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# Detection of Quantity of Used Oil Inadulterated Lube Oil by Using Some Important Physical Properties

J. S. Joshi[1], S. A. Puranic[2]
*(Chemical Engineering department, L.D. Engineering,Ahmedabad-380015, Gujarat, India)*
*(Chemical Engineering department, L. D. Engineering, Ahmedabad-380015, Gujarat, India)*
*Corresponding Author: J. S. Joshi*

***ABSTRACT****: To reduce the friction and make machine more energy efficient in terms of output and heavy duty,lube oil play a vital role. In some of the countries lube oil is being adulterated by used oil andsold atlow costs. The quantity of this type of adulteration is required to be detected asit affects environment by evolving some pollutants and reduce the efficiency of engine. For detectionof this type of adulteration there are lot of sophisticated techniques available but,unfortunately theyall are time consuming and tedious. In this paper some important physical properties are evaluated which are giving larger difference for pure oil, used oil and their blends.*

***KEYWORDS:*** *lube oil, adulteration of lube oil, detection techniques, property curve.*

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## I. Introduction

To reduce the friction and make machine more energy efficient in terms of output and heavy duty, lube oil play a vital role. Or in other words, we can say this lube oil is like blood in human body. It release heat from particular part of machine, which otherwise may melt machine part where friction is taking place. Along with the other facts lube oil helps keeping the moving parts separate,reducing friction, carrying away contaminants and fragments, supplying power, defending against wear, warding off corrosion, sealing for gases, elimination of risk of smoke and fire of objects and avoiding rusting. And if lube oil doesn't give your machine that kind of work performance, then it is clear that the lube oil that you have been using for long is not a genuine lube oil. Hence you should stop that particular brand of lube oil and start using something which gives you right kind of productivity. This process of adulteration are done in a number of forms like mixing of genuine product purchased from licence player with low quality solvent and put up for a sale as a authentic products of approved players beneath the same brand. Sometimes it is done by mixing with novel products of approved players with degradable solvents and put on market as real product with no branding and this cheaper brands poured in to exclusive branded containers and there by misleading the retailers and costumers.While in some of the cases the refined used oils ismixedwith solvents and then it is re-packed of certified player's products and selling them under re-packer's name.

On the other hand because of use of adulterant like used oil, solvent when the adulterated lube oil is use for lubrication it contain some of the metals, and other adulterants which is the main cause of some of the air pollution and other drawbacks.Due to potential environmental contamination and health and safety concerns, used lube oil must be recycled or disposed of properly by local waste management authorities or automotiveworkshops.Many spectroscopic techniques such as UV–Vis, fluorescence, infrared, and near-infrared spectroscopy have been evaluated for the application of oil analysis but all this methodology are very sophisticated and time consuming which required authorised person for evaluation of adulteration.[1]

Some of the physical properties for some petroleum fractions like petrol, diesel [2][3] are change substantial for given quantity of adulteration while for some quantity of adulteration it change drastically. On the bases of that change one can suggest easier [4] methodology by which the quantity of adulteration could be detected. The suggestion could be given on the bases of property curves of all these properties which could be use for determining the range for which the given property is change drastically. After deciding the range the property is decided for detection of quantity of adulteration for that range. These types of properties are smoke point, End boiling point, Initial boiling point, specific gravity, API gravity, diesel index etc. These property are being evaluated as per the standard methodology like ASTM and IP.[5]

## II. Material And Methodology

### 2.1. Material

The lube oil is purchased from Waghodia road, Vadodara -390019 while the sample of used lube oil is being collected from Alang ship yard, Bhavnagar. The gradation of lube oil is SAW 90W which is known as a

gear oil in market is taken for evaluation. The sampling of used oil is also done of same gradation means it is also of gradation SAW 90W. This used oil is also known as gear oil in market.

