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RESEARCH ARTICLE

Mineral Turpentine Adulterant in Lubricating Oil

RAGHUNATH TOCHE[1], SHOBHA BORADE[2],
MADHUKAR MALVE[3] and BHAUSAHEB MORE[3*]

[1]Deparrtment of Chemistry, KTHM College, Nashik, India

[2]S M B S T College, Sangamner, Ahmed Nagar, India

[3]Directorate of Forensic Science Laboratories, Kalina, Santacruz, Mumbai-400098, India

bhaumore1@gmail.com

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Abstract: Mineral turpentine oil (MTO) is used to adulterate lubricating oil. The kinematic viscosity and flash point of lubricating oil and mineral turpentine oil samples are nearly 1.2 mm^2/s and 360 °C respectively. But adulterated samples of lubricating oil showed proportionate decrease in kinematic viscosity and flash point with percentage of mineral turpentine oil. This fact was used to detect adulteration of lubricating oil. The gas chromatographic analysis of the distillate of suspected lubricating oil sample when compared with standard mineral turpentine oil also showed the presence of mineral turpentine oil as adulterant. This approach was used to detect adulterated lubricating oil samples referred to forensic laboratories.

Keywords: Forensic sciences, Lubricating oil, Kinematic viscosity, Flash point

Introduction

In several countries, fuel adulteration is very common, this is because the products of comparable quantities have different price. Now a days fuel dealers do adulteration so as to make maximum profit. Adulterated fuel may damages motor vehicles and other harmful gas effect to human health[1]. Adulteration is a criminal act, therefore the government authorities like Police and food and civil supply departments monitor the quality of petrol and diesel from dealers by random collection of samples and screening it for adulteration in forensic and other authorized laboratories.

Lubricating oil is consist of mixture of C_{28} to C_{40} hydrocarbons blended with 2 to 20% additives mainly paraffin, naphthalene, aromatics and the base stock obtained during petroleum refining by-products. The lubricating properties of oil mainly depend up on their viscosity and the length of hydrocarbon chain. The most important properties of lubricating oil are density, flash point, kinematic viscosity. The viscosity index is governed by BIS specifications IS 496:1982[2].

The function of lubricating oil is to reduce the friction between the two moving metallic or plastic surfaces with respect to each other. The performance efficiency and operational durability of internal combustion of engine depends on quality of lubricating oils[3].

The lubricating oils are available in market in different trade names based on their purity and use in engine. They are more expensive than petrol, diesel, kerosene and mineral turpentine oil. Also they are susceptible for adulteration and hence the illegal syndicates for monitory gain adulterate it with turpentine oil. In Nashik region mineral turpentine oil is cheaply available and mainly used as an industrial solvent, for organic synthesis, thinner for oil paints and in adhesives[4-6]. Different workers reported various instrumental techniques for detection of adulterants in lubricating oil[7-12].

In our previous work, we described analysis of adulteration of diesel by measuring kinematic viscosity[13]. In this paper, we study the physical properties such as kinematic viscosity, flash point and gas chromatography analysis for determination adulteration in lubricating oil.

Experimental

Mineral turpentine oil and lubricating oil samples were procured from refineries. Admixtures of lubricating oil in mineral turpentine oil in the ratio (9:1), (8:2), (7:3), (6:4), (5:5), (4:6), (3:7), (2:8) and (1:9) were prepared. Gas liquid chromatography (Model-5765- Nucon Gas Chromatograph, India) coupled with Flame ionization detector. Viscosity was measured using Anton Paar (Stabinger) Viscometer (SVM3000/G2) by using toluene solvent at 40 ^oC temperature. The operating parameters were used are shown in Table 1.

Table 1. Instrument parameters

Instrument	Operating parameters
Column (packed)	Apizeon-L10%
Carrier gas	Nitrogen 30 mL/Min
Fuel	Hydrogen 35 mL/Min
Air	350 mL/Min
Oven initial temp	120 ^oC
Heating Rate	10 ^oC
Oven final temp	220 ^oC
Injector temp	220 ^oC
Detector temp	250 ^oC

Ten different samples of mineral turpentine oil and lubricating oil were obtained from different standard sources. 2 mL of sample was injected to sample cell and the kinematic viscosity was measured twice at 40 °C. If relative standard deviation is below 2%, the instrument shows valid results and gives the actual value of kinematic viscosity (Table 2). The flash point of standard lubricating oil and mineral turpentine oil was measured on (Pensky Martens ASTM D 93) instrument B. Flash point of ten different samples of mineral turpentine oils were taken on A (ABEL IP 170, Table 3). The admixtures of lubricating oil in mineral turpentine oil in the ratio (9:1), (8:2), (7:3), (6:4), (5:5), (4:6) (3:7), (2:8) and (1:9) were prepared and their kinetic viscosity and flash points were recorded as discuss above shown in Table 4.

