

# Low Cost On Board Engine Oil Quality Sensor Based On Optical Principle

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## Abstract

Lubricating Oil in any machine is like vital fluid as blood in human body, unlike humans this vital fluid cannot be purified and hence it is to be replaced for proper functionality of any machine. So detection of quality of oil becomes more important. Many methods are proposed and for detection some of them are on-board sensors while some requires samples to be collected and sent to laboratory for finding quality Work accomplished in this paper is for bringing a simple and cost effective measurement concept for determining and relating the physical and chemical properties of engine oil. While developing this sensor optical method is used to determine the state of engine oil with the help of simple arrangement and less cost. And compatibility in existing engines is also take care so that proposed system can be fitted and integrated in a existing engine without much efforts.

**Keywords** – Lubricating oil, oil quality, optical sensor, Drain plug, Arduino,.

### 1.1. Lubricant oil Quality Parameters

There are many parameter to measure oil quality and most of these parameters have method related to it a few of them are listed here.

1. Acid Number (AN), is a parameter determining oil quality and it is mainly considered for oil quality deterioration. ASTM D664 (American Society for Testing and Materials) is a method for measuring the acid number [2][3][4].
2. Remaining Useful Life Evaluation Routine (RULER) by measuring remaining antioxidant additives. Due to these additives degradation process of oil slows so remaining additives level may indicate the oil degradation condition. [2][3].
3. Viscosity. Lubricating oils need to have a specific viscosity for their correct operation, this is another important parameter to measure for evaluation of oil[2][4].
4. ASTM D500, is another method that visually determines the colour of oil and frequently used by technicians to evaluate contamination. [2][3][4].



Fig. 1

Aging and colour relation[1]

### 1.2. Different types of phenomena's due to interaction of light with oil

When light ray is incident on oil under observation there are many this which happen under their interaction as mentioned in Fig. 2

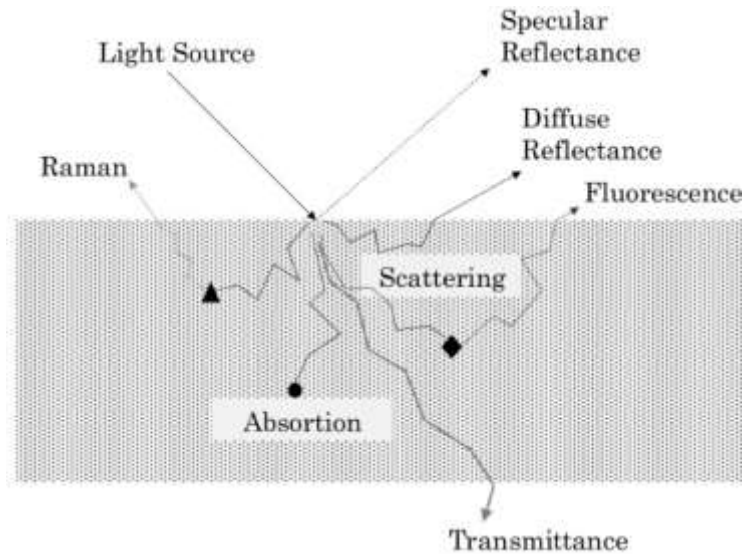


Fig. 2

## Interaction of light with oil

In this paper it was having main focus on light transmission through oil as medium for which we want to find quality. Arrangement is represented in the diagram Fig. 3. In this arrangement sample of oil is kept in a cavity, one side of cavity is having white source of light and other side is having photo detector so that light travels from transmitter and is traveled through oil under test depending on the condition of oil under test output from the photo detector may vary relating to oil property.

This type of arrangement contribute for low cost and simple hence more reliable operation of the whole system but proposed work also has some uncertainties because of its simple design and arrangement these are

- Firstly Interrelation of the temperature and optical devices such as LED, photo diode and photo transistor so measurement is uncertain. So it becomes necessary to analyze this dependency and remove uncertainties up to a acceptable extent.
- Secondly the position of cavity may not guarantee that oil may be circulated or not so that exact sample is under observation otherwise it may result in false alarm.
- Third colour of oil may not be exact measurement some times.