## III. Methodology

Some of the important properties like viscosity index, flash point and carbon residue are evaluated for the blends of lube oil and used oil. First of all to evaluate the viscosity index it is required to understand the viscosity properly. The viscosity is an important property of all lube oil. Lubrication assists in removing the frictional forces between two moving bodies. Viscosity is defined as the force in dynes required to maintain 1 sq. Cm plane, with a unit velocity gradient from another similar plane separated by a distance of 1 cm. Lubricants are specified by another derived property namely viscosity index, which indicates the variation characteristics of viscosity with temperature. Dean and Devis had given the following formula for viscosity index,

$$V.I. = \frac{L - U}{L - H}$$

Where,
L = Viscosity of a reference oil of zero viscosity index deg. At 100 deg. C.
H = Viscosity of a reference oil of 100 viscosity index deg. At 100deg C.
U = Viscosity of test sample at 40 deg C.

**Fig. 1. Redwood viscometer type II**

L and H are determined from standard table which is given as per the standard ASTM D2270.
Viscosity at 40 deg C of test sample is being evaluated by Redwood viscometer type II. The time required for the cup become empty is being calculated by filling the 67 ml sample in the cup and allow it to empty. By knowing the time the kinematic viscosity is being evaluated by following equation.

$$\mu = \frac{A}{t} + B * t$$

Where,
A = Constant 1
B = Constant 2
t = Time required to empty the cup of Redwood viscometer type II.
This equipment is giving the kinematic viscosity. This kinematic viscosity is the ratio of absolute viscosity to density of liquid. This two constant is required to evaluate first by trial and error method. In this method you have to prepare two equations for known kinematic viscosity fluids. By solving this two equation we can calculate the Constant 1 and 2. This constant 1 & 2 are required to evaluate because it change with seasonal change.

**Figure.2 Cleveland apparatus for determining falsh point.**

The flash point is another property which evaluated for blends of lube oil and used oil. The flash point is defined as the minimum temperature at which the vapours from oil sample will give a momentary flash on application of a standard flame under specific test condition.The highly volatile sample, whose flash point shall be less than 40 deg C. Pensky-Martens closed cup can be used and for medium or high flash point liquids like lube oil open cup Cleveland apparatus is used for evaluation.

**Figure 3. Condredson carbon residue apparatus**

The carbon residue which is another property that evaluated for preparing property curve. The carbon residue is propensity of cracking. Heavy oils being delicate to high temperature have tendency to crack, with deposition of carbon.The amount of carbon formed during cracking does ultimately provide an idea of usability of oil at high temperature. This test is conducted by two methods namely conradson method (IP 13/ 66) and Ramsbottom method (IP 14/65; IS 1448 P : 8). From this two method conradson method is selected for evaluation of carbon residue. This methodology is consists of some of the steps like first of all take 10 gm of oil in silica crucible and heated out of contact with ait. The set up provides the necessary precautions, such that the oil is thermally decomposed out of contact with air. The decomposition is brought by means of high heating rates. The total heating time is taken to be 13 minute with constant heating rate.

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For preparation of property curve the following different blends are prepared for different properties. For viscosity index blend of pure lube oil and used lube oil prepared for evaluating the property. These blends are 100% pure lube oil,50%pure lube oil and 50% used lube oil, 25% pure lube oil and 75% used lube oil, 20% pure lube oil and 80% used lube oil,15% pure lube oil and 85% used lube oil, 10% pure lube oil and 90% used lube oil and 100% used lube oil.For flash point different blends are prepared like 100% pure lube oil, 25% pure lube oil and 75% used lube oil, 40% pure lube oil and 60% used lube oil, 50% pure lube oil and 50% used lube oil, 100% used lube oil. For carbon residue different blends are prepared like 100% pure lube oil, 75% pure lube oil and 25% used lube oil, 65% pure lube oil and 35% used lube oil, 50% pure lube oil and 50% used lube oil, 25% pure lube oil and 75% used lube oil, 20% pure lube oil and 80% used lube oil. By preparing these blends for different properties like viscosity index, flash point, carbon residue and then the range for which the change in property is drastically is decided then this range is given as an easier methodology by which one can determine the adulteration for this mentioned gradation lube oil SAW 90W.

