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Studies on kerosene and biodiesel flame characteristics using metallic wick stove and lamp

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Abstract: Cotton wick stove is normally used for heating purpose .It is felt that frequent changing of cotton wicks can be avoided by incorporating metallic wicks developed by powder metallurgical techniques. A suitable stove is proposed to be developed incorporating wick holder and lifting mechanism. A suitable stove is proposed to be developed incorporating wick holder and lifting mechanism. It is proposed to be developed biodiesel from broiler chicken waste. Using biodiesel and kerosene oil the performance of flame characteristics is to be studied . The following are the objectives to perform the studies to fabricated stove suitable for metallic wick fabricated earlier. To design lifting system for incorporating the metallic wicks movement up and down. To study the performance of metallic wick using kerosene To study the performance of metallic wick using biodiesel.To compare the performance of these stoves.
Keywords: Metallic wick

I. INTRODUCTION

Various engineering techniques are used for the manufacture of different components. Each process is suitable for particle component and material only, and cannot be used for manufacturing all types of machine parts. But compared with paper, glass, ceramics, metals and other materials, porous bronzes exhibit a number of virtues. They are lighter in weight, corrosion resistance and work in wide range of temperatures and possess high electrical and thermal conductivity besides enough mechanical strength. Wick can be considered as a capillary –porous metal. It sucks fuel at one end and delivers to the other end like a capillary pump where it is utilized. Usually in kerosene stoves cotton wicks are used which need to be replaced frequently. To avoid this, non- consumable metallic wicks are developed. The wicks are developed from bronze powder. Bronze powder is selected due to its high corrosion resistance and it ensures porous structure undisturbed.

To produce these wicks graphite dies are used. Also these are having high fusion point and good lubricating characteristics. Hence easy ejection of the wick from the die takes place. The conventional wick carrier stove is no longer useful because the diameter of the wick is 6mm whereas the diameter of metallic wick is 8mm.The wick carrier tubes are enlarged and shortened. The mechanism used in stove slightly being modified to accommodate metallic wicks because of its complexity.

The powder is filled in the graphite die of length 80mm and vibrated two times. Powder is not compacted to get maximum permeability. Powder is further sintered in muffle furnace under nitrogen atmosphere at 7700c for 50 minutes. The sintering temperature has been adopted after conducting several experiments and from copper- tin phase diagram.

The objective of the project work is to study the performance characteristic such as capillary rise with respect to time with different fuels .Therise in water temperature with respect to time, fuel tank temperature rise with respect to time and fuel consumption .

II. EXPERIMENTAL DETAILS

Various tests have been carried out to evaluate the performance of kerosene and biodiesel are given below

2.1 CAPILLARY ACTION TEST

The arrangement for determination of capillary rise as a function of time is shown in figure 1..Metallic wicks are coated with chalk powder throughout and marks are made at regular intervals of 5mm. Length of the wicks used are 70mm during the test, specimen is held in the stand by fixing it at the top end. Consider a three beaker, which contains kerosene, Diesel and Bio-Diesel respectively ,which is raised to required depth of immersion and held at that position. At the same instant, stopwatch is started. The liquid ascends by capillary action and wets the specimen. This wetting is clearly observed by the color of the specimen. The same procedure is repeated for different depths of immersion.

2.2 FLAME HEIGHT TESTS

The wick is held in position using a wick holder. The wick holder has a retaining screw using, which the length of tip exposure may be adjusted. A scale is marked on the bottle to monitor the flame without parallax.After lighting the flame height is recorded for different fuels levels, for different tip exposures and different diameters of wick..Graphs are plotted between fuel levels, tip exposures versus flame height.

2.2.1Different fuel level test

Wick is immersed for different levels (10mm,20mm,30mm,40mm) of kerosene and biodiesel are used to finding the flame height test are shown in figure 16

2.2.2 Different tip exposures

For using different tip exposures (1mm,2mm,4mm,6mm,8mm,10mm) of wick for kerosene and biodiesel ,to find the flame height are shown in figure 18.

2.2.3 Different diameter

For using different diameter of wick (5.8mm,5.9mm,7.9mm,8.44mm) are immersed in kerosene and biodiesel,to find the flame height are shown in figure 20

2.3 WATER POT TEMPERATURE TEST

To know the output of the fabricated metallic wick stove a sample test has been conducted. 1000ml of water is taken in an aluminum container and kept over the stove. The time required reaching boiling point of water for both Kerosene and bio diesel of metallic wick stove are studied and compared.

