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Development A Burner for Warming Poultry Houses by Used Oil

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ABSTRACT

This research was conducted with the aim of developing a burner model BGO -30A for warming poultry farms using a mixture of used engine oil (UEO) with each of diesel and gasoline. This is to preserve the environment from pollution to reuse a cheap costly waste with no price for warming poultry farms, which reduces the cost of warming. A modified burner covers an area ranging from 30 to 50 m^2, suitable for as using the mixture containing (UEO) and diesel or gasoline. The following factors were studied three levels of mixing ratios between the (UEO) with each of diesel and gasoline [(Ratio of the diesel/ (UEO) (62%/ 38%, 66%/ 34% and 70%/ 30%) (Ratio of gasoline/ (UEO) (40%/ 60%, 45%/ 55% and 50%/ 50%)], three levels of filtering (without filter, one filter, and two filters) and three levels of feeding rate (2.0, 2.5 and 3.0 L/h). The best results of experiment were at mixing ratio of gasoline / (UEO) (50%/ 50%), filtration degree of two filters and feeding rate of 2.5 L/h.

Keywords: heating, used engine oil, combustion efficiency.

INTRODUCTION

Used oil cannot be used for Road Oiling, Weed Control, or to Keep Dust Down. You should be very careful not to put some amount of used oil on the ground, since this can contaminate soil, groundwater, and surface water both on your property and on neighboring properties.

Once this kind of contamination occurs, it can be very difficult and expensive to clean up, and can reduce the value of your property; used oil rules allow a generator to burn used oil in an on-site oil-fired space heater. The manufacturers of certain types of diesel-powered vehicles recommend that you can add used oil to your diesel fuel. If you have vehicles of this type, you may mix your used oil with the diesel fuel per the manufacturer's instructions, and the resulting mixture would no longer have to be managed as used oil. During combustion and chemical processing, the physical properties of engine oil must not change as much as possible. However, due to mechanical movement, a high temperature, and particulate matter, engine oil gradually loses its properties, and engine oil therefore needs to be replaced in a determined period. Thus, waste oil is formed. Today, with the awareness of environmental hazards, many developed and developing countries have been legitimized with the idea of collecting waste mineral oil, which started with economic reasons in advance *(Tamunaidu et al. (1998)).* Studied that no under department of environmental protection (DEP) rules, used oil cannot be used for any of these purposes. It can also lead to your becoming the subject of a DEP enforcement action, which could include a substantial monetary penalty, found that also the manufacturers of certain diesel engines recommend that you add used oil to your diesel fuel. If you have a diesel engine of this type, you may mix your used oil with virgin diesel fuel according to the manufacturer's instructions. However, up until the point that the used oil is actually mixed with the diesel fuel, it must be handled exactly the same as any other used oil. Please note that this exemption applies only to your used oil and only if it is used in your own diesel engines. You may not accept used oil from someone else to put into your diesel fuel. You may also not offer your used oil to others to add to their diesel fuel and found that also Used Oil Burned for Energy Recovery or Used Oil Fuel‖ means used oil with heating value of more than 5,000 Btu/lb *(Rocque and Commissioner (1999)).* All studies indicate that high temperatures reduce the efficiency of utilizing feed energy for productive purposes. Layers not only eat less at high temperature, but also produce less per unit of intake, especially at temperatures above 30°C. The single or combined dietary supplementation with vitamin C and vitamin E of laying chickens exposed to heat stress significantly improved production performances of feed consumption, conversion and egg/bird/day.

Supplementation, of vitamin E alone into diets appeared to be more beneficial for laying hens during heat stress, probably, due to its concurrent function as fertility factor *(Sahin et al. 2002).* There is no obstacle to the use of waste oil as fuel when environmental restrictions are adhered to. Depending on the conditions of use, waste engine oils contain metals and derivatives and some ash. Such materials can be removed from waste oil by various filtration methods. However, for the use of waste oils as direct fuel, only the application of the filtration process may not be sufficient. Depending on the use of waste oil as fuel, some of the physical properties of the oil should be made compatible with the system to be used. While work on the use of waste oil as a direct fuel is ongoing, it is also possible to mix it with existing fuels *(Audibert (2006)).*

Waste engine oils can produce olefin-rich oils at elevated temperatures and that these oils can be obtained with gasoline-like fuel with 96 octane number of prolyl in the presence of an aluminum catalyst *[Demirbas (2008)]*.

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By mixing pyrolysis of used engine oil with filtered wood waste ash, alternative gasoline or diesel fuel can be obtained *[Balat et al. (2009)]*. The recycling of waste oils emerged in order to save raw materials. New sources for the supply of petroleum-based oils to the market were introduced, and the acquisition of competitive value, that is, energy saving, was promoted by considering energy saving [*Arpa et al. (2010)*]. The disposal of waste mineral as oils is an important question, just like the disposal of vegetable oils (*Lam et al. (2010)*). *Aburas et al.* (2015).

Describe the use of pyrolysis and cracking methods to convert waste engine oils to reusable products such as gasoline, diesel, and fuel oil. In the study conducted, calcium oxide was used as an additive in various proportions. Note that zeolite can be reformed in the presence of a catalyst to convert waste engine oils into a fuel that is suitable for diesel engines. For this, the physical and thermal properties of the oil obtained after reforming are compared with those of diesel fuel. The resulting oil is said to be usable in diesel engines *(Kannan and Saravanan (2015)).* In their study, *Prabakaran and Zachariah (2016).*

Examined the physical and thermal properties of waste engine oil reformed in acetic acid and clay compartments by diesel fuel at various ratios. The resulting mixture was tested in a fuel diesel engine and was reported to reduce specific fuel consumption (sfc), nitrogen oxide (NOx), and hydrocarbon (HC) emissions. *Zandi-Atashbar et al. (2017).* Studied the catalytic conversion of waste engine oil to diesel engines in the presence of the nano-CeO2/SiO2 catalyst synthesized by different analytical methods and examined the physical and thermal properties of the fuel. *Bülent Özdalyan and Recep (2018)* found that the availability of waste mineral oils as a direct fuel in diesel engines was investigated firstly, and then the degree of improvement with organic-based Mn additive material was investigated experimentally using a diesel engine with a power of 6.4 kW. Characteristic measurements were made for a constant speed (3000 rpm) and a variable load (750 W–4.5 kW) with an alternator rated at 5 kW. The kinematic viscosity of the waste oil used was too high compared to standard diesel fuel. High kinematic viscosity caused poor atomization of the fuel, poor combustion, clogging of the injectors, and carbon buildup in the segments. High viscosity required a high pumping pressure and injector spraying was reduced. Experiments confirmed this information. For stable working temperature, the oil temperature was used as a reference. The engine used in the experiments was air-cooled and the cooling load was constant for constant engine speed. For this reason, stable working temperature was a clear indication of engine heat loss. The use of oil produced from waste tire as fuel, and the production of synthetic diesel fuel from renewable sources are at least as popular research topics as biodiesel (*Trongkaew et al. (2011), Rowhani (2016), Rosa (2017), Hamilton et al. (2018) and Samavati et al. (2018).* Waste mineral oils are generally divided into two groups: waste mineral engine (or automotive) oil and waste mineral industrial oil. Waste metal engine oils are considered different from industrial waste oils due to the usage conditions. Waste mineral engine oils operate under more severe conditions such as high temperature, high pressure, and combustion. Waste engine oils are called black waste oil due to their color. Waste oils used in machines that are not combustible are called clean waste oil *(Petder (2018)).*