## IV. Result And Discussion

### 4.1. Viscosity Index

By observing the property curve of viscosity Index (Table.4.1 ) (Figure 4.7) it is concluded that the 0% adulterated lube oil is giving the 116.32 value of viscosity index while 25% pure lube oil blend is giving viscosity index 96.96. Furthermore when it is observed that for 0% pure lube oil to 5% pure lube oil blend it is concluded that the viscosity index is change only around 1% of whole which is not much more comparative to

the span of 10% pure lube oil to 25% pure lube oil blend. The change between 10% pure lube oil to 25% pure lube oil blend is nearly about 10% of the whole values.

So when we observed the change from 0% to 5% pure lube oil blend viscosity index change is minor while the change from 10% to 25% pure lube oil blends, viscosity index change is stringent and when we increase the percentage of pure oil above 25% the viscosity index change is minor. So when we want to determine the adulteration of used oil in pure oil of grade SAW 90W one can determine the adulteration only for 10% to 25% range of pure oil blends that means viscosity index is only important property for this prescribed range.

For this type of lube oil like SAW W90 if one want to find the adulteration, 0% pure lube oil to 25% pure lube oil is the range for which one can find the viscosity index an important test for determining the adulteration.

**4.2. Flash Point**

Further evaluated property for this petroleum fraction is flash point is shown in Table. 4.2andFigure 4.8. . By observing the property curve of this property (flash point) it is concluded from changes in value of this property for 0% pure lube oil to 25% pure lube oil which is from 158 ° C to 232 ° C it is around nearer to 28% of the whole change in the property. Furthermore the change in this property for 25% pure lube oil to 50% pure lube oil it is nearer to 1.9% of whole values while that for 50% to 100% it is observed that change is from 242 ° C to 258 ° C which is around 6.2% of whole change in values. So if one want to evaluate this grade lube oil (SAW 90W) on the bases of the adulteration then because of change in flash point from 0% pure lube oil to 25% pure lube oil is stringent, one can evaluate flash point for this range (0% to 25% pure lube oil) and determine the quantity of adulteration done in this graded lube oil (SAW 90W). The change in the property from 50% pure lube oil to 100% pure lube oil is also considerable so this range is also important for determining the adulteration of this pure lube oil.

So if one want to determine the adulteration of this lube oil (SAW 90W) then the important range of this property is 0% pure lube oil to 25% pure lube oil and 50% pure lube oil to 100% pure lube oil.

**4.3. Carbon residue**

Another property evaluated is carbon residue (g) (Table. 4.3)(Figure.4.9). By observing the readings and property curve the interpretation done is that the property curve for carbon residue is linear if one point is to be removed from the curve which is 20% pure lube oil adulteration point. The value of this point is 1.4 and that for 0% is 1.5 so the difference between these two points is 0.1 which could be the error of instrument. So here for carbon residue the property curve is considered as a linear so carbon residue is not give any range for which one can concluded that the change in this property is significant. So this property is not important with reference to adulteration. But one can calculate the intermediate value of carbon residue if a linear property curve is available. So anyone could not find the adulteration by using this property for % quantity of used oil mixed with SAW W90 grade lube oil.

So when anyone intense to find the adulteration of this petroleum fraction -lube oil and specially SAW W90 grade lube oil, one could determine by evaluating two properties one is flash point and another is viscosity index. But one could not find the % quantity of mixing (adulteration) by using the carbon residue because it is change linearly and not give any significant change in property.

## V. Figure And Table:

**5.1. Viscosity index of blends of pure lube oil and used lube oil.**

| Sr. No. | % Pure lube oil | Viscosity index |
|---|---|---|
| 1 | 0% | 116.92 |
| 2 | 10% | 113.59 |
| 3 | 15% | 108.11 |
| 4 | 20% | 99.43 |
| 5 | 25% | 96.96 |
| 6. | 50% | 93.21 |
| 7. | 100% | 92 |

**5.2. Flash point of blends of pure lube oil and used lube oil.**

| Sr. No. | % Pure lube oil | Flash point (° C) |
|---|---|---|
| 1 | 0% | 158 |
| 2 | 25% | 232 |
| 3 | 40% | 237 |
| 4 | 50% | 242 |
| 5 | 100% | 258 |