2.4 FUEL TANK TEMPERATURE TEST

The temperature produced in the fuel tank during boiling of 1000ml of water with respect to time is noted. The same test is conducted for metallic wick stove using kerosene and both results are compared

2.5 ESTIMATION OF EFFICIENCY OF METALLIC WICK STOVE

The fuel consumed during boiling of 1000ml of water is measured for metallic wick using kerosene and Bio-diesel results are compared

2.6 FABRICATION OFWICK HOLDER AND LIFTING MECHANISM

Fig 3 shows conventional Nutan Stove. Figure 4 shows the wick carrier and lifting mechanism of stove designed.To accommodate metallic wicks the locally available wick carrier is modified. The wick carrier tubes are enlarged and shortened. The existing stove mechanism as shown in the figure 4 is not suitable for metallic wicks. Cotton wicks are flexible and any misalignment in lifting and lowering mechanism it can accommodate. But metallic wicks are rigid and they cannot bear any misalignment in lifting mechanism. Uniform rising and lowering is made by incorporating lever mechanism. The modified stove lifting mechanism is as shown in figure 6 and figure7

Specifications of metallic wick stove
Fuel tank Diameter = 24.98 cm
Fuel tank Height = 6.5 cm
Wick carrier tube diameter = 1.2 cm
Maximum lift = 10 cm
Number of wicks = 10..

III. RESULTS & DISCUSSIONS

3.1 CAPILLARY ACTION TEST

The graph pertaining capillary action of metallic wick with time is given in figures 12 to 15,for various depth of immersion of wick.It is found that capillary rise increases exponentially with time for kerosene compared to Bio diesel .Also it is found that Bio diesel takes more time to complete the capillary rise that kerosene.The wick was immersed in the kerosene and bio diesel for 1cm ,2cm,3cm and 4cm is shown in the figure 12 to 15 respectively .it is clearly observed that when increasing the depth of immersion of metallic wick ,the time taken to complete the capillary rise of fuel was to be decresing.By comparing capillary rise of kerosene and bio diesel ,kerosene get take fast rise of capillary action .Because of kerosene have less viscosity compared to biodiesel.

For each observation time taken to complete capillary rise of kerosene which is less than one minute.But in the case of Bio diesel ,which is clearly observed that the total time taken to complete capillary rise in between 3minute and 4 minutte

3.2 FLAME HEIGHT TESTS

Properties of biodesel:
Sp. gravity 0.915
Flash point 250°C
Fire point 296°C
Viscosity (at 35°C) 5.83CentiStoke
Calorific value (HHV) 39300KJ/Kg

Properties of kerosene :

Sp. gravity 0.820
Flash point37 and 65 °C (100 and 150 °F)
Fire point 220 °C (428 °F).
Viscosity 1.64 CentiStoke
Calorific value 46200KJ/Kg

3.2.1 Different fuel levels

The graph pertaining flame height of metallic wick lamp with fuel level is given in figure 17. It is clearly found that increase in fuel level increases flame height of kerosene and biodiesel. from the test it is observed that kerosene give better flame than bio diesel. This is due to higher Calorific value of kerosene (46200KJ/Kg) than biodiesel (39300KJ/Kg).

3.2.2Different tip exposures

The relation between tip exposures and flame height is given in figure 19.It is found that slightly increasing tip exposures flame height also increasing .By comparing the flame height of kerosene and bio diesel , kerosene flame height is more than biodiesel.

3.2.3Different diameter

From the test it is observed that when increasing the wick diameter corresponding flame height isincreasing.By comparing flame height of kerosene and biodiesel ,kerosene get show better flame height than biodiesel are shown in the figure 21.Hence increase in wick diameter increase flame height

3.3WATER POT TEMPERATURE TEST

The relation between water temperature with time for both kerosene and Biodiesel are given in figure 22. it is found that water get boil fast for kerosene compared to biodiesel. It is noted that the difference between boiling time of kerosene and biodiesel is varying from 2 to 3 minutes.It assumed that biodiesel is also useful to use it an a fuel like kerosene

3.4. FUEL TANK TEMPERATURE TEST

It is clearly found that fuel tank temperature increases with time is given in figure 23.From the test it is observed that the rise in temperature varying kerosene is faster than biodiesel .This is also due to higher Calorific value of kerosene(46200KJ/Kg)

3.5.ESTIMATION OF EFFICIENCY OF METALLIC WICK STOVE

Fuel consumed for boiling 1 litter of water,for one hour in aluminum container for both metallic wicks and cotton wicks are given below Kerosene and Bodiesel are used initially is 2 liter.
Kerosene consumed for metallic wick = 360ml
Biodiesel consumed for metallic wick =323ml
Hence the kerosene is more consumed than biodiesel.

3.6 CALCULATION OF UTILIZATION EFFICIENCY

The following data is used to calculate the utilization efficiency. This data is obtained by conducting sample experiments on metallic wick stove such as water pot temperature rise test, fuel tank temperature test and fuel consumption test.