## 2.1 Method

Proposed sensor uses a very simple approach to find out oil quality, as mentioned in last section the working depends on the amount of the light transmitted through the oil and this depends on the colour of the oil and can be treated as indication of the oil quality. The approach used here becomes very simple with help of a microcontroller or development board eg. Arduino so that conversion of analog to digital can be done from same chip.

As mentioned in Fig.4 a photo transistor is used. Photo transistor is a device which is not having base terminal to have base current but current flows through base if light falls on the junction. Working can be understood as follows:-

A phototransistor[5] is kind of BJT in which the base region contains transparent window which is exposed to the illumination. This may be P-N-P or N-P-N types. Common emitter configuration is mostly used. It can work without base. Compared to the conventional transistor constructional difference is that more base and collector areas. phototransistors used single semiconductor materials like silicon and germanium but now a day's modern components use materials like gallium and arsenide for high-efficiency levels. for activating transistor base supply is require depends on type of transistor. The output of transistor is change in current due to change in incident light now the light depends medium (that is oil) as mention in Fig. 3. If change in colour of the oil due to aging and use of oil for the the light intensity. As this change of current cannot be interpreted by microcontroller so it is converted into change in voltage with the help of 2k resistance as voltage divider as shown in the Fig.3. this input now change in voltage is feed to analog input channel of microcontroller so that it can be converted into digital value. This value can be measure of oil quality eg. 0 to 255. Less value means lesser amount of light falling on it and hence darkened colour oil (degraded quality)

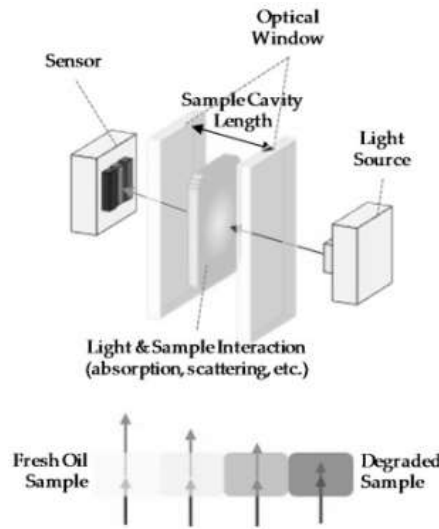


Fig 3

Proposed method and arrangement

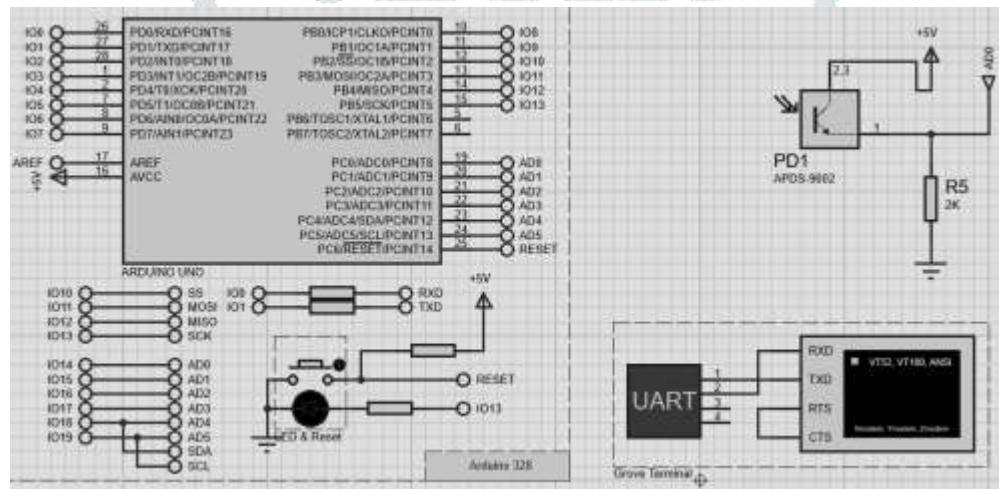


Fig. 4

Circuit diagram

Output may vary depending on the type of component being used mainly resistance and photo transistor. For display purpose serial module was used in this setup afterwards it may be replace by a display device such as LCD,7 segment or a simple meter having pointer.

