International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 389-392 www.ijaem.net ISSN: 2395-5252

Monitoring Degradation of Lubricating Oil

Vishal Pande[1], Omkar Ardalkar[2], Kunal Karkera[3], Ojas Ghone[4], Mayur Kudtarkar[5]

Instrumentation Engineering Department Vidyavardhini's College of Engineering & Technology
Instrumentation Engineering Department Vidyavardhini's College of Engineering & Technology
Instrumentation Engineering Department Vidyavardhini's College of Engineering & Technology
Instrumentation Engineering Department Vidyavardhini's College of Engineering & Technology
Instrumentation Engineering Department Vidyavardhini's College of Engineering & Technology

---

Date of Submission: 14-06-2020 Date of Acceptance: 30-06-2020

ABSTRACT

Providing a technology that will assist on making decisions based on parameters like operating conditions, the fuel quality, the ambient conditions and operating parameters and the rate of deterioration of lubricating oils so as to monitor degradation of oil. Our project will focus on one major parameter of oil i.e. Viscosity. Engine oil viscosity refers to how easily oil pours at a specified temperature. Thin oils have lower viscosity and pour more easily at low temperatures than thicker oils that have a higher viscosity. Thin oils reduce friction in engines and help engines start quickly during cold weather. Thick oils are better at maintaining film strength and oil pressure at high temperatures and loads. The technology will help to monitor the degradation of engine oil so that the oil could be removed and re-refined when it's dilapidated.

Keywords: ***viscosity, lubrication, torque***

I. INTRODUCTION

Lubricating oil is a dielectric material with low losses and employed in internal combustion engines for reducing the frictions of the mobile components while keeping the different elements clean. With prolong use, the dielectric property (or non-conducting) property of the oil degrades. Degraded lubricating oil may contain contaminants like water, soot particles, acid combustion products, glycol, ferrous and non-ferrous metallic particles. The degradation of most oils imply the generation of molecules that are generally more polarized than the large hydrocarbon molecules which are weakly polarized. Lubricating oils are exposed to various strains depending on the operating conditions, the fuel quality, the ambient conditions and operating parameters and the rate of deterioration of lubricating oils strongly depends on all these factors. At the same time unnecessary oil change should be curtained in order for environmental effect and economic reason. Hence it is necessary to monitor the degradation of engine oil so that the oil could be removed when dilapidated. The methods. Viscosity is often referred to as a fluid's *thickness* or how much it resists deformation due to an applied force. Rotational viscometers measure the amount of torque needed to rotate an object moving through fluid at a known RPM. Using the measured RPM at load and no load and Power of the motor shaft in Watt, the Torque can be calculated using this equation.

$$T_{NL} = \frac{(P_m)(60)}{(2\pi)(N_{NL})}$$

$$T_L = \frac{(P_m)(60)}{(2\pi)(N_L)}$$

$$T = T_L - T_{NL}$$

The variables represented in the equation are as follows: T_L is Torque in (Nm) at load and T_{NL} is Torque in (Nm) at no load, N_L is the RPM at load and N_{NL} is the RPM at no load. P_m is the Power at the motor shaft in (Watt). Using this Torque the viscosity of the fluid is expressed as:

$$\mu = \frac{(T)(60)}{(4\pi^2)(N_L)(h)} \left({}^{1}/{}_{r^2} - {}^{1}/{}_{(r)(R)} \right)$$

μ is viscosity in (Pa.s), r denotes the radius of the spindle in (m) and R denotes the radius of the outer cylinder in (m).