Data:
Mass of kerosene consumed= 360ml
=0.2963 Kg
Mass of water evaporated = 0.81 liter
Utilization Efficiency:
= Heat utilized for water boiling* 100 **/**Heat supplied
Heat supplied= Mk*C.V of Kerosene
= 0.2963 x 8359
= 2474.78
Heat utilized = [M_w x Cp of water x ΔT] + [M_w evaporated x L_w] +
[M_k x Cp of kerosene x ΔT_k]
= [1 x 4.186 x 69] + [0.81 x 2257] + [1.6464 x 44.4 x 10^{-6} x 25]
= [288.83] + [1828.17] + [0.0019]
= 2117 KJ
Utilization efficiency = (2117 / 2474.78) x 100
= 85.47 %

IV. FIGURES

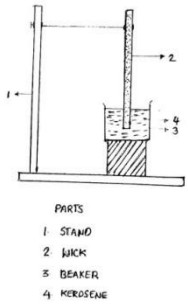

Fig :1 Capillary rise measurement apparatus

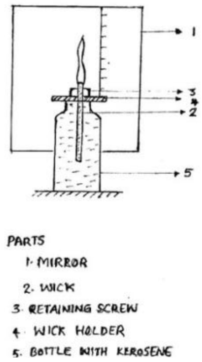

Fig :2 Flame height measurement apparatus

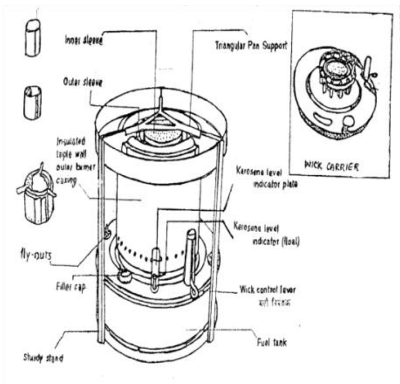

Fig :3Nuttan stove structure

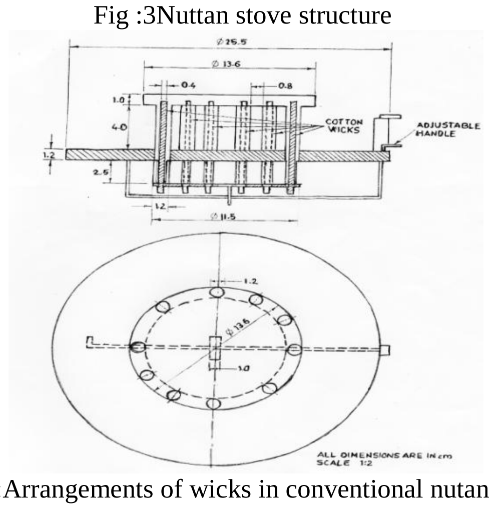

Fig 4 :Arrangements of wicks in conventional nutan stove

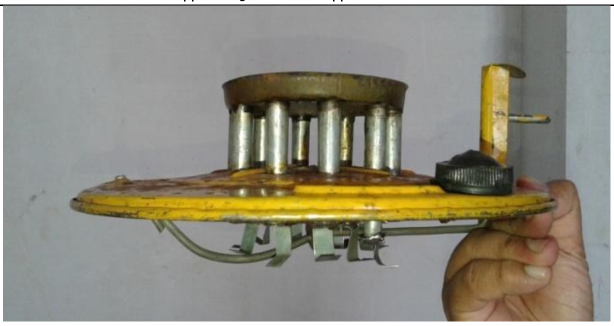

Fig 5:ModifiedNutan Stove with metallic wick (Elevation)

Fig 6: Modified Nutan Stove with Metallic wick(Plan)

