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Online Oil Condition Monitoring of Four-Stroke Engine

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Abstract: In recent days, Automobiles that make easy transportation of goods play an important role in the economic growth of any country. Transportation necessitates the continuous running of a vehicle without any unwanted break downs. The engine is considered as the heart of an automobile. Vehicle break on may happen due to unexpected or premature failures of some critical parts of an engine. Critical parts of engines are mainly cylinder, piston, crankshaft, timing belt, and clutch. The failure of the above components mainly depends on the lubricating performance of engine oil. Now a day's oil is being usually replaced based on periodic maintenance schedule designed by vehicle manufacturers. This schedule is framed based on kilometer coverages of vehicles or time period. In this practice, there is the possibility of being oil replaced before completing its life. Even during service work, technicians in the workshop do not follow any method to know the actual condition of oil before replacing it. There is a need for actual driving habits, traffic conditions, engine speed, and load conditions, road conditions (gradients) to predict the condition up to which oil was being utilized. Thus the above is helpful in the prediction of the remaining life of engine oil. This can be done only by monitoring the properties of engine oil continuously during vehicle running. The properties of any lubricating oil are the viscosity, Viscosity index, density, Specific weight, Specific volume, specific gravity, surface tension, and capillarity. Since viscosity place, a vital role in lubrication oil condition can be judged by monitoring it continuously. The monitoring of viscosity helps to identify the actual condition of the oil. This is done by a system that receives signal for the temperature of oil, converts the same into viscosity units and displays it. Therefore vehicle users can identify the exact replacement of engine oil.

Keyword: This Schedule Is Framed Based On Kilometer Coverages Of Vehicles Or Time Period.

I. INTRODUCTION

In vehicles, Condition monitoring is the process of monitoring some important parameters like lubricating oil characteristics, engine temperature, etc, by which one can identify an indication of a developing fault. It is a major component of predictive maintenance.

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Using condition monitoring allows for scheduling maintenan ce or taking other actions to prevent failure and avoid its con sequences. Health tracking has a unique advantage that symptoms can be resolved before they grow into a major failure that would shorten a normal life span. Condition control methods are typically used to monitor lubrication oil and other lubricants.

whereas periodic inspection using non-destructive testing techniques, which is fit for service evaluation, is used for stationary plant equipment, such as Diesel engines, Petrol engine, and all other vehicles.

The following list includes the main condition monitoring techniques applied in the industrial and transportation sectors:

- Vibration Analysis and diagnostics
- Lubricant analysis
- Acoustic emission (Airborne Ultrasound)
- Infrared thermography
- Ultrasound testing (Material Thickness/Flaw Testing)
- Motor Condition Monitoring and Motor current signature analysis (MCSA)

Most CM technologies are being slowly standardized by ASTM and ISO.

vaporization, thermal conductivity, specific heat capability, boiling points and heat of combustion. Viscosity and density of fuel greatly influence the atomization and vaporization patterns. These fuel properties are temperature-dependent. Thus fuel body of water temperature plays an awfully vital role in the fuel atomization method. At a higher temperature body of fuel decreases which reinforces the atomization of extremely viscous fuels like biodiesels.

II. EXPERIMENTAL SETUP COMPONENTS

A) HARDWARE COMPONENTS

1) TEMPERATURE SENSOR

In many applications, a temperature sensor plays an important role. For example, for equipment used to manufacture medical drugs, heat liquids, or other equipment, maintaining a specific temperature is essential. For the above applications, the detection circuit's sensitivity and accuracy may be crucial to quality control.

Nevertheless, temperature monitoring is more commonly part of preventive reliability. For example, while an appliance may not actually perform any tasks at high temperatures, the device itself may be at risk of overheating. This risk arises from unique external factors such as a harsh operating environment or internal factors such as component self-heating.

Fig 2.1Temperature Sensor-Thermistor Probe

For industries such as petrochemical, automotive, aerospace and defense, consumer electronics, and so on, temperature sensing is one of the most sensitive properties or parameters. These sensors are installed in devices in order to accurately and efficiently measure the temperature of a medium in a set of requirements.