II. LITERATURE SURVEY

1. Viscosity sensors for engine oil condition monitoring-Application and interpretation of results.

It has been shown by A. Agoston a,, C. O¨ tsch a and B. Jakoby b that the viscosity of mineral base oils can be reliably measured by a micro acoustic sensor. At the degradation of lubricating oil is measured by several like OCP, on the macroscopic viscosity is not detected by the sensor. Specifically, neither the thickening effect, nor the degradation of the viscosity modifier polymers is detected by the used micro acoustic sensor. Accordingly, in the case of engine oil containing viscosity modifier additives of high molecular weight, the sensor output does not correlate with a conventional viscosity measurement. This behavior was attributed to the fact, that the sensor probes a thin oil film and thus will not detect any changes, which are induced by structures or interaction mechanisms with associated characteristic lengths being in the same magnitude or larger than the penetration depth of the acoustic wave in the oil ("macroscopic" viscosity changes). Alternatively, the effect could also be caused by the high oscillation frequency and/or the small oscillation amplitudes associated with the micro acoustic sensor (in comparison to conventional methods).At the same time, experiments with artificially deteriorated oils indicate, that the relative increase in the sensor signal provides more direct information on the oil's age in terms of oxidation, than the conventionally measured "macroscopic" viscosity. In particular, it was found, that the sensor signal correlates much better with the degree of oxidation of the oil. This can be explained by the fact that oxidative deterioration causes an increase of the base oil's viscosity. Conventional viscosity measurements do not detect this increase distinctively since the deterioration of the viscosity modifiers (if present) yields a decrease in the macroscopic viscosity, which represents an effect in the opposite direction. In experiments with artificially aged oil samples it has been shown that the sensor signal correlates with the measured value of the total acid number (TAN) for artificially aged oil. The acidity of artificially aged oils is caused by the oxidative degradation products of the oil itself where the presence of these thermal degradation products can be detected by the microacoustic sensor independently from the additive content of the oil. Thus, the sensor is potentially suited for the detection of the oxidation-induced viscosity changes caused by thermal deterioration of the oil.

2. Monitoring Of Moisture In Transformer Oil Using
Optical Fiber as Sensor.

S. Laskar and S. Bordoloi describe an instrumentation system to measure moisture content in a transformer oil sample using the measure of RI and temperature of the sample. A bare and bent multimode optical sensor is used to measure the RI of the sample, and LM35 is used as temperature sensor. The noise is associated with the measurement (measurement of RI).

To generate data cycles to train an ANN for the purpose of correlating the measure of RI and temperature of transformer oil samples to the moisture contents of the same time, the influence of particular polymer additives, percentages of water contents are prepared. These transformer oil samples are then subjected to temperature variation from 30°to 50° C, and the microcontroller-based system is used to samples the measure of temperature and RI of the transformer oil samples. Software has been developed to implement the algorithm of the trained ANN in the microcontroller-based system. Therefore, the microcontroller-based system can determine the moisture content of a transformer oil sample at any temperature between temperature range 30° –50° C by sampling the RI and temperature of the sample throughADC0 and ADC1.

III. METHODOLOGY

A typical rotational viscometer works on the principle that the torque required to turn an object in a fluid is a function of the viscosity of that fluid. A rotary motion encoder, a DC motor, motor driver and a spindle are the components incorporated into the rotational viscometer. The Outer Cylinder in this setup consists of liquid under test. The Sensing mechanism i.e. the spindle will be immersed inside the outer cylinder. All the data will be sent to the microcontroller which determines the parameter viscosity. Using a lcd display it will show the entire data to lcd. Also for graphical view the data can be represented on labview for better interpretation. Rotational viscometer has several advantages over others. Each component was tested individually with respect to the controller. It was properly adjusted to match gears.

Fig. 3.1 DC-Servo Gear Mechanism

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 389-392 www.ijaem.net ISSN: 2395-5252

Servo Encoder is connected to the pinion gear as shown in figure 2.2. The spindle will also rotate the servo encoder when it is rotated by dc motor. This connected mechanism of gear makes it simple to also know about the rpm of the spindle. It is important to know the amount of current needed to move the shaft. The samples, standard transformer oil samples with known determination of amount of current is done by servo encoder. When the spindle moves in rotational manner, the frictional force or drag of fluid acting on spindle, causes the system to need and use more current. So that it can be able to maintain the spindle moving at initial speed that is set by the user.

Fig. 3.2 Gear Mechanism Top view

Following coding was done to match the required output i.e. to run the DC motor for a specific period of time. The speed of DC motor was reduced gradually after multiple runs. The Spindle was made according to the requirements. We took a rod of approximately 2 inch and it was welded to a cylindrical shaped circular metal.

Fig. 3.3 Spindle

RPM was calculated to determine the torque values appropriate for maintaining laminar flow throughout testing. Most of the data collected had laminar flow so the data could be analyzed. In this application to get any usable data, medium to high viscosity fluids are used.

IV. RESULT

The determination of viscosity of fluid was carried out on 3 different samples of oil.

Engine Oil	Measured Viscosity (Pa.s)	Calculated viscosity (Pa.s)
Unused oil	1.98×10^{-2}	2.99×10^{-2}
Used for 500 km	1.74×10^{-2}	2.81×10^{-2}
Used for 1000 km	1.55×10^{-2}	2.68×10^{-2}

First, viscosity was calculated from equation. In the test, it was seen that this measured viscosity was not confirmed to the actual viscosity. This can be corrected by introducing a Correction Coefficient. This is the usual practice what every viscometer manufacturer does. For every viscometer, manufacturer provides a correction coefficient. It has been observed that there is loss of power consumed by motor under load which affects the RPM, torque and the measured viscosity.

