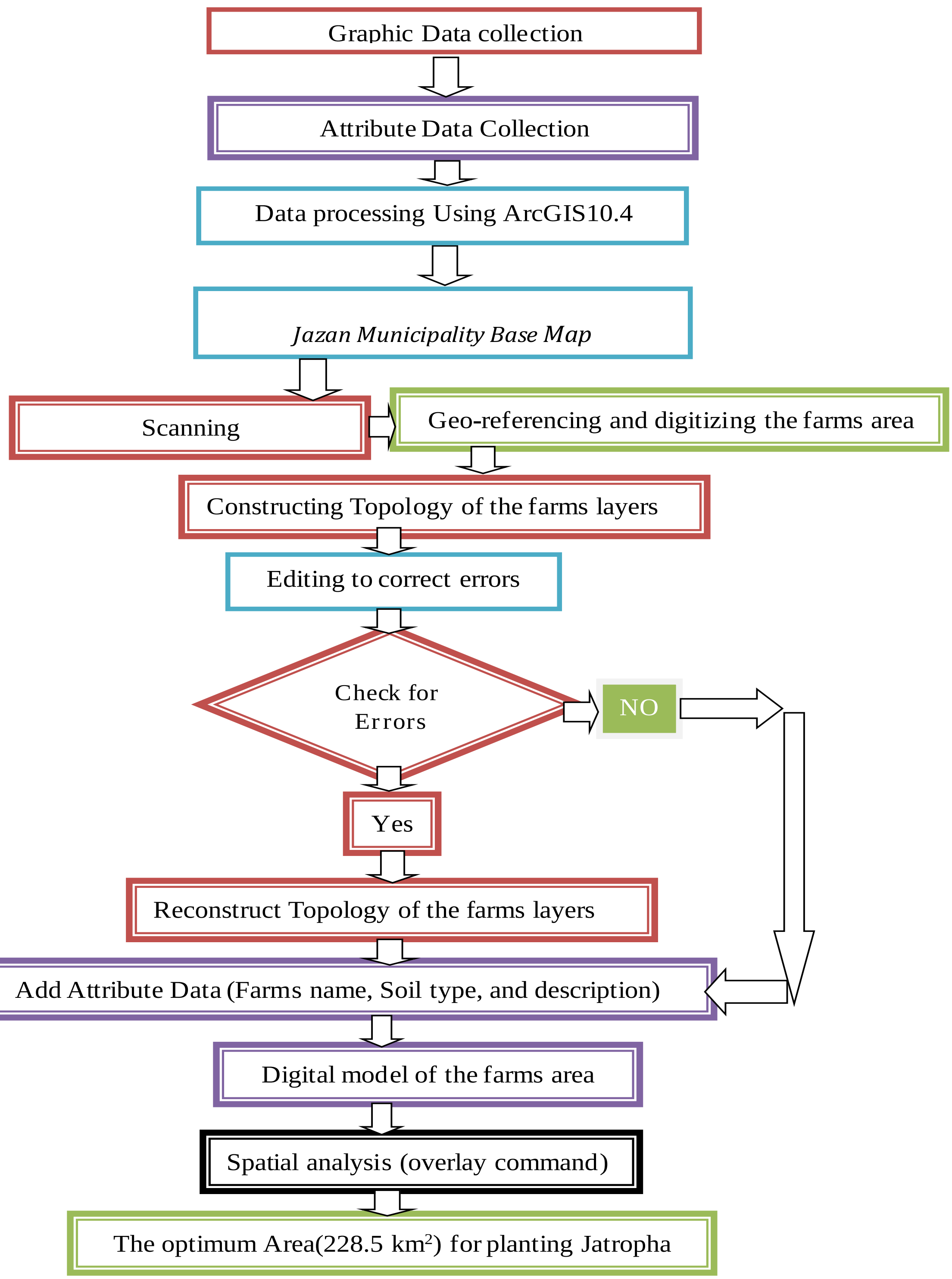

Fig. 4. The flow-chart diagram of the methodology of selecting the optimum area

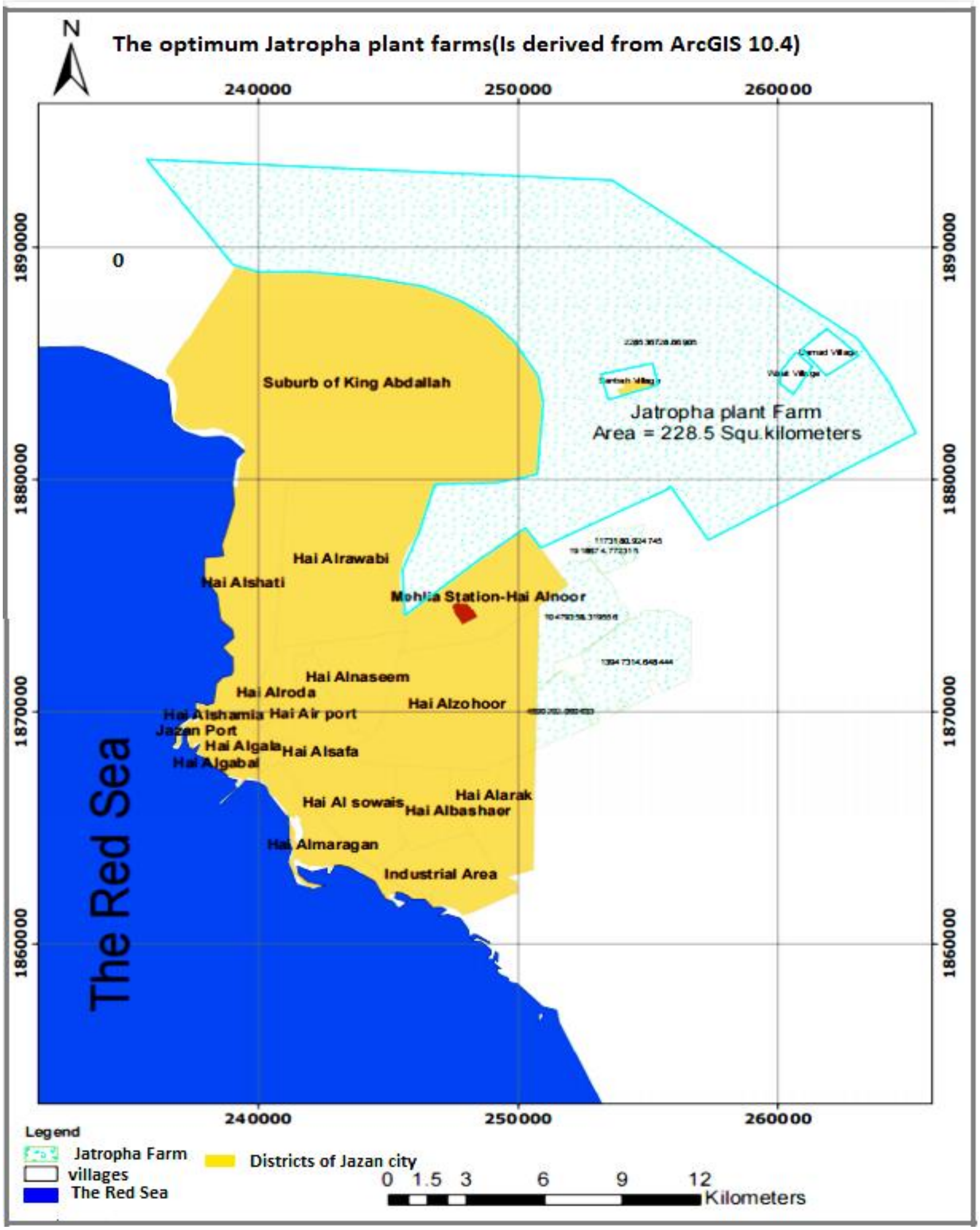

Fig. 5. The area for planting Jatropha (Is derived from ArcGIS10.4)

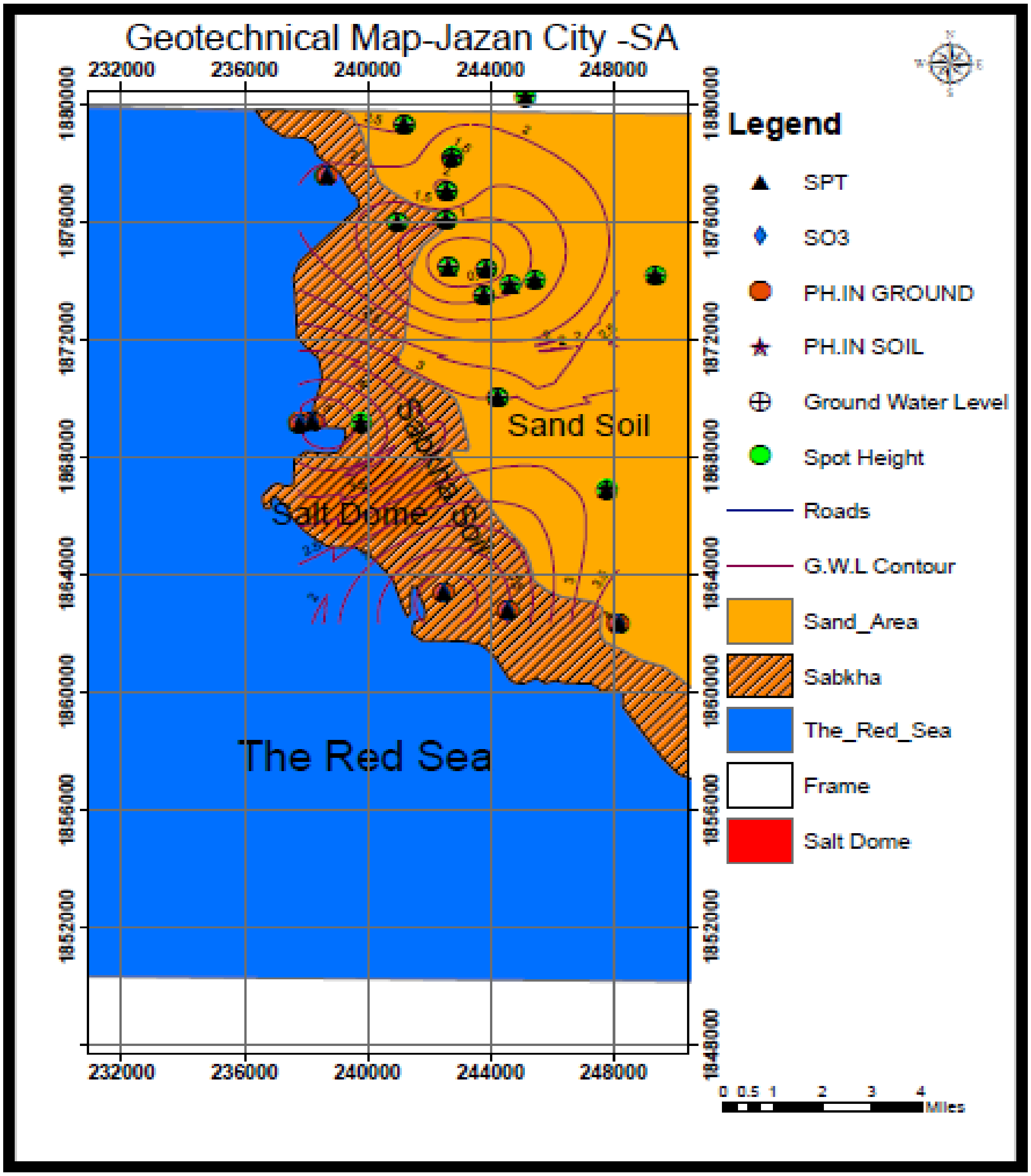

Fig. 6. The classification of the soil of the study area for planting Jatropha (Is derived from ArcGIS10.4)

3.2 .1RESULT OF QUERY ANALYSIS

Figure(7) shows the steps of the analysis according to the six conditions used for optimum site selection of the Jatropha farm, and the command (selection by attribute) in ArcGIS10.4 is selected at first, and the Query facility is used to find the best location that meets the requirements which include an area is at least (20000) hectare and suitable soil.