It doesn't have to be expensive to design a robust circuit for temperature detection. Nor is it necessary to compromise a low-cost detection circuit on responsiveness and accuracy. This article examines the different types of available technologies for temperature detection and what each has to offer. It also discusses the needs of different applications and how engineers can build a circuit for temperature detection that is tailored for their specific needs. SAE 20 W 40 servo lubrication oil was used for research work in this project.

Fig 2.2 Temperature sensor inserted in drainage port.

2) Vehicle

The Hero Honda splendor plus bike has been taken for our testing purpose. The vehicle specifications are given below,

Fig 2.3 Vehicle

Table-I: Engine and transmission

Displacement:	97.50 ccm (5.95 cubic inches)
Engine type:	Single cylinder, four-stroke
Power:	7.37 HP (5.4 kW)) @ 8000 RPM
Torque:	7.95 Nm (0.8 kgf-m or 5.9 ft.lbs) @ 5000 RPM
Compression Ratio :	8.8:1
Fuel system:	Carburetor
Fuel control:	Over Head Cams (OHC)
Ignition:	CDI
Cooling system:	Air-cooled
Gearbox:	four-speed
Transmission type, final drive:	Chain drive

Table-II: Chassis, suspension, brakes, and wheels

Frame type:	Tubular double cradle
Front suspension:	Telescopic fork
Rear suspension:	Swinging arm
Front tire size:	2.75-18
Rear tire size:	2.75-18
Front brakes:	Expanding brake (drum brake)
Front brakes diameter:	130 mm (5.1 inches)
Rear brakes:	Expanding brake (drum brake)
Rear brakes diameter:	130 mm (5.1 inches)

Table-III: Physical measures and capacities

Dry weight:	110.0 kg (242.5 pounds)
Weight incl. oil, gas, etc:	119.0 kg (262.4 pounds)
Power/weight ratio:	0.0670 HP/kg
Overall length:	1,970 mm (77.6 inches)

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Overall width:	720 mm (28.3 inches)
Ground clearance:	159 mm (6.3 inches)
Fuel capacity:	11.00 litres (2.91 gallons)
Reserve fuel capacity:	1.00 litres (0.26 gallons)

B) Software components

1) Arduino

Arduino is the open-source software. It can be easily downloaded from the internet. The cost of this program is very less. The program can be easily made with this software and also the program can be easily modified. Basic Program model is

```
void setup() {
 // put your setup code here, to run once:
}
void loop()
{
  // put your main code here, to run repeatedly:
}
```

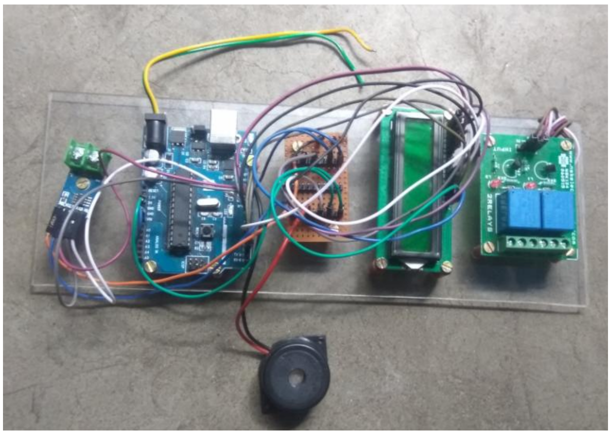

Fig 2.4 Arduino kit

III. WORKING OF AN EXPERIMENTAL SETUP

A) Calculation of viscosity using Redwood viscometer

First found the viscosity of fresh lubricating oil (SAE 20 W 40). This lubricating oil should be more suitable for a four-stroke engine in two-wheelers. The viscosity of the lubricating oil easily founded by means of the redwood viscometer apparatus. In this apparatus, there are two thermometers that have been used, one for the water and another one for the lubricating oil.

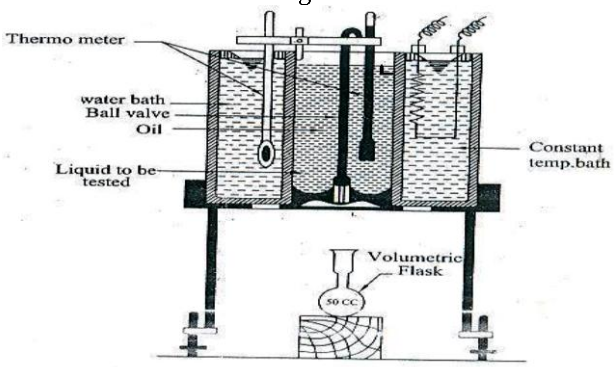

Fig 3.1 Redwood viscometer

The room temperature has taken as 36^{0}C. First found the viscosity for room temperature and next found the viscosity value for every 5^{o}C.