V. CONCLUSION

A rotational viscometer has been developed and digitalized in this project. The provision for the measurement of viscosity of oil at different conditions has been provided with the instruments. The initial results of the project are promising. The viscosity data obtained from the variety of fluids that were used suggest that the device is capable of obtaining reliable viscosity values over a range of temperatures. There are a number of additional things that need to be addressed before the device can be implemented into laboratory use. A more permanent and tamper resistant housing for the interface and wiring needs to be constructed, as well as a clear safety shield over the device when operating. Lastly, the viscometer needs to be properly calibrated to guarantee consistent and accurate data values. With these tasks completed the device should produce viscosity values within the acceptable level of accuracy and be entirely ready for lab use.

REFERENCES

[1]. P.Ingole, P.Kapse, S.Badhe, S.Bholani, V.Pande, "Predictive Maintenance For Hydraulic System" in International Journal of Engineering Research and Application, volume-9 Issue No 5, Series-I May 2019.

[2]. Y. Liu, Z. Liu, S.Z. Wen, Y.B. Xie, Motion analysis on the particles in a magnetic field detector, Tribol. Int. 33 (2000) 837–843.

[3]. P.N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics including Hydraulic Machines, 2005-2006

[4]. B.J. Roylance, Ferrography then and now, Tribol. Int. 38 (2005) 857–862.

[5]. H.L. Xiao, The development of ferrography in China-some personal refflections, Tribol. Int. 38 (2005) 904–907.

[6]. V. Macian, R. Payri, B. Tormos, L. Montoro, Applying analytical ferrography as a technique to detect failures in diesel engine fuel injection systems, Wear 260 (2006) 562–566.

[7]. P. Yaroshchyk, R.J.S. Morrison, D. Body, B.L. Chadwick, Quantitative determination of wear metals in egine oils using laser-induced breakdown spectroscopy: a comparison between liquid jets and static liquids, Spectrochim. Acta Part B 60 (2005) 986–992.

[8]. P. Yaroshchyk, R.J.S. Morrison, D. Body, B.L. Chadwick, Quantitative determination of wear metals in engine oils using LIBS: the use of paper substrates and a comparison between single-and double-pulse LIBS, Spectrochim. Acta Part B 60 (2005) 1482–1485.

[9]. B. Jakoby, M. Buskies, M. Scherer, S. Henzler, H. Eisenschmid, O. Schatz, A novel multifunctional oil condition sensor, in: S. Krueger, W. Gessner (Eds.), Advanced Microsystems for Automotive Applications, Springer, Berlin/Heidelberg/New York, 2001, pp. 157–165.

[10]. B. Jakoby, M. Scherer, M. Buskies, H. Eisenschmid, An automotive engine oil viscosity sensor, IEEE Sens. J. 3 (2003) 562–568.

[11]. S.J. Martin, G.C. Frye, K.O. Wessendorf, Sensing liquid properties with thickness-shear mode resonators, Sens. Actuators A 44 (1994) 209–218.

[12]. K.K. Kanazawa, O.R. Melroy, The quartz resonator: electrochemical applications, IBM J. Res. Dev. 37 (2) (1993).

[13]. D. Kroger, Stabinger Viscometer, Petro Industry News, vol. 3, issue 4, Annual Buyers Guide 2002/2003.

[14]. Viswanath, D., T.K. Ghosh, et al. (2007) Viscosity of Liquids: Theory, Estimation, Experiment, and Data. Springer.

[15]. Forsythe, W.E.. (1954; 2003). Smithsonian Physical Tables (9th Revised Edition) - Table 318. Viscosity of Organic Liquids. Knovel.

[16]. E. M. Barber , J. R. Muenger , F. J. Villforth, "High rate of shear rotational viscometer" Anal. Chem., 1955, 27 (3), pp 425–429, DOI: 10.1021/ac60099a030.

[17]. E. Hatschek, The General Theory of the Viscosity of Two-phase Systems. Trans. Faraday Sco. 9, 80-93 (1913)

[18]. A. Mallock, Determination o f the viscosity of water, Proc. Roy. Soc. 45, 126-132 (1888).

[19]. C. H. Lindsley and E. K. Fisher, End-effect in rotational viscometers, J. Appl. Phys. 18, 988-996 (1947).

International Journal of Advances in Engineering and Management

ISSN: 2395-5252

IJAEM

Volume: 02 Issue: 01 DOI: 10.35629/5252

www.ijaem.net

Email id: ijaem.paper@gmail.com