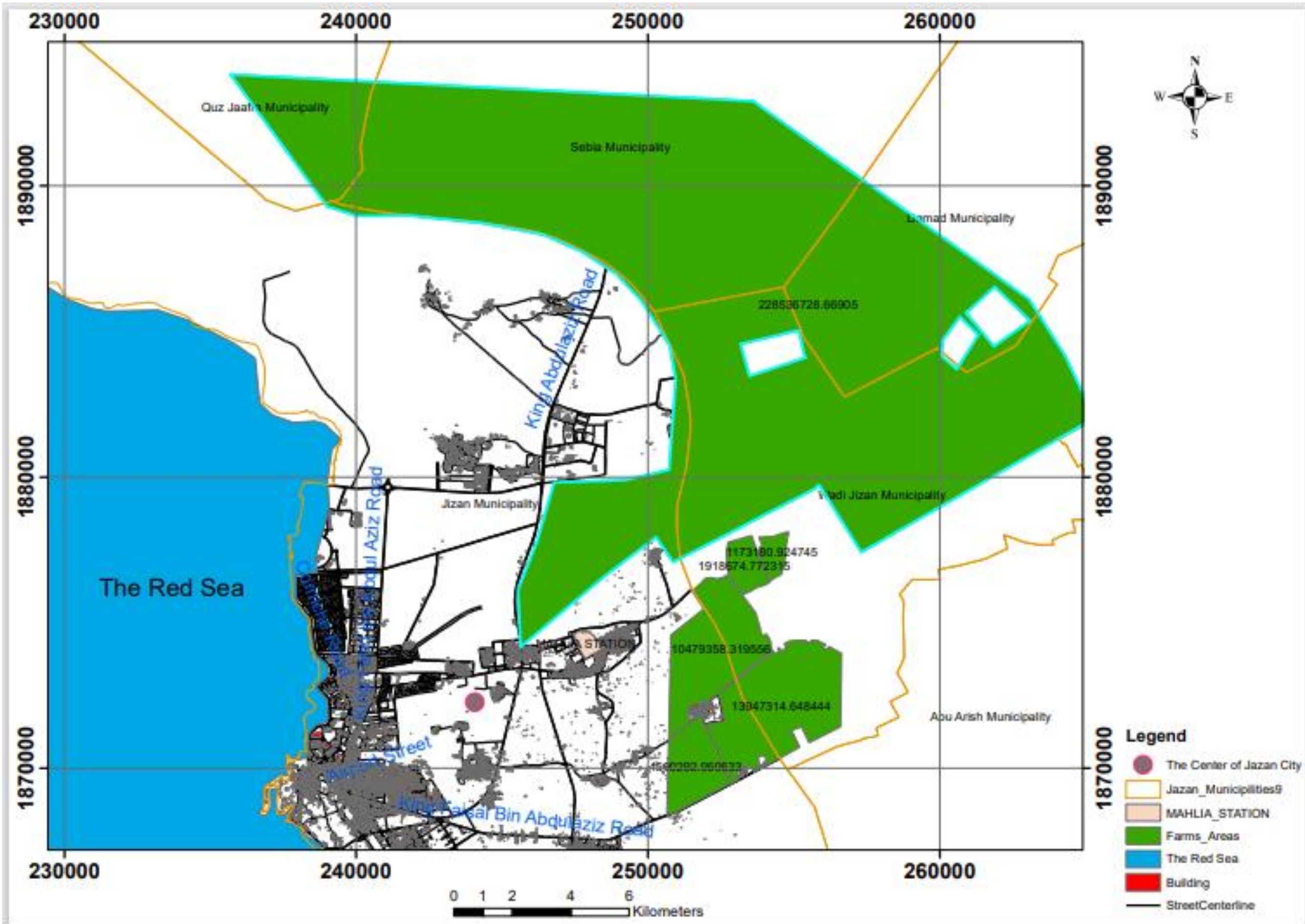

Fig. 7. Select by attributes command (is derived from ArcGIS10.4).

a) Proximity analysis (Buffer command)

A 200-m buffer zone has been establish these roads, a buffer zone of 200 m from the Mahlia generation station, a buffer of 8 kilometers around the watershed area were created, and 10 kilometers a buffer around the center of Jazan using ArcGIS10.4 facility. The results are shown in Figures (8,9,10 and 11)