A large part of these waste engine oils is petroleum-based products, and approximately 1.2% of annual petroleum consumption is composed of engine oil. The heat values of waste mineral oils are equal to the heat value of the fuel oil (42–44 MJ/kg) *(Procházka et al. (2018)).* The objectives of this study are (Using of used engine oil in warming poultry farms by using a mixture of used engine oil with diesel or gasoline instead of diesel, for two purposes. The first is to preserve the environment from pollution and the second is to reduce the cost of poultry farms warming.

MATERIALS AND METHODS

THEORETICAL CONSIDERATIONS

This part includes the necessary calculations to figure out the amount of air (m^3/h) that, confirms complete ignition of mixture of used engine oil (UEO) with each of diesel and gasoline fuel and push heat as exhaust values are recommended, then it easy to adjust the fan capacity by accelerating the air which gives the appropriate amount.

Theoretical oxygen (O_2) amount:

Regard on of to data presented in table (1) shown that the diesel fuel consists (by mass) of 86.3% Carbon and 12.8% Hydrogen and 0.9% Sulphur; the gasoline consists of 84% carbon and 16% hydrogen and (UEO) consists (by mass) of 88% Carbon and 11.6% Hydrogen and 0.4% Sulphur. The diesel fuel formula is $C_{7.25}H_{13}$; the gasoline formula is C_7H_{16}. The ambient air consists (by mass) of 76% nitrogen gas (N_2), 23% oxygen gas (O_2) and 1% rare gases. The heating value of diesel 45575 (kJ/kg), gasoline 46536 (kJ/kg) and (UEO) 42210 (kJ/kg). Also, molecular weight, the number of moles and amount of oxygen required to burn one kg of diesel fuel are illustrated in tables (2 & 3) and chemical synthesis of (UEO) in table (4).

To perform the calculations according to burning one kg of mixture of (UEO) with diesel or gasoline fuel per unit mass and net volume a simple relation was conducted by multiplying mass of constant kg/kg (UEO) (table -1) in Oxygen ratio per kg (table-3). Then the amount of Oxygen to burn one kg of diesel, gasoline and (UEO) is 3.334, 3.519 and 3.278 kg respectively.

Table 1. Diesel, gasoline and (UEO) fuel and set specifications for components ratios (Gamaly, 1981 in Arabic).

Fuel	Compositions by mass			Rang of heating values, kJ/kg
	% C	% H	% S	
Diesel ($C_{7.25}H_{13}$)	86..3	12.8	0.9	42612 - 45575
Gasoline (C_7H_{16})	84	16	-	43448 - 46536
(UEO)	88	11.6	0.4	39466 - 42210

Table 2. The molecular weight and the number of moles (Gamaly, 1981 in Arabic)

Substance	Atom		Molecule	
	Symbol	Atomic mass	Symbol	Molecular mass
Carbon	C	12	C	12
Hydrogen	H	1	H_2	2
Sulphur	S	32	S	32

Table 3. The amount of oxygen required to burn one kg fuel (Gamaly, 1981 in Arabic)

Substance	Oxygen red in (kg)	Oxygen red in (m^3)
Carbon (C)	2.666	1
Hydrogen (H2)	8	1/2
Sulphur (S)	1	1

Table 4. Chemical synthesis of (UEO) (Bentaher, 2019 in Arabic).

Chemical synthesis	%
Fe_2O_3	0.43
CaO	15.9
SO_3	37.0
P_2O_5	8.95
ZnO	17.7
Cl	15.9
Another	4.12

Regarding to air density is 1.204 kg/m3, density of diesel is 870 kg/m3, density of gasoline is 760 kg/m3 and density of (UEO) is 890 kg/m3, then the size of one kilogram of diesel fuel is 1.149 L, one kilogram of gasoline fuel is 1.315 L and one kilogram of (UEO) is 1.123 L, so the theoretical amount of air required to burn one kilogram of diesel is 11.93 m3, one kilogram of gasoline is 12.71 m3 and one kilogram of (UEO) is 11.84 m3.

Usually diesel, gasoline and (UEO) fuel needs amount of combustion air more than the theoretical quantity necessary for combustion to ensure that all mixing fuel with oxygen molecules and a full ignition. The amount of surplus air may range from 30% to 70% in some applications, and by controlling the amount of air down to the required quantity, and high degree of precision, control good operational conditions as there are many indicators that help get the process done (temperature, combustion efficiency, combustion exhausts, etc.), and practically in modern designs 25% excess air to fuel gas, 40% excess air for fuel oil is used (Gamaly, 1981 in Arabic). The actual amount of air required to burn one kilogram of diesel fuel is: -

So, the actual amount of air required burning one kilogram of diesel, gasoline and (UEO) fuel is 16.70, 17.81 and 16.58 m3/ kg respectively). Then, the actual amount of air required burning one kilogram of mixing ratios of diesel/ (UEO) [Md1 (62%/ 38%) = 16.654, Md2 (66%/ 34%) = 16.659 and Md3 (70%/ 30%) = 16.664 m3/ kg] and ratios of gasoline/ (UEO) [Mg1 (40%/ 60%) = 17.072, Mg2 (45%/ 55%) = 17.133 and Mg3 (50%/ 50%)= 17.195 m3/ kg].