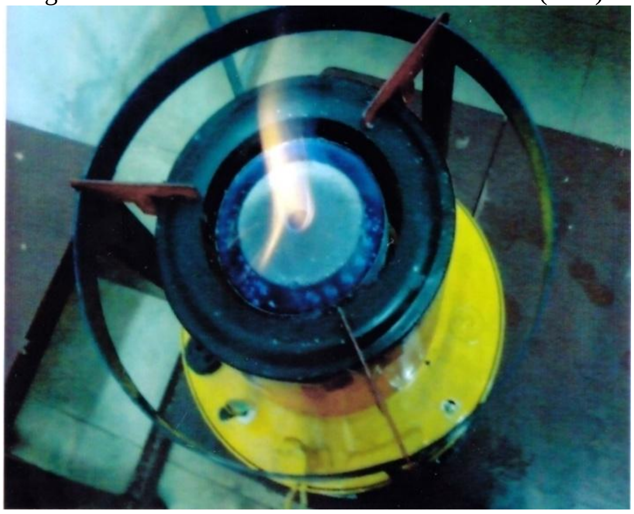

Fig 7 Metallic wick stove with wick burning

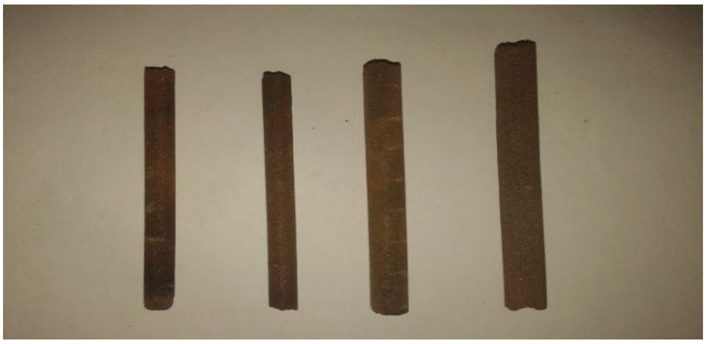

Fig :8 Metallic wicks for different diameter

Fig 9 Metallic wick stove with wick burning using Biodiesel(inside)

Fig 10: Variation of flame height with different wick diameter

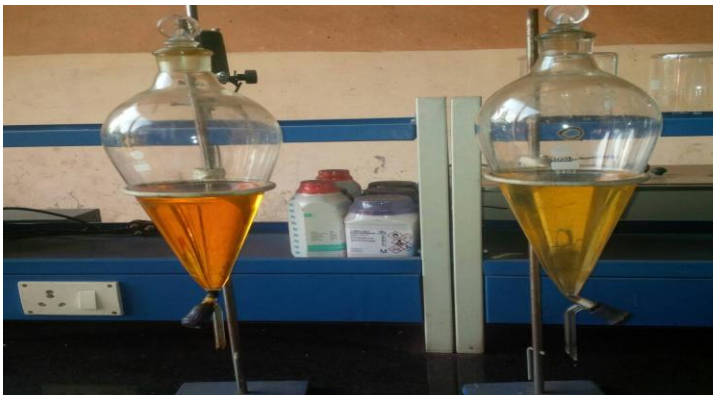

Fig 11 : Diesel and Bio diesel

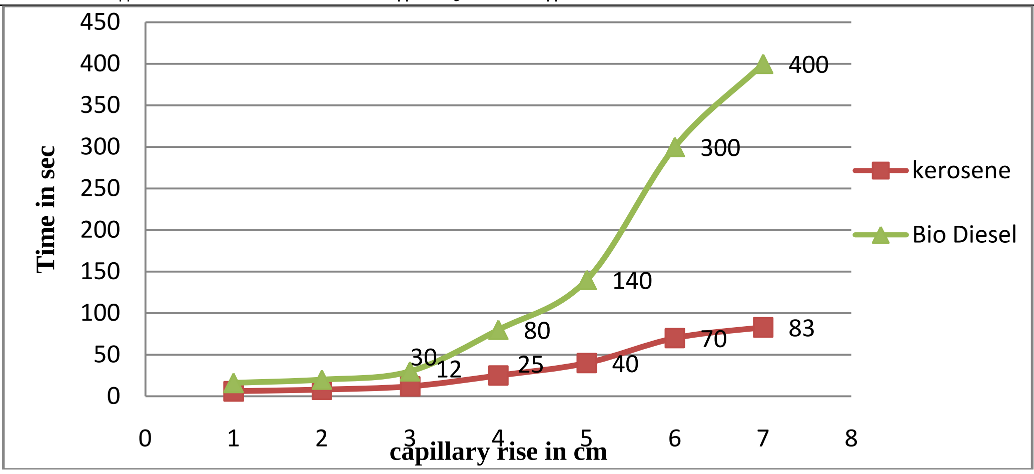

Fig 12:Variation of time with capillary rise for 1cm depth of immersion for different fuels

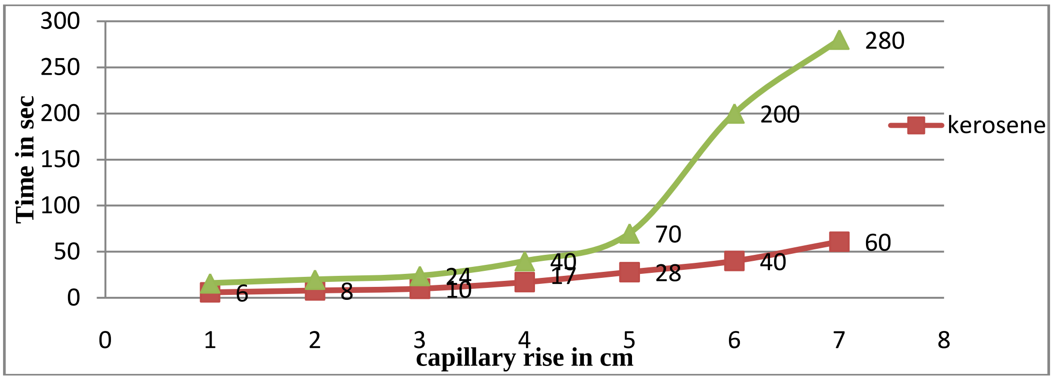

Fig 13Variation of time with capillary rise for 2cm depth of immersion for different fuels