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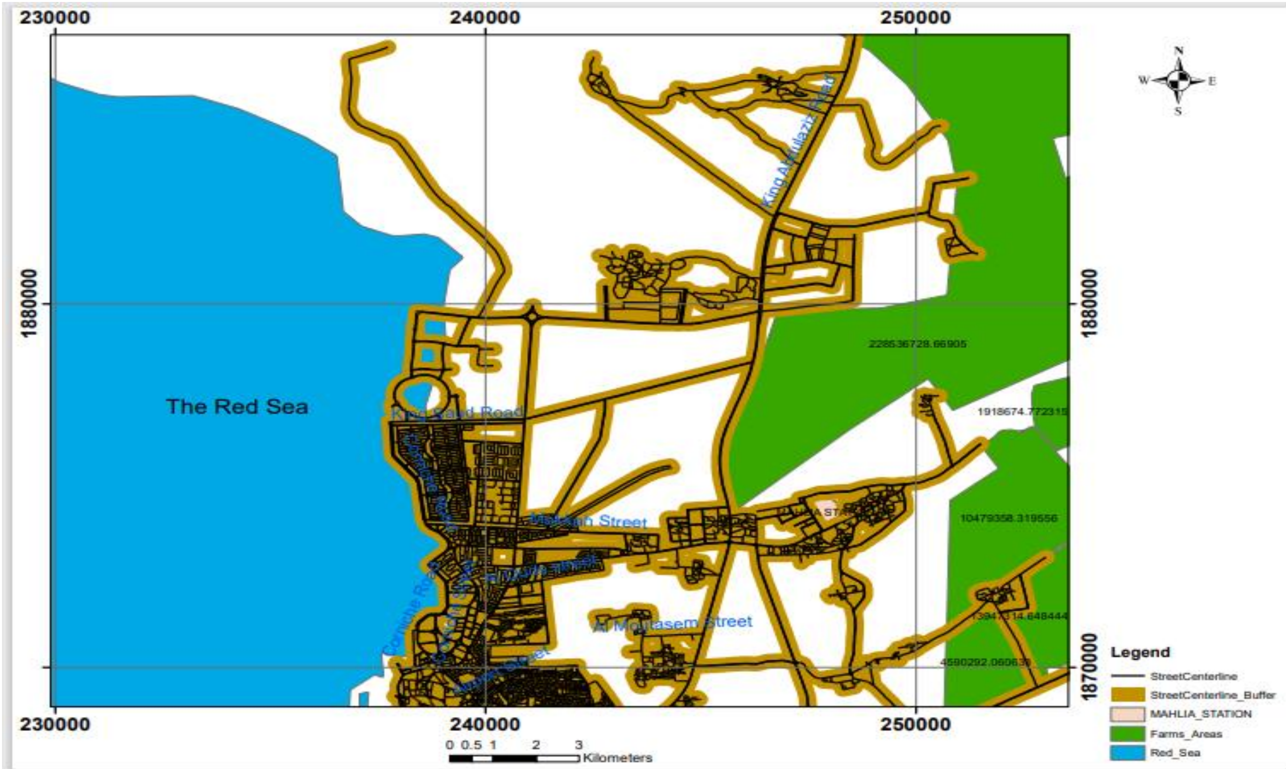

Fig. 8. Buffer 200 meters around Jazan City's main streets(is derived from ArcGIS10.4).

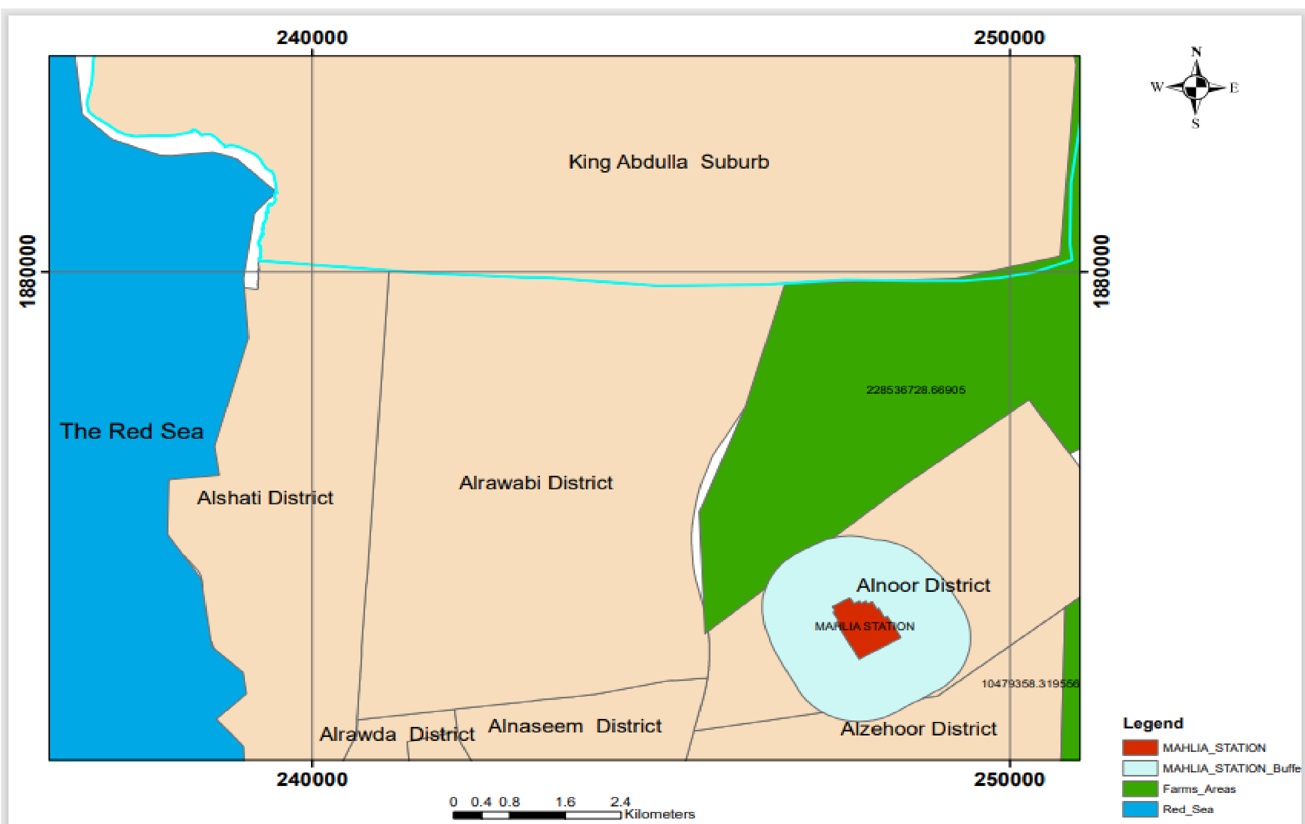

Fig. 9. Buffer 1000 meters around the Mahlia Generation Station(is derived from ArcGIS10.4).