The kinematic viscosity of oil founded by the following formula,

(AT-B/T) in Centi stokes.

Where

A=0.26 (Constant value)
B=171.5 (Constant value)
T=time taken in second

Note: A and B may vary depending upon the size of the orifice of the viscometer.

Absolute viscosity = kinematic viscosity X density of oil at a particular temp ^{o}C.

Dynamic viscosity = kinematic viscosity X density of oil at a particular temp ^{o}C.

ρt = Density of oil at a particular temp ^{o}C.

ρt = 0.831-0.00065(T_{oil}-T_R) gm/cc

Where T_{oil} = Temperature of oil and T_R=Room Temperature. Tabulate this reading.

Table-IV Viscosity values

Sl.no	Temperature in ^{o}C	Fresh oil	
		Kinematic viscosity CS	Dynamic Viscosity Ns/m^2
1	36	64	56
2	40	52	46
3	45	39	34
4	50	36	31
5	55	31	27
6	60	26	22
7	65	22	19
8	70	18	15
9	75	16	14
10	80	14	12
11	86	11	9
12	90	9	7

By using these values, make the following graph.

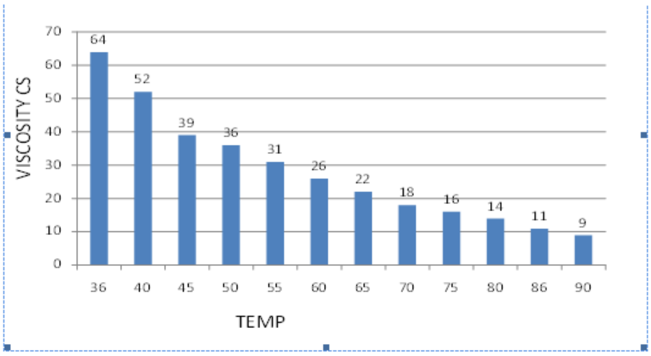

Fig 3.2 Viscosity vs temperature - fresh oil

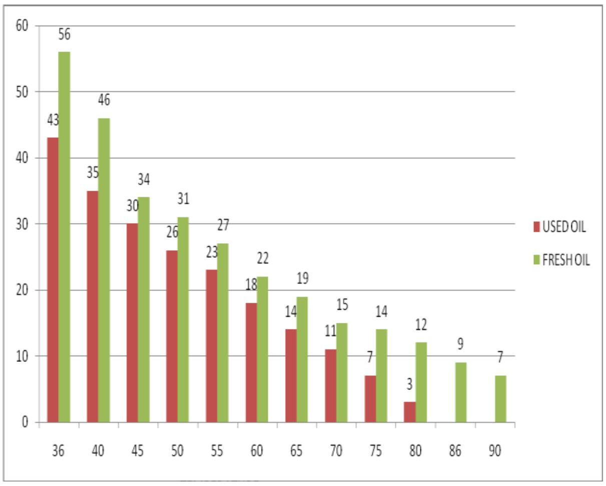

Fig 3.3 Comparison of fresh and used oil

B) Viscosity measurement using project

This project involves the following units, they are

- Temperature sensor
- Control unit
- Display unit

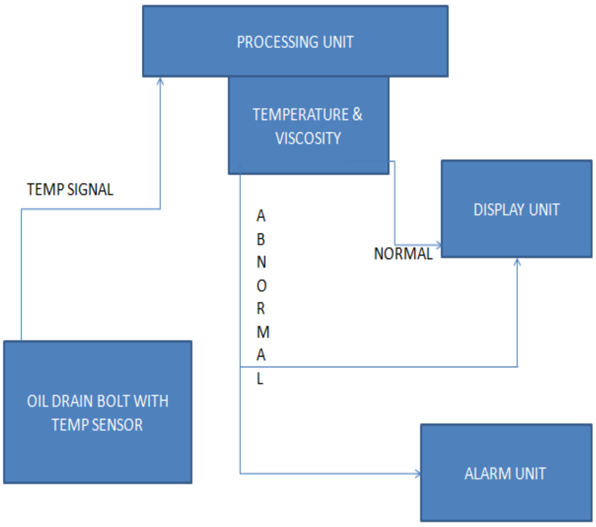

Fig 3.4 Block Diagram

The temperature sensor should be placed in the oil drainage port of the engine. The temperature sensor senses the temperature of the lubricating oil inside the engine. This signal should be transferred into the control unit of the microprocessor. The microprocessor gets the temperature signals and it should be converted into the viscosity units by means of the processor by using the following formula.

$$\mu = \mu o\left(\frac{1}{1 + \alpha t + \beta t^2}\right)$$

Where,

M^o= 0.179
α= 0.3368
β= 0.00221

By substituting the above value and the temperature signals, the processor finds out the viscosity unit. This viscosity and temperature value should be displayed in the display unit.

Fig 3.5 Working kit

Consider the SAE 20 W40 fresh lubricating oil. Find out the viscosity of the fresh lubricating oil and next taken the used lubricating oil (2000km). Again find out the viscosity of used lubricating oil, by using these two values first find out the lowest viscosity value of the lubricating oil. This value should be placed in the processor if the lubricating oil will reach this value suddenly the buffer gets the signals and buffer makes alarm. This indicates the viscosity of lubricating oil has been reduced and we should replace the lubricating oil to avoid the sudden breakdowns. The temperature and viscosity reading has been displayed.