Table 2. Kinematic viscosity and flash point of ten different lubricating oil samples

Sample No.	Kinematic viscosity at 40 °C in mm^2/s	Flash point °C
1	356	191
2	362	192
3	358	190
4	359	193
5	361	194
6	361	195
7	360	192
8	356	194
9	356	193
10	363	193
Average	359.2	192.7

Table 3. Kinematic viscosity and flash point of ten different mineral turpentine oil

Sample No.	Kinematic viscosity at 40°C in mm^2/s	Flash point °C
1	1.2036	30
2	1.2532	32
3	1.2456	35
4	1.1986	33
5	1.2218	32
6	1.2613	34
7	1.2017	31
8	1.2741	33
9	1.2215	35
10	1.2340	32
Average	1.23154	32.7

Table 4. Kinematic viscosity and flash point of ten different mineral turpentine oil and lubricating oil mixtures

MTO	Lubricating oil	Kinematic viscosity at 40 ^{o}C in mm^2/s	Flash point °C
10	0	363	194
9	1	109	69
8	2	50	56
7	3	22	52
6	4	14	50
5	5	7	48
4	6	6	46
3	7	5	45
2	8	3	44
1	9	2	43
0	10	1	42

The kinetic viscosity and flash points of suspected adulterated samples (unknown samples) were also measured by same procedure. Suspected adulterated samples were distilled and the collected distillate sample (0.5 uL) was injected at identical condition of Apeizon-L column (LabSpere Inc) and chromatogram was recorded. Similarly, control sample 0.5 uL of mineral turpentine oil was injected at same condition and chromatograms was recorded. The chromatogram obtained was compared with standard mineral turpentine oil samples as shown in Figure 1 and 2.

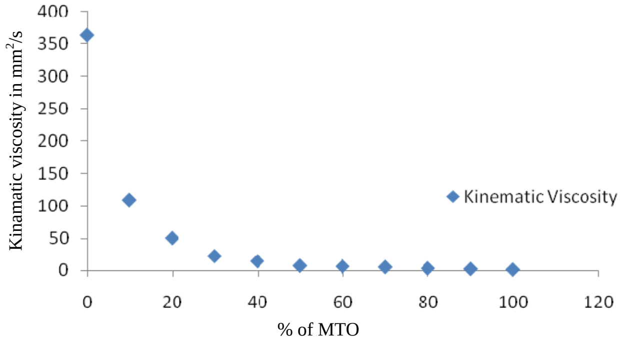

Figure 1. Graph of kinematic viscosity *vs*. percentage of MTO

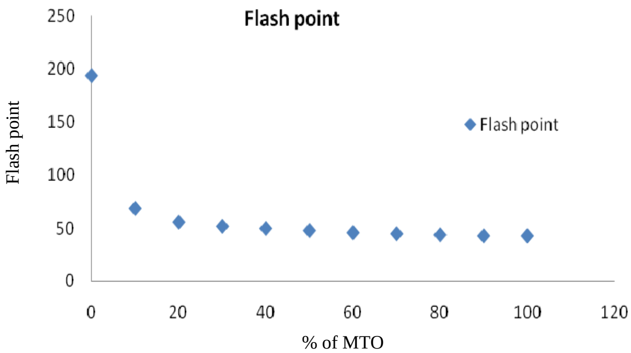

Figure 2. Graph of flash point *vs*. percentage of MTO

Results and Discussion

When liquid flows through tube the liquid layer in contact with wall of the tube is stationary where as the liquid in the center has high velocity. Intermediate layers move with a gradation of velocities. The flowing liquid may therefore be regarded as composed of a number of concentric tubes sliding over other. Each layer exerts a drag on the next and maintains the flow. This internal friction produces retarding force to oppose the flow of liquid. The kinematic viscosity depends on molecular size (length in particular) and on the magnitude of intermolecular force.