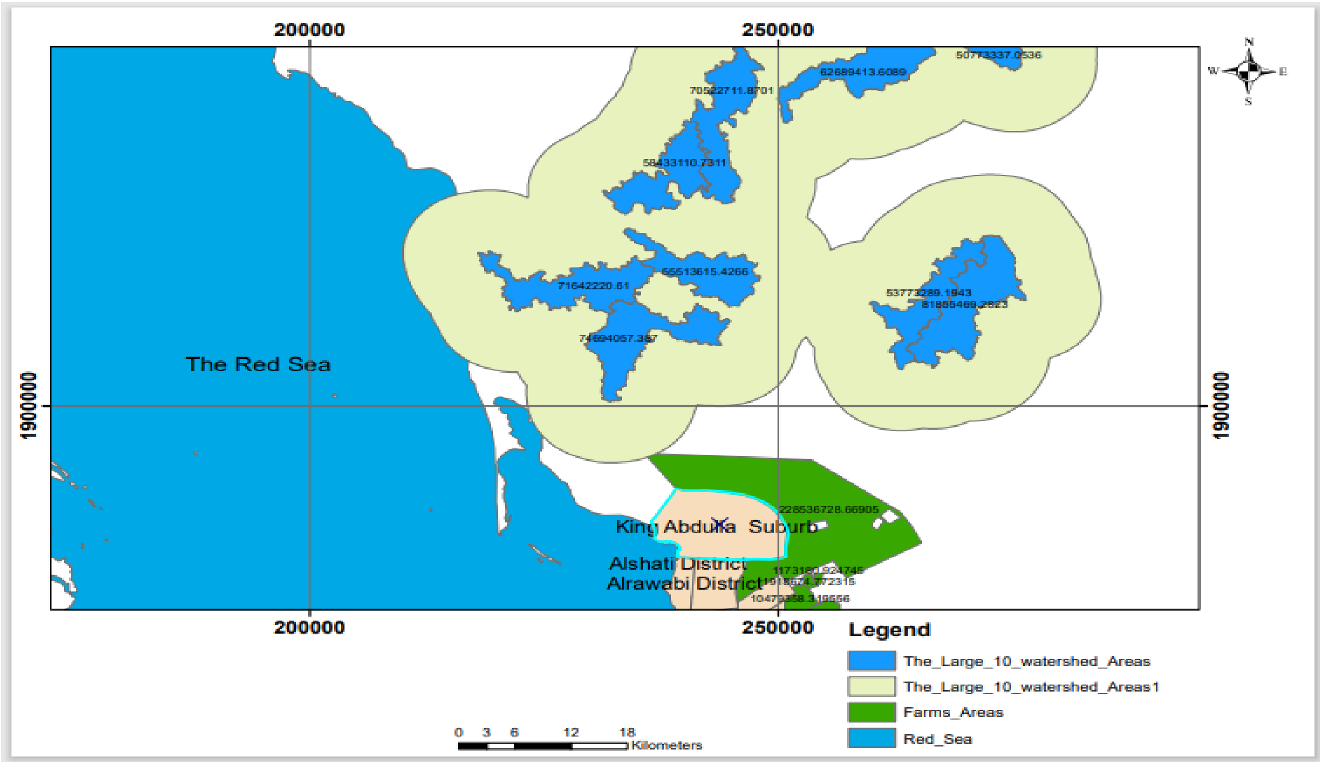

Fig. 10. Buffer 8 kilometers around the Watershed (basins of rainwater harvesting) Areas. (is derived from ArcGIS10.4).

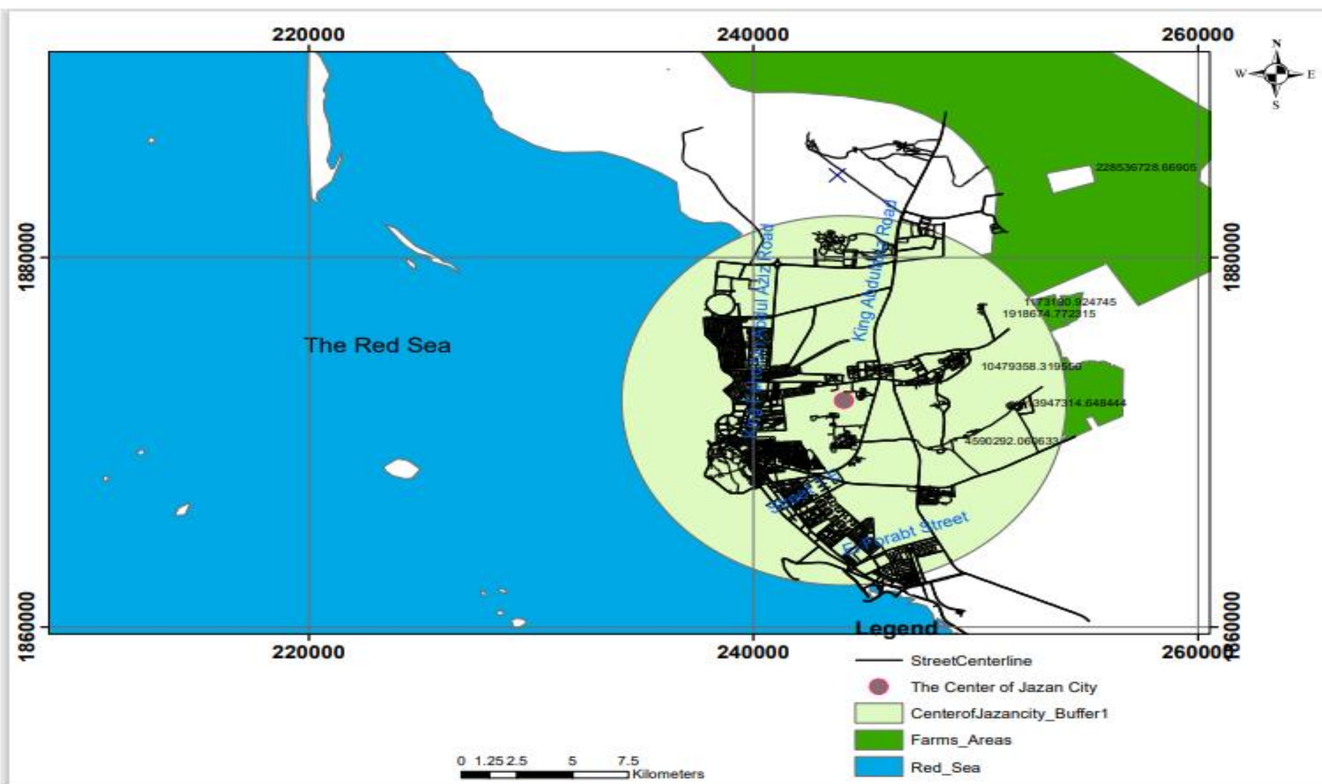

Fig. 11. Buffer 10 kilometers around the Center of Jazan City (is derived from ArcGIS10.4)

b) The facilities of GIS overlay analysis (intersect)

In the below graphs, the facilities of GIS overlay analysis (intersect), the analysis showed that the agricultural farm whose Object ID number is 6 in Jazan Municipalities farms is the most suitable area for Jatropha cultivation.