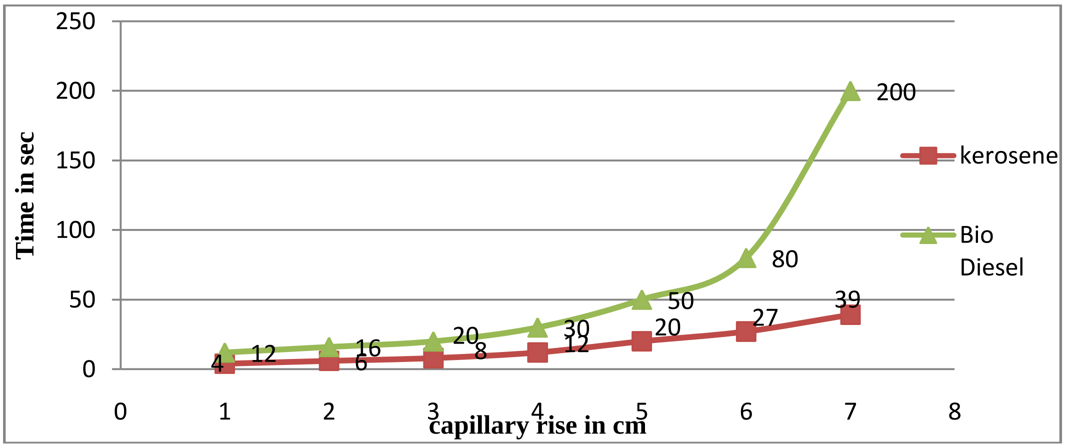

Fig 14 Variation of time with capillary rise for 3cm depth of immersion for different fuels

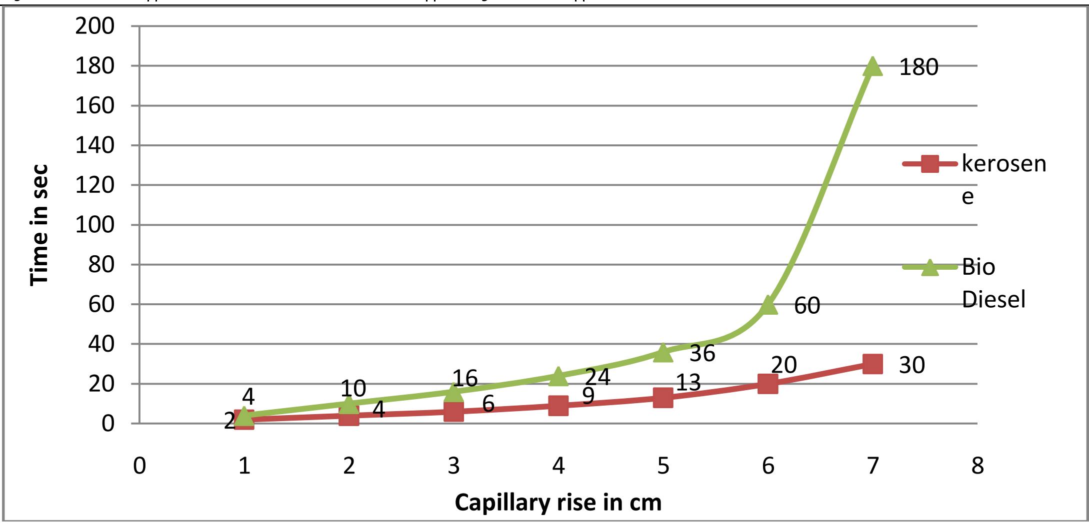

Fig 15 Variation of time with capillary rise for 4cm depth of immersion for different fuels