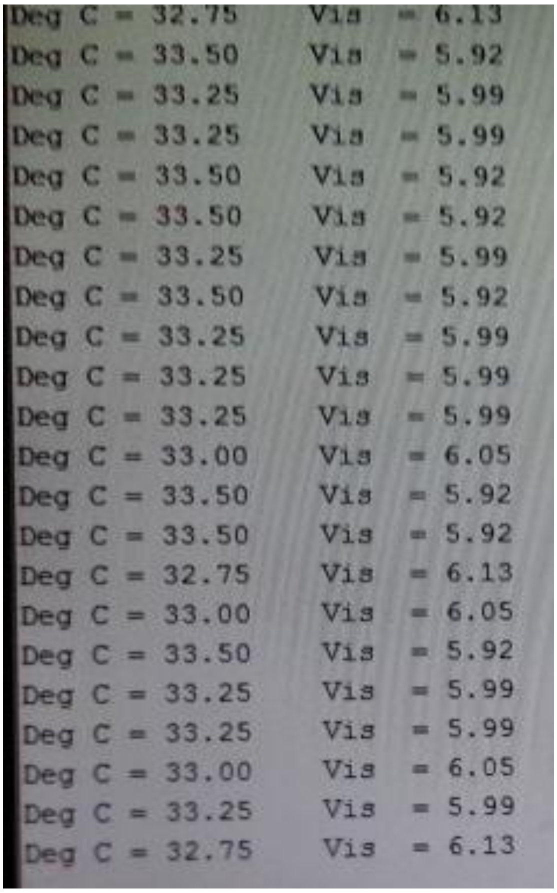

Fig 3.6 Result value 1

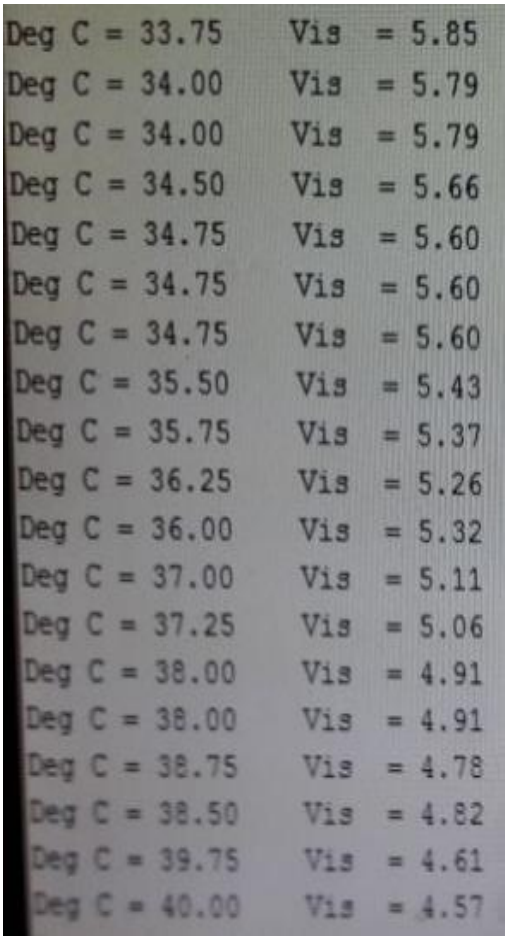

Fig 3.7 Result value 2

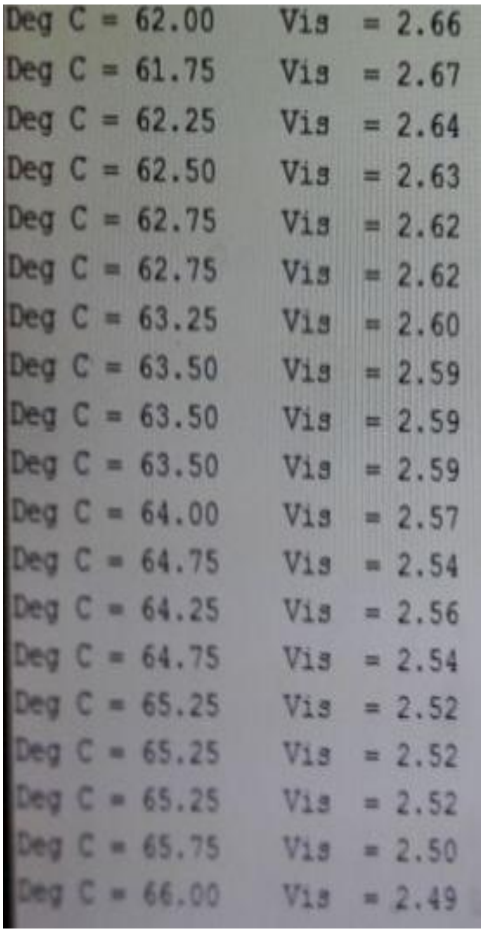

Fig 3.8 Result value 3

IV. CONCLUSION

Dynamic viscosity has been calculated theoretically using redwood viscometer. The same is also being calculated by the processing unit of our project during the engine running.

When the viscosity value reaches to predetermined value the processing unit gives the signal to the alarm unit. In turn, the driver or vehicle user knows the exact time of replacement of lubricating oil for the engine.

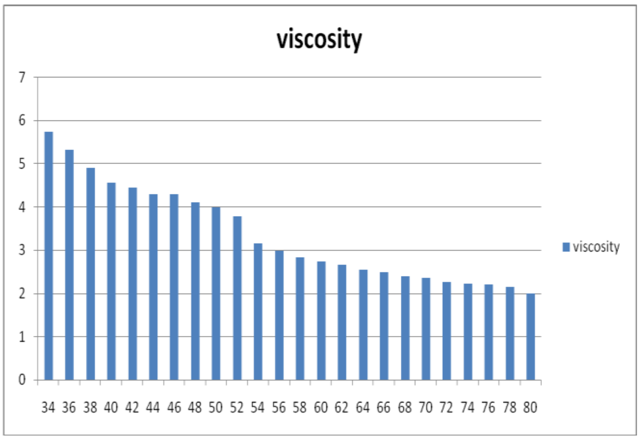

Figure 4.1 Viscosity Vs temperature –used oil

From the graph, when the temperature increases viscosity decreases. Also, the above values measured using the project are compared with values already calculated using redwood viscometer. Since both sets of values are nearly equal. This project gives the exact timing of engine oil replacement.

ADVANTAGES

- It increases the oil-changing period.
- It enhances customer satisfaction.
- It will be more economical.
- It reduces the oil import requirement.
- It prevents failure due to the reduction of the lubricating properties of the oil.
- It can forecast the lubrication between the piston and cylinder.

Through this project, it is possible to identify the exact lifetime of the lubricating oil. Therefore, oil change in an engine can be done at the correct time.

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