Figures 12, 13, and 14 show the final results of selecting the optimum site selection of Jatropha farms, the graph of the farm's area in Jazan City, and the graph of the watershed areas classifications in Jazan Municipalities.

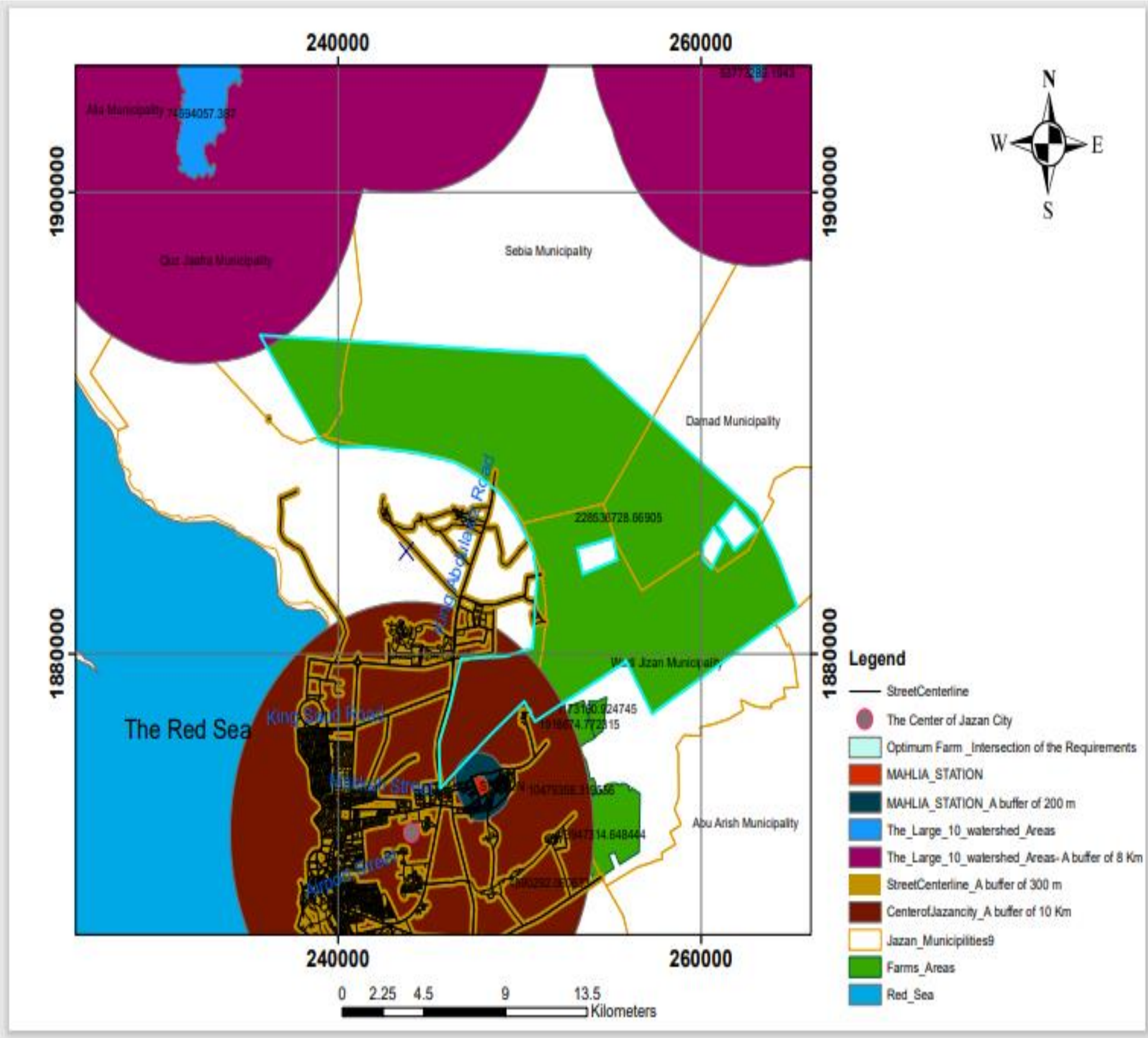

Fig.12. The optimum area for planting Jatropha (is derived from ArcGIS10.4)