**5.3. Carbon residue of blends of pure lube oil and used lube oil.**

| Sr. No. | % Pure lube oil | Carbon residue (g) |
|---|---|---|
| 1 | 0% | 1.500 |
| 2 | 20% | 1.400 |
| 3. | 25% | 1.225 |
| 4 | 50% | 1.000 |
| 5 | 65% | 0.850 |
| 6 | 75% | 0.750 |
| 7 | 100% | 0.500 |

**5.4. Relative change and overall change of viscosity index.**

| Sr. No. | % pure lube oil | Viscosity index | % increase in Viscosity index | |
|---|---|---|---|---|
| | | | Relative change | Overall change |
| 1. | 0 | 116.92 | - | - |
| 2. | 10 | 113.59 | 2.84 | 19.00 |
| 3. | 15 | 108.11 | 4.82 | 14.90 |
| 4. | 20 | 99.43 | 8.02 | 7.472 |
| 5. | 25 | 96.96 | 2.48 | 4.980 |
| 6. | 50 | 93.21 | 3.86 | 1.298 |
| 7. | 100 | 92 | 1.29 | 1.2 |
| | | | | |

**5.5. Relative change and overall change of flash point.**

| Sr. No. | % pure lube oil | Flash point (° C) | % increase in Flash point (° C) | |
|---|---|---|---|---|
| | | | Relative change | Overall change |
| 1. | 0 | 158 | - | - |
| 2. | 25 | 232 | 46.83 | 28.682 |
| 3. | 40 | 237 | 2.150 | 1.937 |
| 4. | 50 | 242 | 2.109 | 1.937 |
| 5. | 100 | 258 | 6.61 | 6.201 |

**5.6. Relative change and overall change of viscosity index.**

| Sr. No. | % pure lube oil | Carbon residue (g) | % increase in Carbon residue (g) | |
|---|---|---|---|---|
| | | | Relative change | Overall change |
| 1. | 0 | 1.500 | - | - |
| 2. | 20 | 1.400 | 6.666 | 20 |
| 3. | 25 | 1.225 | 12.5 | 35 |
| 4. | 50 | 1.000 | 22.5 | 18.36 |
| 5. | 65 | 0.850 | 25 | 15 |
| 6. | 75 | 0.750 | 11.76 | 20 |
| 7. | 100 | 0.500 | 33.33 | 50 |