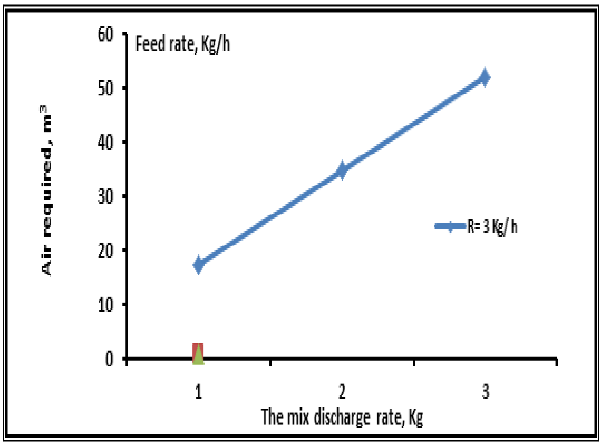

Fig. 1. The quantity of air required for the disposal of different rates mixture of (UEO) each of diesel and gasoline to determine the air pump speed

The air pump of burner gives 720 m^3/ h under rotational speed of a three-blade fan 2700 rev/min to burn 3 kg/h diesel fuel (about 50 m^3/ h). If used mixture of gasoline/ (UEO) fuel (M_{g3}) in burner well be require about 51.6 m^3/ h to burn 3 kg/ h M_{g3} fuel, then the air pump of burner must be gives 743.04 m^3/ h and rotational speed of 2787 rev/min. According to steady fan speed at 2700 rev/min, then the fan must be developed from a three-blade fan to a five-blade fan to increase the amount of air to burn the mixture of gasoline/ (UEO) fuel (M_{g3}).

The experiments were carried out at Refaay village-El-Gamalia region, Dakhlia Government during the winter season 2019-2020. The burner used in the experiment is a 30 kW warming burner, which works on regular electricity 2 won, and has a fuel tank of 30 liters, and the consumption rate reaches 3 L/h, with coverage areas start from 30 to 50 m2 for poultry farms, the burner is equipped with a pump or dual-purpose fuel pump to withdraw fuel from the fuel tank and pump it to the combustion chamber.

The burner is characterized by light weight and small size, which makes it easier for the breeder to move and clean it. The burner before modification parts as shown in table 5 and Fig. (2).

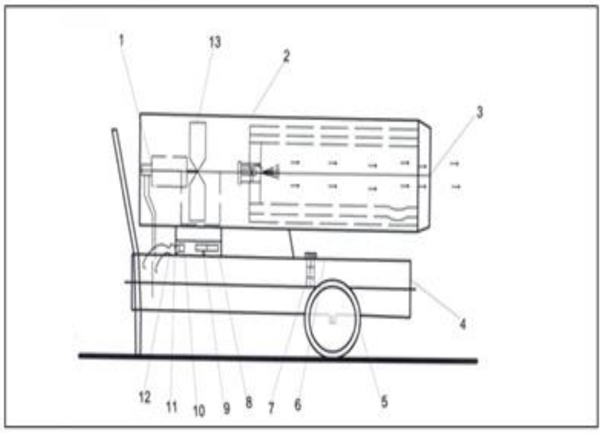

Fig. 2. Burner components for poultry farms that work with diesel before modification

1-Pressure regulator, 2- The body heater: the surface temperature is low when the heater is working, 3-At the air outlet; the temperature is about 200 oc. It is so quick to warm the air, 4- Fuel tank, 5-Rubber wheel for moving, 6-Tank level display, 7-Fuel tank cap, 8-Electric temperature window, 9-Temperature switch, 10-Power switch, 11-Power line with 1.5 m, 12- Temperature sensor and 13- a three-blade fan.

Table 5. Burner specifications before modification.

1	Model	BGO- 30 A
2	Output	30 kW
3	Electrical input	220-240V- 50Hz 340W
4	Fuel consumption(L/h)	3.0
5	Fuel	Diesel
6	filters	Without
7	Fan	three-blade fan

The burner operating:

The warming burner starts operating by connecting it to an electrical source, and then the sensor that gives the burner the temperature surrounding it begins, so if the temperature The ambient is less than the temperature required to reach it, then the electric circuit is closed of signal is given to the lighter to make an electric spark, after that a small period of time the electric motor works to manage the fan installed on a column to suck the air and push it into the room only A flame in conjunction with the work of a dual-purpose pump that sucks fuel from the fuel tank through a hose and pushes it into the ignition chamber by means of a technician or a sprinkler, so the ignition takes place, and therefore the air from the fan is heated to the ignition chamber and from there to the place to be heated and the burner continues to operate until it reaches a degree The temperature to be required, at which time the temperature sensor gives a signal to the thermostat that the temperature has reached the required temperature, at which time the electrical circuit opens and the burner stops working. As shown in fig. (3).

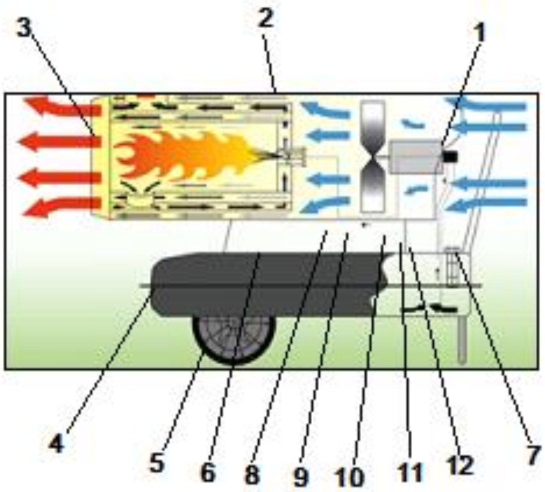

Fig .3. Heat paths in the burner

1- Pressure regulator, 2- The body heater: the surface temperature is low when the heater is working, 3- At the air outlet; the temperature is about 200 oc. It is so quick to warm the air, 4- Fuel tank, 5- Rubber wheel for moving, 6-Tank level display, 7- Fuel tank cap, 8- Electric temperature window, 9- Temperature switch, 10- Power switch, 11- Power line with 1.5 m, 12- Temperature sensor and 13- A three-blade fan.

A developed burner for warming poultry houses by (UEO) for maintaining the necessary temperature in all its distributing warm of poultry farm stages from the age of a day until the end of the breeding cycle. A burner was developed to suit the use of a mixture of (UEO) with diesel or gasoline, with the use of a set of filters and a locker to control the feed rate of the burner. On the other hand, the fan installed on the electric motor (0.5 hp) shaft was developed from a three-blade fan to a five-blade fan in order to increase the amount of air driven into the combustion chamber. The specification developed burner shown in Table 6 and Fig. (4).

Table 6. Burner specifications after modification.