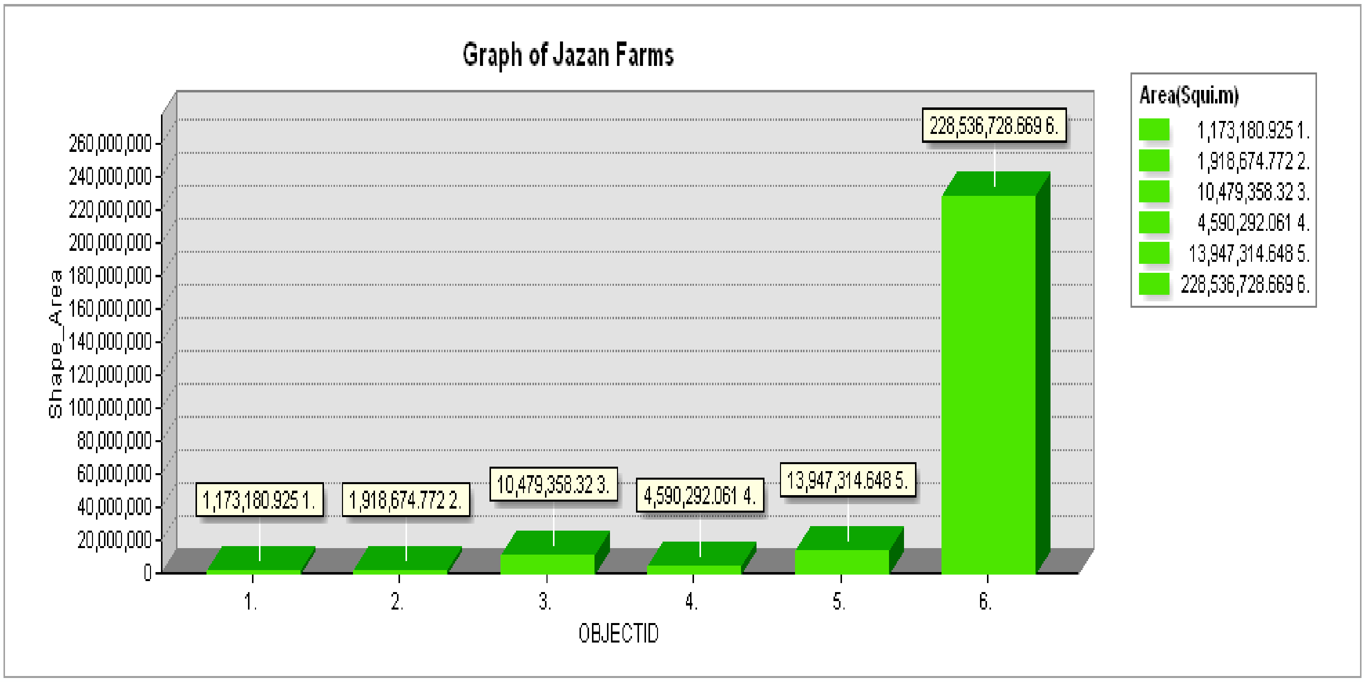

Fig. 13. Graphs of the optimum area for planting Jatropha (is derived from ArcGIS10.4).

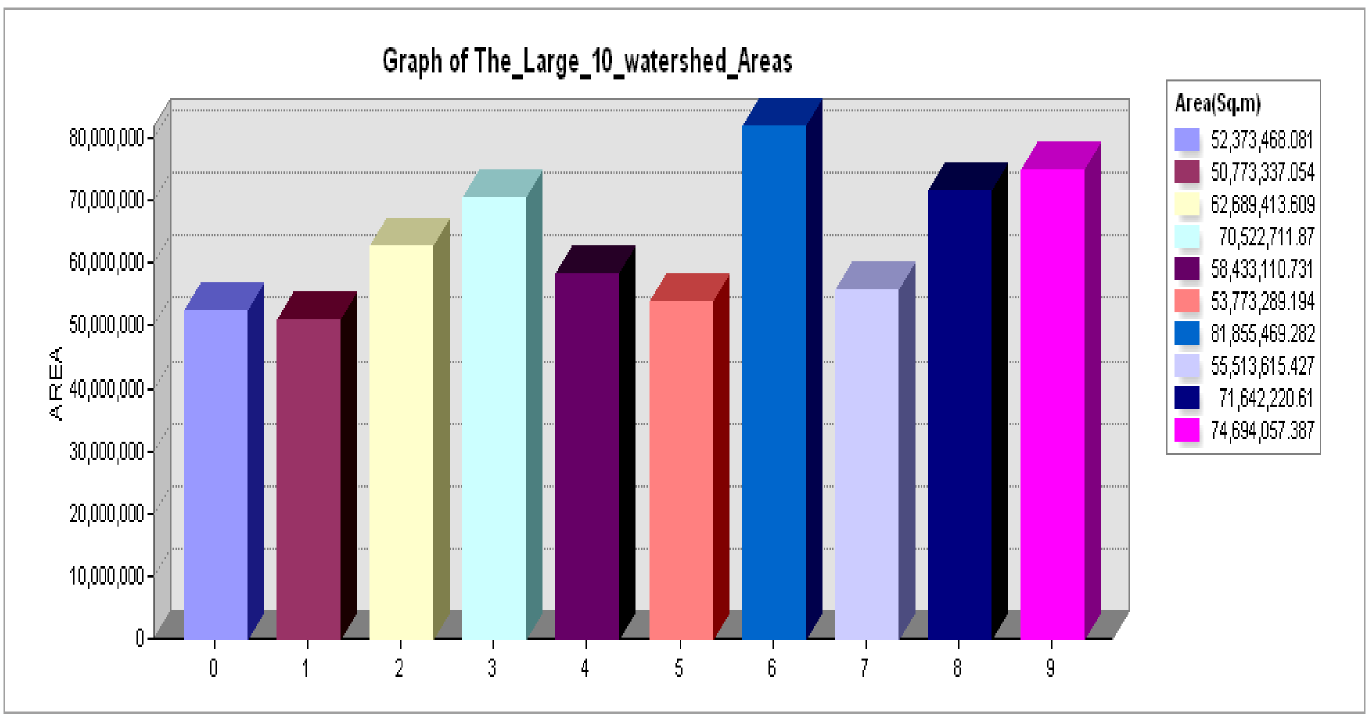

Fig. 14. Graph of the watershed areas for irrigation system (is derived from ArcGIS10.4).

3.3 SIMULATION AND PRODUCTION OF BIODIESEL FUEL IN JAZAN

As discussed above the area used to cultivate Jatropha is about 228.5 Km^2. this area produces 1.62 Kg/s of oil. In this paper, a simulation using DWSIM software was conducted. The second objective of this paper, to use the Jatropha seeds oil for biodiesel production.

Figure 15 shows the steps of the simulation.