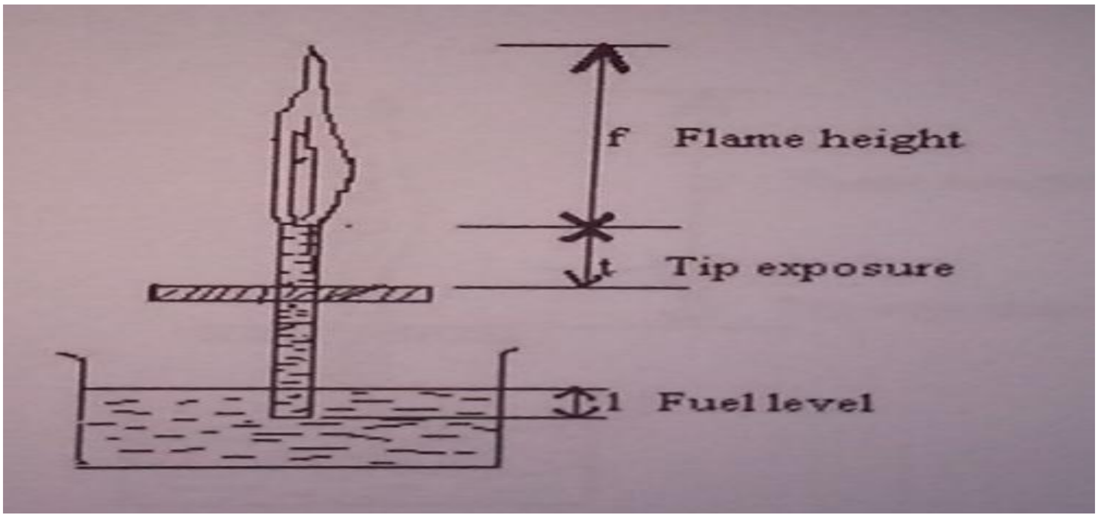

Fig: 16. schematic representation of flame height test for different fuel level

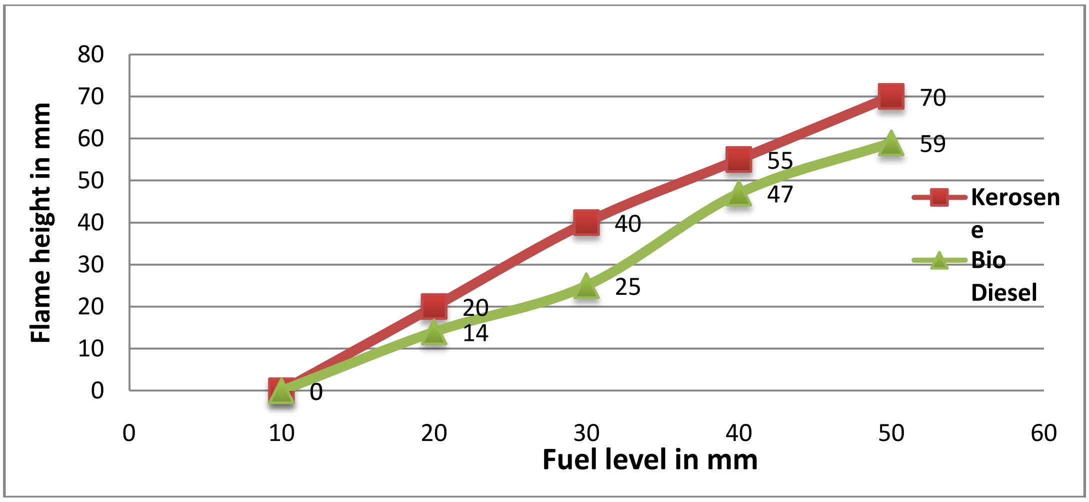

Fig 17: variation of flame height for different fuel levels for different fuels

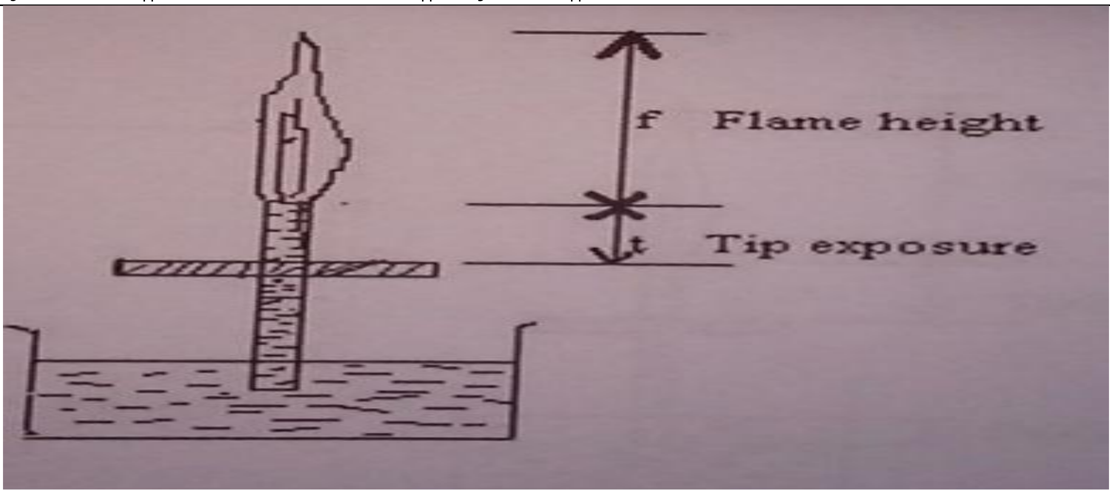

Fig 18 schematic representation of flame height test for different tip exposures

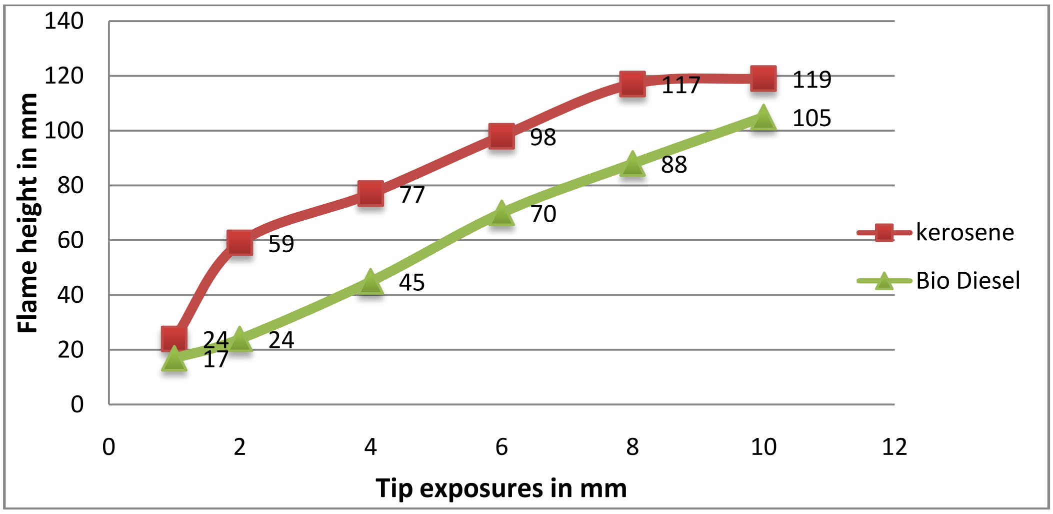

Fig 19 variation of flame height for different tip exposures for different fuels

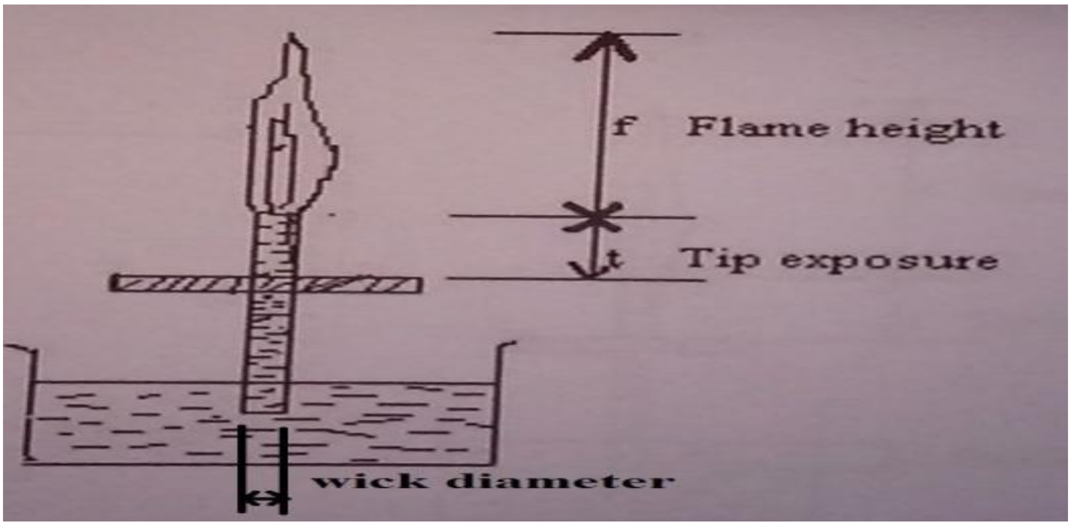