1	Model	BGO- 30 A
2	Output	30 kW
3	Electrical input	220-240V- 50Hz 340W
4	Fuel consumption(L/h)	3.0
5	Fuel	Mixture of (UEO), gasoline or diesel
6	filters	Two filters
7	Fan	a five-blade fan

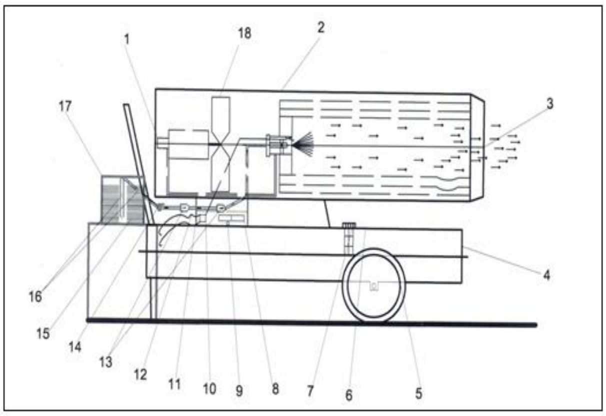

Fig .4. The burner model BGO- 30 A after modification

1-Pressure regulator, 2- The body heater: the surface temperature is low when the heater is working, 3- At the air outlet, 4- Fuel tank, 5- Rubber wheel for moving, 6-Tank level display, 7-Fuel tank cap, 8- Electric temperature window, 9-Temperature switch, 10-Power switch, 11-Power line with 1.5 m and 12- Temperature sensor, 13- Two filters, 14- locker, 15- a mixture of used motor oil, gasoline or diesel, 16- proboscis have inch, 17- vessel of mixture of used motor oil, gasoline or diesel and 18- a five -blade fan.

Test factors:

The following factors were investigated to evaluate the performance of the developed burner:

1- Mixing ratios (M): (ratios of gasoline/ (UEO) and ratios of diesel/ (UEO) in) three levels of gasoline/ (UEO) (40%/ 60%, 45%/ 55% and 50%/ 50%)named M_{g1}, M_{g2} and M_{g3} respectively) and three levels of diesel/ (UEO) (62%/ 38%, 66%/ 34% and 70%/ 30%) named M_{d1}, M_{d2} and M_{d3} respectively),
2- Filtration degrees (F): three levels were (Without filter, One filter and Two filters) named F_1, F_2 and F_3 respectively)
3- Feeding rates (R): three levels were (2.0, 2.5 and 3.0 L/h) named R_1, R_2 and R_3 respectively).

Measurements:

1- **Temperature (T), ºC:** A three mercury thermometers were used to measure the temperature at each experiment, and at each of the three dimensions that were determined to take the measurement at centigrade temperatures.

$$T_d = T_a - T_b \qquad (1)$$

Where: T_d = **temperature (ºC), in side poultry farm,**
T_a = **temperature before working heater (ºC),**
T_b = **temperature after working heater (ºC).**

2- **Combustion efficiency (η_f), %:** The Combustion efficiency was calculated according to (kerschbaumer *et al*, 1989):

$$\eta_f = 100 - V_{therm} - V_{chem} \quad [\%] \qquad (2)$$

Where: η_f = **Combustion efficiency,**
V_{therm} = **thermal losses of the flue gas, [%]**
V_{chem} = **chemical losses of the flue gas, [%].**

$$V_{therm} = [(TA - TU) \{1.39 + (122 / (CO2+CO)) + 0.02 u\}] / [(hu / 100) - 0.25 u], [\%] \qquad (3)$$

$$V_{chem} = [CO \times 11800] / [(CO2+ CO) ((hu / 100) - 0.25 u)], [\%] \qquad (4)$$

Where: **TA = flue gas temperature [^{O}C],**
TU = ambient temperature [^{O}C]
CO2, CO, O2= concentrations in [vol. %]
u = fuel humidity, [%] hu = heating value of the mixture

If O2 is measured in splte of CO2, CO2 is calculated as follows:

$CO_2 = 0.98\ (21 - O_2) - 0.61\ CO$ [vol. %]……. (5)

3- **Combustion exhausts (Ce), %:** It was measured according to (Nepal , 2006):

$Ce, \% = [(C_m - C)/ C_m] \times 100$ …………….. (6)

Where: **C_m: manually packing mounting fumes, mg/m^3**
C: mechanically packing mounting fumes, mg/m^3

The manually packing mounting fume was estimated the personal fume sampler and it was about 20 mg/m^3.

4- **Economic costs (Ec), L.E/h:** The operating cost was determined using the following formula:

Economic costs (Ec), L.E/h= (Fr Q PF) + (Fr UPO) … (7)

Where: **F_r: the mixture consumption rate per hour, L/h.**
Q: the percentage of fuel (gasoline or diesel) of the mixture, %.
P_F: the price of litter (gasoline or diesel), L.E/ L.
U: the percentage of (UEO) of the mixture, %.
P_O: the price of litter (UEO), L.

Statistical analysis: All obtained data was tabulated and analyzed in split-split plot design [main treatment (mixing ratio), sub main treatment (filtration degrees) and sub sub main treatment (feeding rate)] by Minitab program under level of probability of 5%.

RESULTS AND DISCUSSION

1- Temperature (T), oC

By increasing mixing ratio of mixing gasoline to (UEO) from [M_{g1}= (40%/ 60%) to M_{g2}= (45%/ 55%)] the temperature increased from 23.0 to 25.3 ºC and increasing mixing ratio of mixing gasoline to (UEO) from [M_{g2}= (45%/ 55%) to M_{g3}= (50%/ 50%)] the temperature increased from 25.3 to 28.1 ºC. On the other hand increasing mixing ratio of mixing diesel to (UEO) from [M_{d1}= (62%/ 38%) to M_{d2}= (66%/ 34%)] the temperature increased from 22.4 to 24.2 ºC and increasing mixing ratio of mixing diesel to (UEO) from [M_{d2}= (66%/ 34%) to M_{d3}= (70%/ 30%)] the temperature increased from 24.2 to 26.6 ºC. All these results were obtained under Filtration degree (F_1= without filter) with feeding rate of mixing gasoline or diesel to (UEO) (R_1= 2 L/h) as shown in Figs (5 & 6).

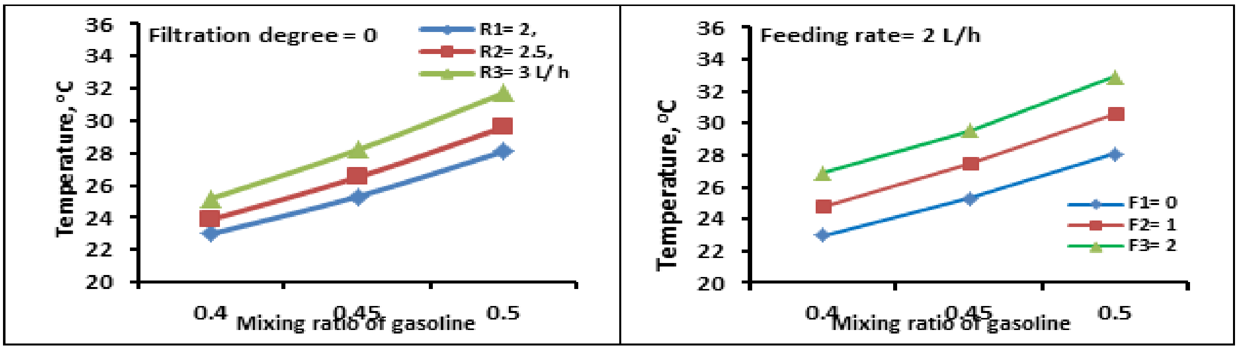

Fig.5. The effect of the mixing ratios on the temperature of mixing gasoline to (UEO).