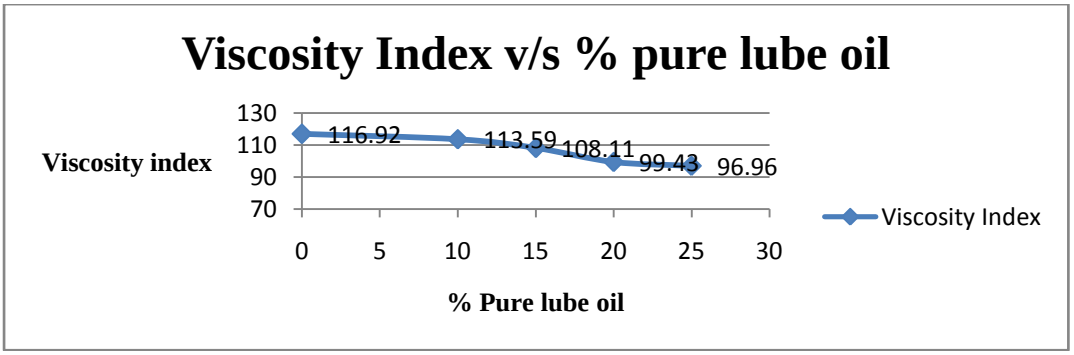


**Figure. 4.7.Property curve of viscosity index v/s % pure lube oil**

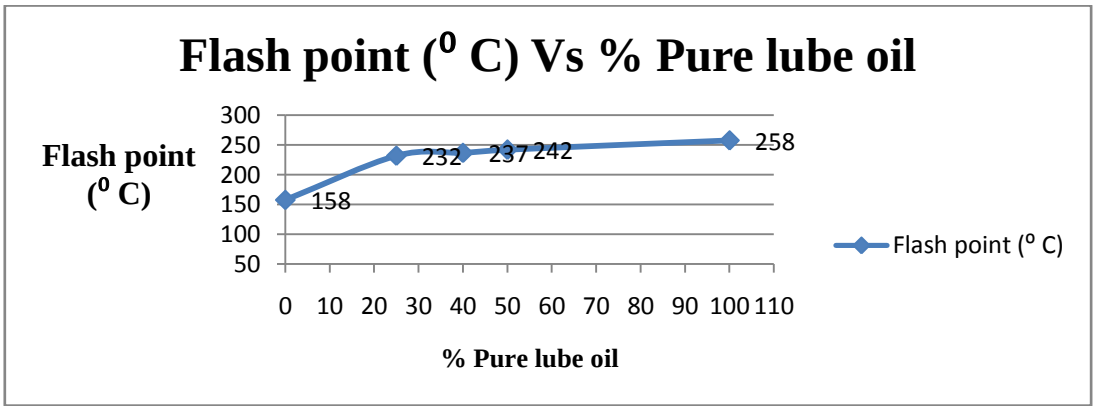


**Figure. 4.8.Property curve of flash point v/s % pure lube oil**

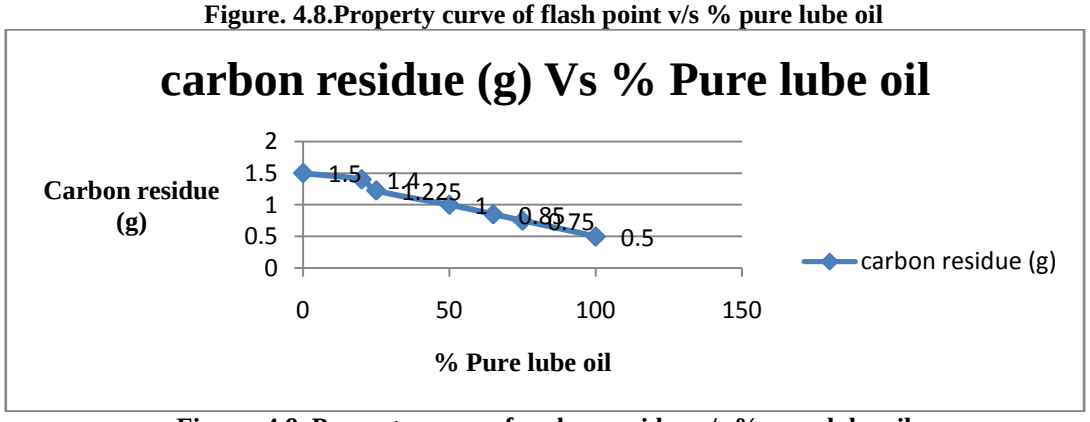


**Figure .4.9. Property curve of carbon residue v/s % pure lube oil**

## VI. Conclusion

There is lots of way by which the adulterated oil could be sold in market and it has environmental and safety hazards which is mentioned in literature. And furthermore there is no any easier methodology by which one can find the quantity of adulteration done. Some of the techniques are there for detection but it required sophisticated operator to operate. As per this research adulteration done by any one is in the range of above properties which is discussed above. So for the lube oil which is considered here (SAW 90W)), If one want to know how much adulteration is done in this particular grade oil then he can evaluate easily the viscosity index, flash point and carbon residue which takes only 10 to 13 minutes and could be easily find adulteration done. The evaluation equipments are also very simple which are shown in figures.

The range decided for the viscosity index is 10% pure lube oil to 25% pure lube oil while the range for flash point it is 0% pure lube oil to 25% pure lube oil it means that for this range change is drastically while for the range of 50% pure lube oil to 100% pure lube oil it change substantial so if any one ask to find the adulteration of the lube oil SAW 90W then he has to find the viscosity index for the range of 10% to 25% adulteration and flash point for the range of 0% to 25% adulteration and 50% to 100% adulteration. As per the property curve of carbon residue change is linear so there is no any range for this property decided but one can find the adulteration for intermediate range of % pure lube oil.

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