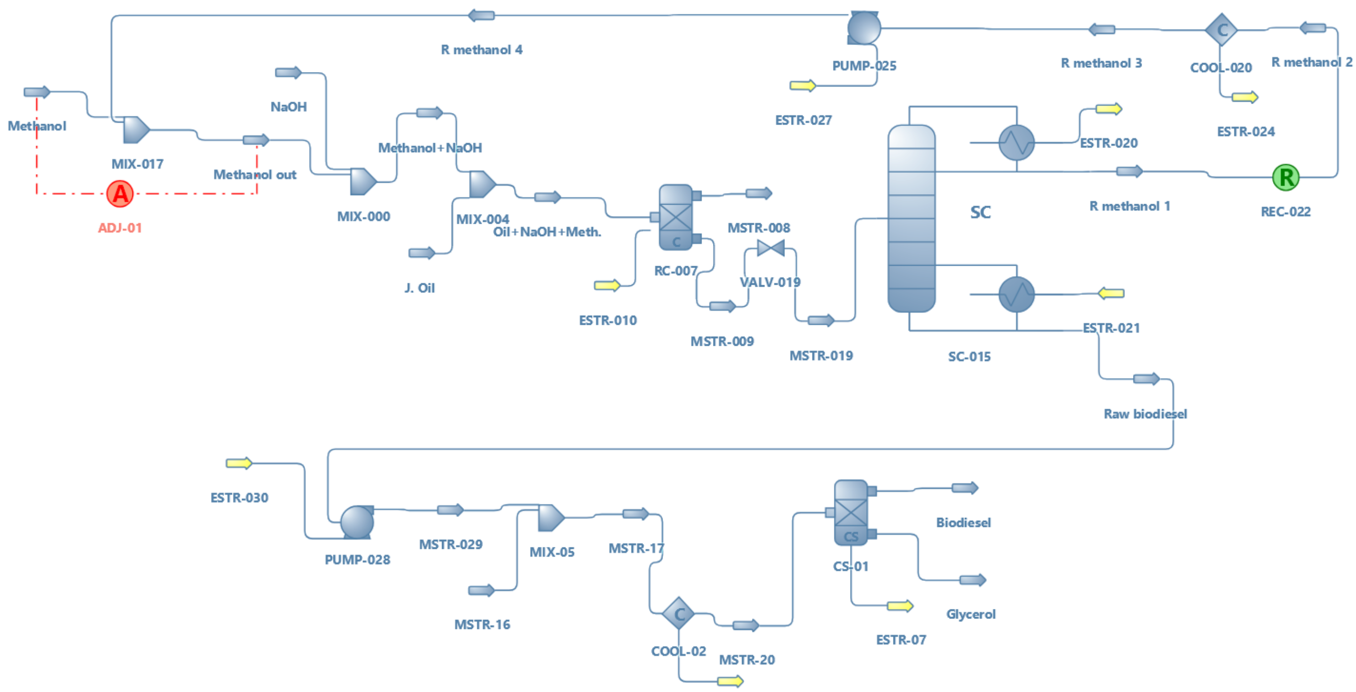

Fig. 15. Simulation of biodiesel production

A simulation of biodiesel production was successfully built as seen in Figure 15 above. Firstly the methanol is mixed with recycled methanol then mixed with the caustic soda then mixed with Jatropha oil. The mixture is then introduced to the reactor. In the reactor, a reaction between the oil and methanol took place to produce biodiesel and Glycerol. Unreached methanol was separated using a shortcut column. The methanol comes out from the shortcut column with a slightly raised temperature of around (39^{o}C) as seen in Table 2 so it passed to the cooler to cool the methanol to around (25^{o}C). Before mixing the methanol is linked to the adjuster to adjust the amount of molar flow rate after methanol mixer to be around 10.11 mol/s methanol's. Then the raw biodiesel and glycerol went to a separator to separate them from each other after adding water. The biodiesel produced is 1.54 kg/s which can be transferred to a power plant to generate energy. Also, the solid wastes of Jatropha can be processed to generate more energy.

Table 2: *Biodiesel production simulation results*

	Biodiesel	Glycerol	R methanol 1	Methanol out	R methanol 3	Raw biodiesel	Methanol	J. Oil	R methanol 4
Temperature (K)	298.15	298.15	312.208	305.266	298.15	502.391	311.924	333.15	298.167
Pressure (Pa)	101325	101325	30397.5	101325	30397.5	30397.5	101325	101325	101748
Mass Flow (kg/s)	1.53769	2.3944	0.156704	0.324	0.156939	1.80631	0.167061	1.62	0.156939
Molar Flow (mol/s)	6.51481	119.011	4.88543	10.1073	4.89275	7.52672	5.21455	1.82959	4.89275
Volumetric Flow (m3/s)	0.001714	0.002392	0.000248	0.000427	0.000205	0.002192	0.000223	0.001808	0.000205
Density (Mixture) (kg/m3)	897.111	1001.19	633.053	757.915	766.041	824.167	750.19	896.221	766.042

4. CONCLUSIONS

The findings of this paper have shown the ability to use GIS analysis techniques for selecting the optimum site of the Jatropha farm according to the requirement of design, which in turn supports the decision-making. The effort made revealed the potentiality of using modern GIS analysis software for selecting the optimum site for the Jatropha farm. In this study, different sources of Jazan Municipalities data were captured and used for selecting the Jatropha farm which includes the topographic base map, the satellites image, contour map, rain falls data, the soil data, and information of the map of land use was digitizing on screen using ArcGIS10.4 to create shape files.

The integration of these shape files is used to select the site of Jatropha farm, because it provides the planners with flexible methods for planning and re-planning for towns. Therefore, many countries of the world use the GIS for all needs of life due to the possibility of this software in storing, retrieving, and analyzing data according to the requirements of the analysis. This is evident in the investment project sites that have been selected by GIS software.

The type of GIS software (ArcGIS10.4, Arc Hydro 9, and DWSIM for simulation) used should also be considered. In this paper, establishing a digital model, and output maps can be used for site selection of different investment projects such as markets, industrial areas, etc in Jazan Municipalities. Besides the simulation software (DWSIM), the study includes two GIS application software, such as ArcGIS10.4 is used for establishing digital models, building geo-databases, carrying out the analysis layout, and mapping. The ArcHydro9 is used for the analysis of rainwater harvesting. The result of optimum site selection of the Jatropha planting area can be useful for decision-makers in producing Biodiesel Fuel in Jazan.

Table 2. Shows the simulation results. These results summarized that the biodiesel production built to process 1.62 Jatropha oil to produce 1.53 kg/s biodiesel.

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