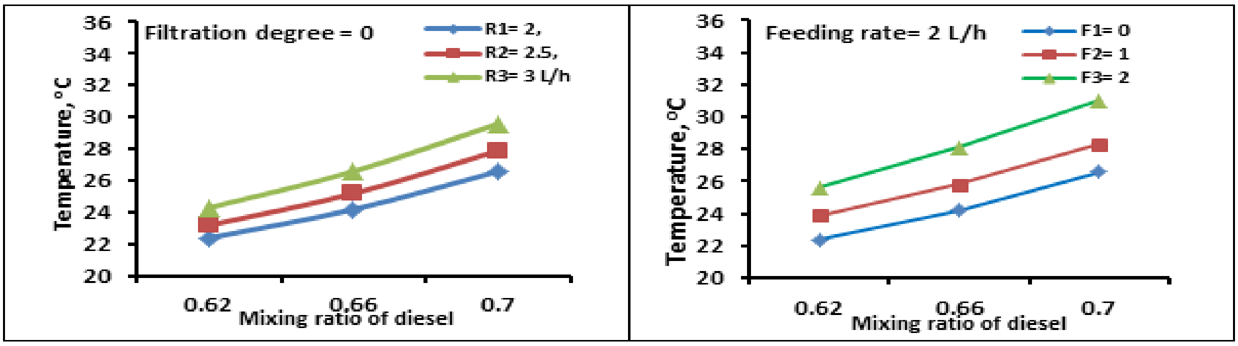

Fig.6. The effect of the mixing ratios on the temperature of mixing diesel to (UEO).

These results may be due to that increasing mixing ratio led to an increase in the percentage of gasoline or diesel in the mixture, i.e. an increase in the heating value of the mixture, which leads to an increase in temperature. Statically there are high significant effects for different treatments with ($P < 0.05$) for the temperature values.

From ANOVA analysis tables (7a, 7b) shows that mixing ratios affect temperature more than filtration degrees and feeding rates. While feeding rates showed be less effect on temperature than filtration degrees. The effects of different parameters on temperature may be summarized as follows (mixing ratio > filtration degrees > feeding rates).

Table 7a. Regression Analysis: Temperature versus mixing ratios; filtration degrees; feeding rates and regression equation of gasoline/ (UEO) mixture.

T, oC = -9.087 + 61.33 Mg + 2.4056 F + 3.333 R

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	323.441	107.814	853.06	**
Mixing ratios	1	169.280	169.280	1339.40	**
Filtration degrees	1	104.161	104.161	824.15	**
Feeding rates	1	50.000	50.000	395.62	**
Error	23	2.907	0.126		
Total	26	326.347			

S	R-sq	R-sq(adj)	R-sq(pred)
0.355506	99.11%	98.99%	98.76%

Table 7b. Regression analysis: Temperature versus mixing ratios; filtration degrees; feeding rates and regression equation of diesel/ (UEO) mixture.

$T, ^{o}C = -22.61 + 62.36\ M_d + 2.1222\ F + 2.744\ R$

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	226.963	75.654	512.84	**
Mixing ratios	1	112.001	112.001	759.22	**
Filtration degrees	1	81.069	81.069	549.54	**
Feeding rates	1	33.894	33.894	229.76	**
Error	23	3.393	0.148		
Total	26	230.356			

S	R-sq	R-sq(adj)	R-sq(pred)
0.384083	98.53%	98.33%	97.93%

2- Combustion efficiency (η_f), %

Increasing mixing ratio of mixing gasoline to (UEO) from M_{g1} to M_{g2} the combustion efficiency increased from 60.8 to 69.2 (%) and increasing mixing ratio of mixing gasoline to (UEO) from M_{g2} to M_{g3} the combustion efficiency increased from 69.2 to 77.4 (%). On the other hand increasing mixing ratio of mixing diesel to (UEO) from M_{d1} to M_{d2} the combustion efficiency increased from 58.9 to 66.9 (%) and increasing mixing ratio of mixing diesel to (UEO) from M_{d2} to M_{d3}= the combustion efficiency increased from 66.9 to 73.9 %. All these results were obtained under F_1 with feeding rate of mixing gasoline or diesel to (UEO) (R_1), as shown in Figs (7 & 8).

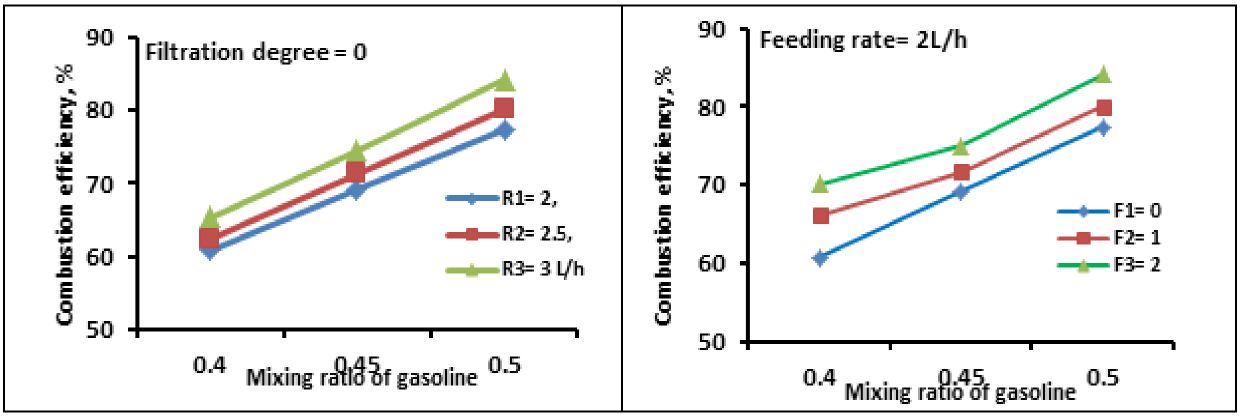

Fig.7. The effect of the mixing ratios on the combustion efficiency of mixing gasoline to (UEO).