### 2.2 Arrangement of proposed sensor

Arrangement is as show in Fig .5 so that it can be fitted in existing system. For the said purpose it has been done so that without any modification in the engine it can be implemented. Drain plug is chosen for above said purposed so that just existing drain plug can be removed and proposed sensor can be inserted in place of it. A four wire connector for inter face has been proposed to have connection of power , ground ,digital output and temperature output to it which ca be further connected to ECU[6] or BCU[6] of vehicle capable of reading signal [7][8][9]

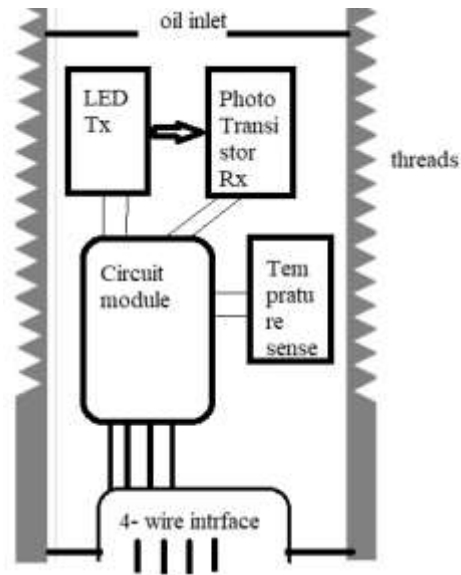


Fig . 5

Arrangement of sensor

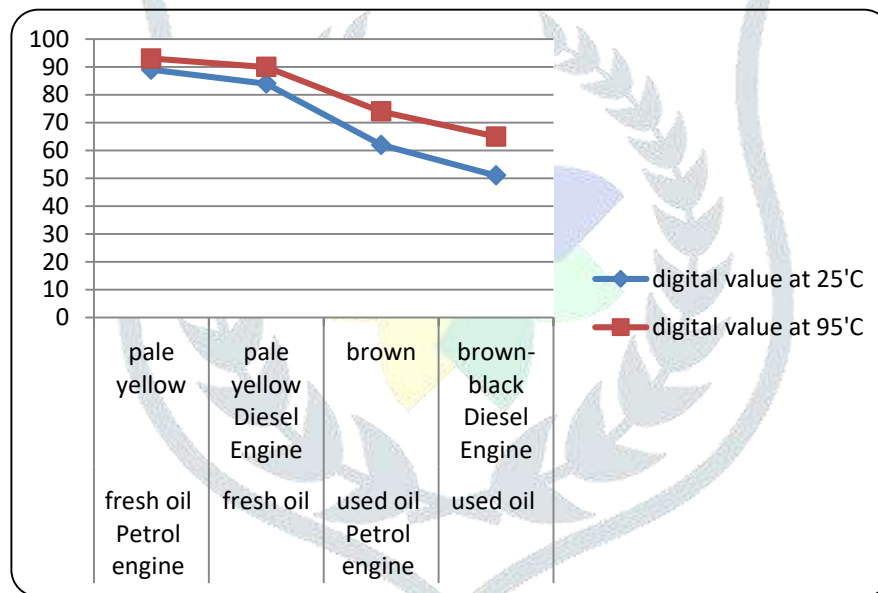


Fig. 6

Experimental results for different types of engine oils

### 3.1 Result and discussion

While doing experiment with said arrangement as described. Results were in the form of the number received ranging from 0- 255 (ADC dependent) digital value was seen on the serial monitor in arduino IDE as a representation of oil quality. Whole of the setup (transmitter and receiver) was kept in temperature bath to depict engine temperature following were observations from this:-

- The output received was much dependent on the temperature so may require temperature compensation
- Output in case of diesel engine is different even oil being used for same duration inside engine
- Proposed method can be easily used to find the oil quality in case of engine oil

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