Fig 20: schematic representation of flame height test for different diameter

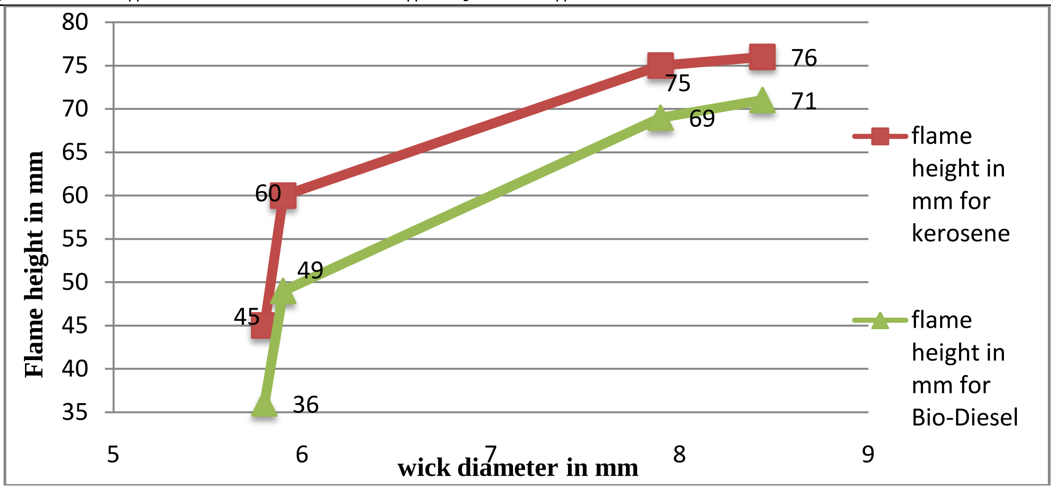

Fig.21:Variation of flame height for wick with different diameter

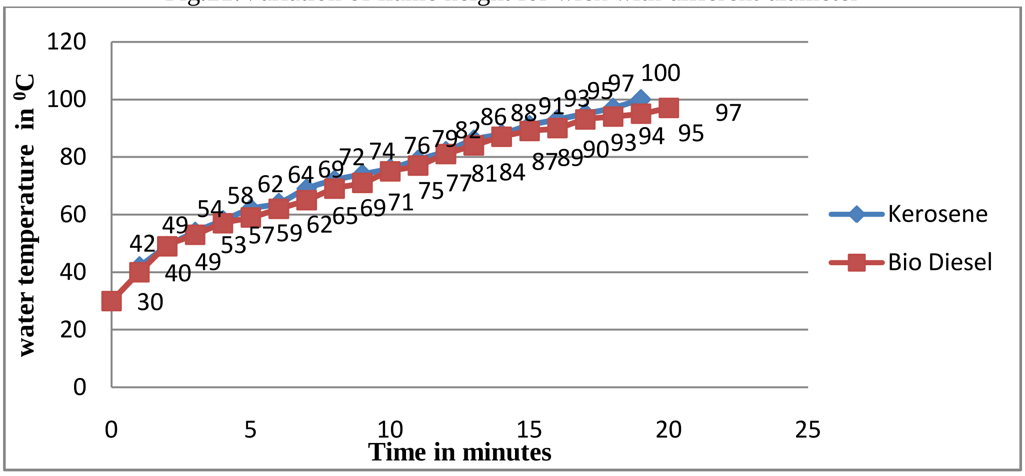

Fig 22 estimation of time taken to reach boiling point of water

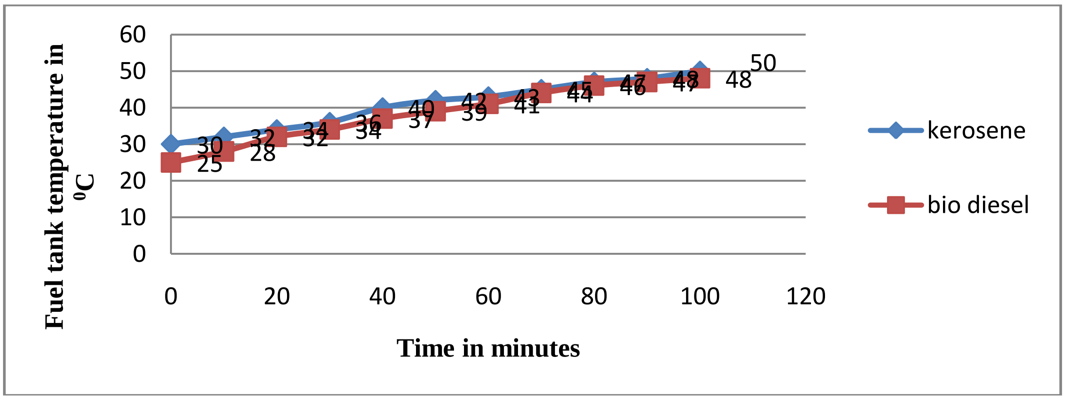

Fig :23 Fuel tank temperature versus time for metallic wick by using Kerosene and Biodiesel

V. CONCLUSION

From the observations made during the study of metallic wick stove using kerosene and biodiesel ,following are the conclusions

- Capillary action of metallic wicks depends on the depth of immersion and length of wick in kerosene.
- Metallic wick is a viable one like cotton wick in capillary action and is a permanent one .
- Flame height of metallic wick depends on fuel level and tip exposure.
- Flame height is enhanced with increase in diameter of metallic wick.
- Biodiesel is also a viable fuel like kerosene for lighting and heating process.

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