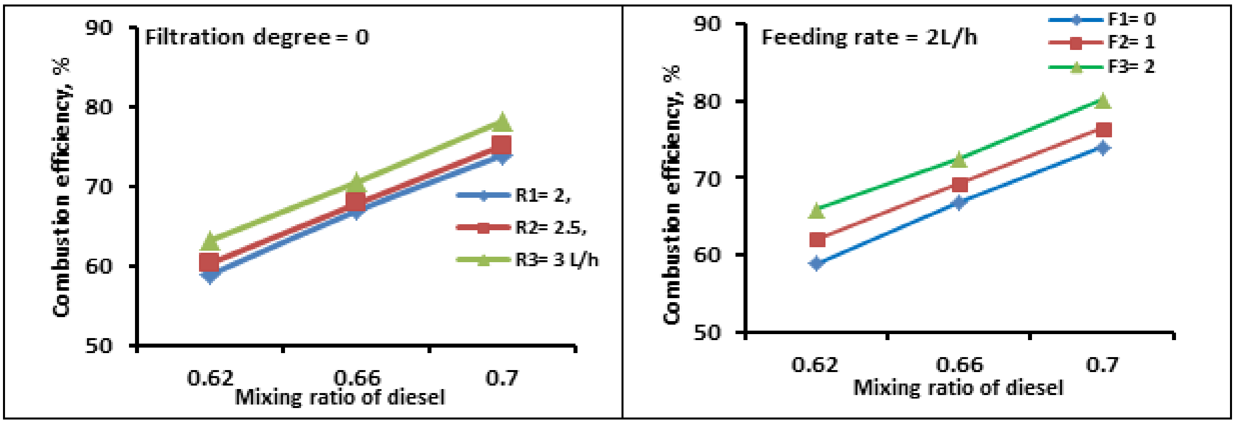

Fig.8. The effect of the mixing ratios on the combustion efficiency of mixing diesel to (UEO).

These results may be due to that increasing mixing ratio led to an increase in the percentage of gasoline or diesel in the mixture, i.e. and increase amount of air required to burn the mixture thus increasing amount of oxygen led to increasing of heating value of the mixture, which leads to an increase in combustion efficiency.

Statically there are high significant effects for different treatments with ($P < 0.05$) for the combustion efficiency values. From tables (8a, 8b) ANOVA analysis it could be concluded that mixing ratios affects combustion efficiency more than filtration degrees and feeding rates.

While feeding rates showed be less effect on combustion efficiency than filtration degrees. The effects of different parameters on combustion efficiency could be summarized as follows (mixing ratios> filtrating degrees> feeding rates).

Table 8a. Regression Analysis: Combustion efficiency versus mixing ratios; filtration degrees; feeding rates and regression equation of mixing gasoline to (UEO).

$(\eta_f), \% = -9.07 + 154.00\ Mg + 3.350\ F + 4.544\ R$

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	1362.16	454.05	344.13	**
Mixing ratios	1	1067.22	1067.22	808.87	**
Filtration degrees	1	202.01	202.01	153.10	**
Feeding rates	1	92.93	92.93	70.44	**
Error	23	30.35	1.32		
Total	26	1392.51			

S	R-sq	R-sq(adj)	R-sq(pred)
1.14865	97.82%	97.54%	96.92%

Table 8b. Regression analysis: Combustion efficiency versus mixing ratios; filtration degrees; feeding rates and regression equation of mixing diesel to (UEO).

(η_f), % = -53.38 + 168.06 M_d + 3.528 F + 4.300 R

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	1120.61	373.536	479.08	**
Mixing ratios	1	813.39	813.39	1043.22	**
Filtration degrees	1	224.01	224.01	287.31	**
Feeding rates	1	83.21	83.21	106.71	**
Error	23	17.93	0.780		
Total	26	1138.54			

S	R-sq	R-sq(adj)	R-sq(pred)
0.883003	98.42%	98.22%	97.84%

3- Combustion exhausts (Ce), %

Increasing mixing ratio of mixing gasoline to (UEO) from M_{g1} to M_{g2} the combustion exhausts decreased from 4.9 to 4.1 (%) and increasing mixing ratio of mixing gasoline to (UEO) from M_{g2} to M_{g3} the combustion exhausts decreased from 4.1 to 3.0 (%). As increasing mixing ratio of mixing diesel to (UEO) from M_{d1} to M_{d2} the combustion exhausts decreased from 5.5 to 4.7(%) and increasing mixing ratio of mixing diesel to (UEO) from M_{d2} to M_{d3} the combustion exhausts decreased from 4.7 to 4.0 (%). All these results were obtained under filtration degree F_1 with feeding rate of mixing gasoline or diesel to (UEO) (R_1), as shown in Fig (9 & 10).

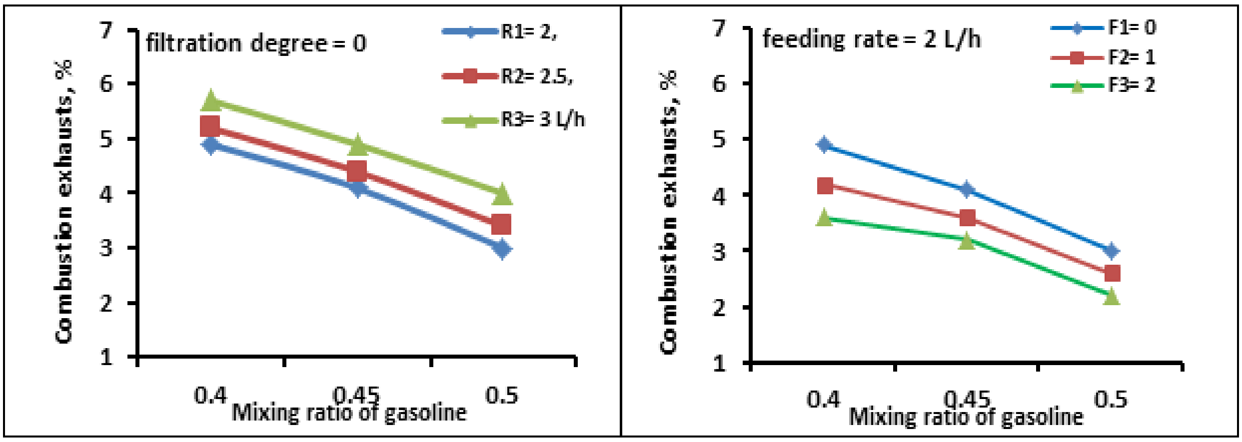

Fig.9. The effect of the mixing ratios on the combustion exhausts of mixing gasoline to (UEO).

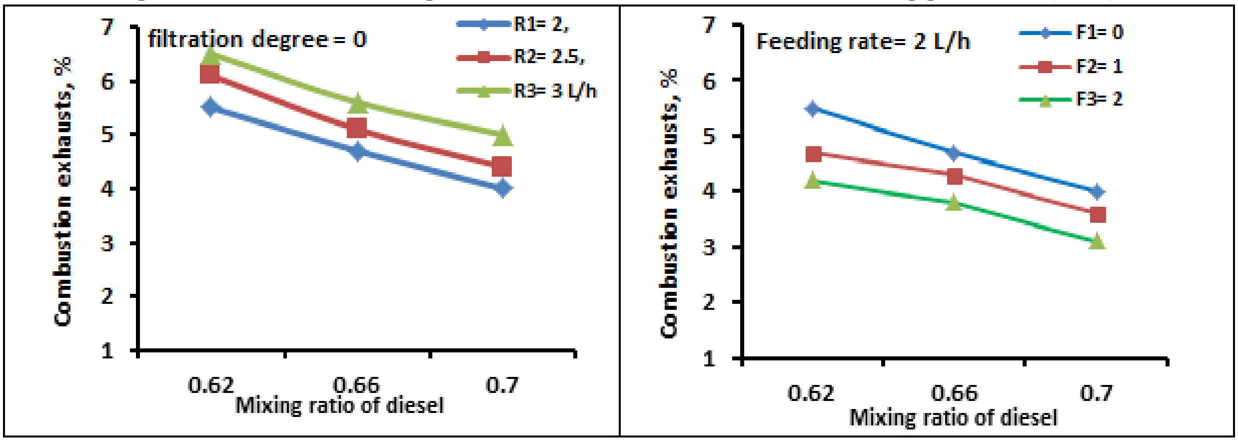

Fig.10. The effect of the mixing ratios on the combustion exhausts of mixing diesel to (UEO).

These results may be due to that increasing mixing ratio (M) led to an increase in the percentage of gasoline or diesel in the mixture, i.e. an increase in the clearness of the mixture with set of filters, which leads to a decrease in combustion exhausts. Statically there are high significant effects for different treatments with ($P < 0.05$) for the combustion exhausts values. From ANOVA analysis tables (9a, 9b) show that mixing ratios affects combustion exhausts more than filtration degrees and feeding rates.

While feeding rates showed be less effect on combustion exhausts than filtration degrees. The effects of different parameters on combustion exhausts could be summarized as follows (mixing ratios> filtrating degrees> feeding rates).

Table 9a.Regression analysis: Combustion exhausts versus mixing ratios; filtration degrees; feeding rates and regression equation of mixing gasoline to (UEO).

Ce, % = 9.554 - 15.889 Mg - 0.5000 F + 0.8000 R

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	18.7406	6.2469	191.81	**
Mixing ratios	1	11.3606	11.3606	348.82	**
Filtration degrees	1	4.5000	4.5000	138.17	**
Feeding rates	1	2.8800	2.8800	88.43	**
Error	23	0.7491	0.0326		
Total	26	19.4896			

S	R-sq	R-sq(adj)	R-sq(pred)
0.180467	96.16%	95.66%	94.73%

Table 9b. Regression analysis: Combustion exhausts versus mixing ratios; filtration degrees; feeding rates and regression equation of mixing diesel to (UEO).

Ce, % = 13.261 - 15.833 Md - 0.5167 F + 0.9667 R

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	16.2300	5.41000	330.35	**
Mixing ratios	1	7.2200	7.2200	440.87	**
Filtration degrees	1	4.8050	4.8050	293.40	**
Feeding rates	1	4.2050	4.2050	256.77	**
Error	23	0.3767	0.01638		
Total	26	16.6067			

S	R-sq	R-sq(adj)	R-sq(pred)
0.127972	97.73%	97.44%	96.89%

4- Economic costs (Ec), L.E/h

By increasing mixing ratio of mixing gasoline to (UEO) from M_{g1} to M_{g2}= the economic costs increased from 6.8 to 7.27 (*L.E/h*) and increasing mixing ratio of mixing gasoline to (UEO) from M_{g2} to M_{g3} the economic costs increased from 7.27 to 7.75 (*L.E/h*). While increasing mixing ratio of mixing diesel to (UEO) from M_{d1} to M_{d2} the economic costs increased from 9.51 to 9.93 (*L.E/h*) and increasing mixing ratio of mixing diesel to (UEO) from M_{d2} to M_{d3} the economic costs increased from 9.93 to 10.35 (*L.E/h*). All these results were obtained under F_1 of mixing gasoline or diesel to (UEO) (R_1) as shown in Fig (11).

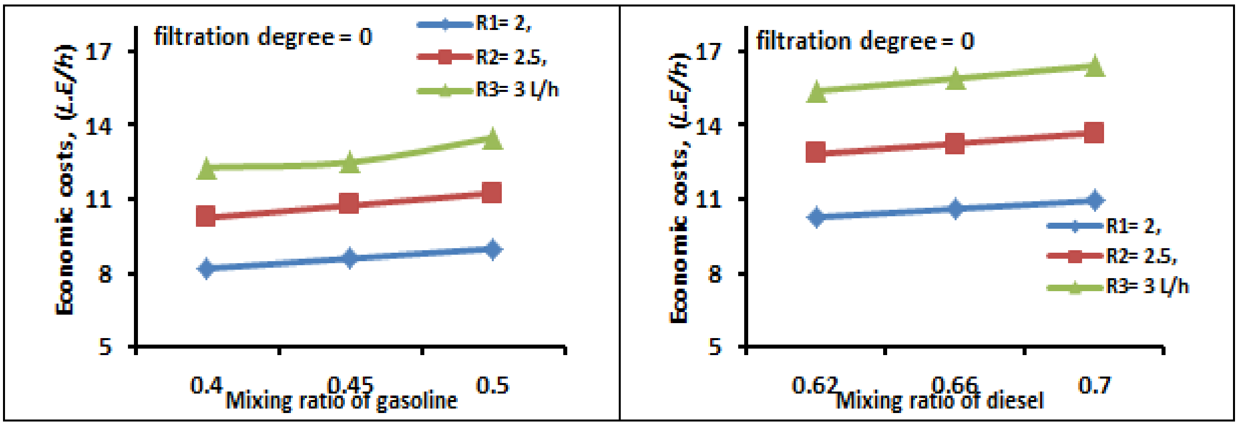

Fig.11. The effect of the mixing ratios on the economic costs of mixing gasoline or diesel to (UEO).

These results may be due to that increasing mixing ratio led to an increase in the percentage of gasoline or diesel in the mixture, as well as an increase in the prices of gasoline and diesel, which leads to an increase in economic costs. Statically there are high significant effects for different treatments with ($P < 0.05$) for the economic costs values. Through tables (10a, 10b) ANOVA analysis could be concluded that feeding rates affects economic costs more than mixing ratios. While filtration degrees no affect economic costs. The effects of different parameters on economic costs could be summarized as follows (feeding rates> mixing ratios).

Table 10a. Regression analysis: Economic costs, (*L.E/h*), versus mixing ratios; filtration degrees; feeding rates and regression equation of mixing gasoline to (UEO).

(Ec), L.E/h = -5.317 + 11.833 Mg - 0.0000 F + 3.6333 R

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	65.7063	21.9021	3030.67	**
Mixing ratios	1	6.3013	6.3013	871.93	**
Filtration degrees	1	0.0000	0.0000	0.00	**
Feeding rates	1	59.4050	59.4050	8220.08	**
Error	23	0.1662	0.0072		
Total	26	65.8725			

S	R-sq	R-sq(adj)	R-sq(pred)
0.0850107	99.75%	99.71%	99.62%

Table 10b. Regression analysis: Economic costs, (*L.E/h*), versus mixing ratios; filtration degrees; feeding rates and regression equation of mixing diesel to (UEO).

(Ec), L.E/h = -8.625 + 13.083 M_d + 0.0000 F + 4.9600 R

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	115.637	38.546	6696.00	**
Mixing ratios	1	4.930	4.930	856.39	**
Filtration degrees	1	0.000	0.000	0.00	**
Feeding rates	1	110.707	110.707	19231.61	**
Error	23	0.132	0.006		
Total	26	115.769			

S	R-sq	R-sq(adj)	R-sq(pred)
0.0758717	99.89%	99.87%	99.83%

CONCLUSION

The main results could be summarized as follows:

1- The maximum value of temperature was (36.7 ºC) of mixing gasoline to (UEO) and (34.1 ºC) of mixing diesel to (UEO) at $M_{g3, d3}$, F_3 and R_3, when the lowest value of temperature was ((23.0 ºC) of mixing gasoline to (UEO) and (22.4 ºC) of mixing diesel to (UEO) at $M_{g1, d1}$, F_1 and R_1.

2- The maximum value of combustion efficiency was (87.7 %) of mixing gasoline to (UEO) and (83.5 %) of mixing diesel to (UEO) at $M_{g3, d3}$, F_3 and R_3, when the lowest value of combustion efficiency was (60.8 %) of mixing gasoline to (UEO) and (58.9 %) of mixing diesel to (UEO) at $M_{g1, d1}$, F_1 and R_1.

3- The maximum value of combustion exhausts was (5.7 %) of mixing gasoline to (UEO) and (6.5 %) of mixing diesel to (UEO) at $M_{g1, d1}$, F_1 and R_3, when the lowest value of combustion exhausts was (2.2 %) of mixing gasoline to (UEO) and (3.1 %) of mixing diesel to (UEO) at $M_{g3, d3}$, F_3 and R_1.

4- The maximum value of economic costs was (11.62 *L.E/h*) of mixing gasoline to (UEO) and (15.52 *L.E/h*) of mixing diesel to (UEO) at $M_{g3, d3}$, F_3 and R_3, when the lowest value of economic costs was ((6.8 *L.E/h*) of mixing gasoline to (UEO) and (9.51 *L.E/h*) of mixing diesel to (UEO) at $M_{g1, d1}$, F_1 and R_1.

5- From this study found that costs of operating a warming burner model BGO- 30 A/ h using diesel fuel only at feeding rate of burner 3 *L/ h*, that is, the costs of operating a *burner/ h* = 20.25 *L.E/ h*. On the other hand, we found that the operating costs of burner at using a mixture for the ratio of the diesel in it 70% at feeding rate 3 *L/ h* = 15.52 *L.E/ h* at filtration degrees F_3, while we found that the operating costs of burner at using a mixture for the ratio of gasoline in it 50% at feeding rate 3 *L/ h* = 11.62 *L.E/ h* at filtration degrees F_3. Recommended that working developed burner at M_{g3}, F_3 and R_2**.**

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تطوير محرقة لتدفئة عنابر الدواجن باستخدام الزيت المستعمل.

محمد منصور شلبى رفاعى
معهد بحوث الهندسة الزراعية- مركز البحوث الزراعية- مصر.

تم اجراء البحث بهدف تطوير محرقة طراز BGO- 30 A لتدفئة مزارع الدواجن باستخدام مخلف عديم القيمة وذلك بتعديل عدد ريش المروحة خمسة بدلا من ثلاثة مع استخدام مجموعة من الفلاتر الدقيقة لتنقية الخليط وصمام للتحكم فى معدل التغذية حتى يناسب استخدام خليط من زيت المحركات المستعمل مع السولار او (بنزين80) كوقود بدلا من السولار فقط وذلك للحفاظ على البيئة من التلوث باعادة استخدام مخلف وتخفيض تكاليف التدفئة. تم دراسة تفاعل عوامل الدراسة الآتية: أولا: نسبة الخلط: تم اسخدام ثلاثة مستويات من نسب السولار والبنزين فى الخليط مع زيت المحركات المستعمل (1- نسب السولار: 62%، 66% و 70%. 2- نسب البنزين: 40%، 45% و 50%). ثانيا: ثلاث مستويات من درجات الفلتره (1- بدون فلتره ، 2- فلتر واحد ، 3- فلتران). ثالثا: ثلاث مستويات من معدلات تغذية الخليط (2، 2.5 و 3 لتر/ س). وكانت نتائج القياسات كالآتي: اولا: تاثير زيادة نسبة السولار او البنزين فى الخليط يؤدى الى (زيادة درجات الحرارة، زيادة كفاءة الاحتراق، انخفاض عوادم الاحتراق وزيادة التكلفة الاقتصادية). ثانيا: تاثير زيادة درجة الفلتره يؤدى الى (زيادة درجات الحرارة، زيادة كفاءة الاحتراق، انخفاض عوادم الاحتراق). ثالثا: زيادة معدل التغذية يؤدى الى (زيادة درجات الحرارة، زيادة كفاءة الاحتراق، زيادة عوادم الاحتراق وزيادة التكلفة الاقتصادية). وكانت اعلى قيم لدرجة الحرارة 34.4 درجة مئوية، كفاءة احتراق 87.7%, عوادم الاحتراق 5.7% وتكلفة اقتصادية 11.62 جنيه/ ساعة تشغيل. وكانت اعلى قيم عند نسبة سولار فى الخليط 70% لدرجة الحرارة 32.2 درجة مئوية، كفاءة احتراق 83.8% ، عوادم احتراق 6.5% وتكلفة اقتصادية 15.52 جنيه/ ساعة تشغيل. من خلال الدراسة وجد ان تكاليف تشغيل محرقة التدفئة لكل ساعة تشغيل بالسولار بمعدل استهلاك 3 لتر / س = 20.25 جنيه/ ساعة. بينما وجد ان تكاليف تشغيل المحرقة فى الساعة تشغيل بخليط نسبة السولار 70% بمعدل تغذية 3 لتر/ س = 15.52 جنيه/ ساعة بينما كان تشغيل المحرقة فى الساعة تشغيل بخليط نسبة البنزين 50% بمعدل تغذية 3 لتر/ س = 11.62 جنيه/ ساعة. نوصى بتشغيل المحرقة المطورة عند نسبة خلط: البنزين/ زيت المحركات المستعمل (50%/ 50%)، درجات الفلترة: فلتران ومعدل تغذية: 2.5 لتر/ ساعة.