The values of kinematic viscosity in mm^2/s of ten different lubricating oil samples ranges from 355 to 365 mm^2/s (average 359.5) and flash point ranges from 193-190 °C (average 359.5) shown in Table 2. The kinematic viscosity of ten different MTO samples ranges from 1.2036-1.2741 mm^2/s (average 1.2315, Table 2) and flash point ranges from 30-34 °C (average 32.7, Table 3). The kinematic viscosity of admixtures decreases sharply up to 70% with increase in percentage of MTO in lubricating oil (Table 4).

The hydrocarbons in lubricating oil (C_{28} to C_{40}) have flash point about 192 °C and kinematic viscosity is about 360 mm^2/s. The measurement of flash point and kinematic viscosity of ten different samples of lubricating oil and ten different samples of MTO (Table 2 and 3), indicated that when lubricating oil is adulterated with 10% mineral turpentine oil, the flash point sharply decreases to 69 ^{o}C and kinematic viscosity sharply decrease to 109 mm^2/s as shown in Figure 1 and 2. Due to high price of lubricating oil the illegal syndicates adulterate lubricating oil with MTO. The diesel engine performance is a function of compression ratio, injection time and ignition temperature. These parameters are depending on the quality of lubricating oil. Advance analytical instruments like gas chromatography, mass spectroscopy, kinematic viscosity and flash point can be used for detection and measurement of adulteration in lubricating oil.

The suspected adulterated samples were analysed by same method and results are shown in Table 5. The flash point and viscosity analysis indicated that the suspected sample is adulterated. The type of adulterant can be found out by gas chromatographic analysis by comparing the chromatogram of distillate with standard MTO (Figure 3 & 4). The two chromatograms are identical indicated that the lubricating oil is adulterated with MTO.

Table 5. Kinematic viscosity and flash point of unknown suspected lubricating oil samples

Sample	Kinematic viscosity at 40 °C in mm^2/s	Flash point in °C
1	110	71
2	98	68
3	122	73

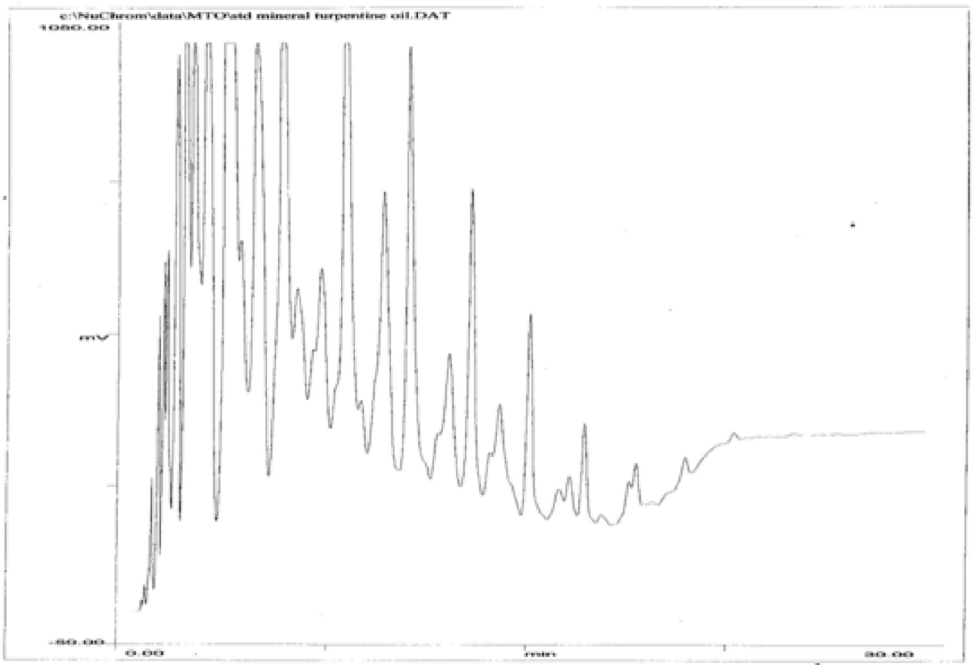

Figure 3. GC chromatogram of MTO

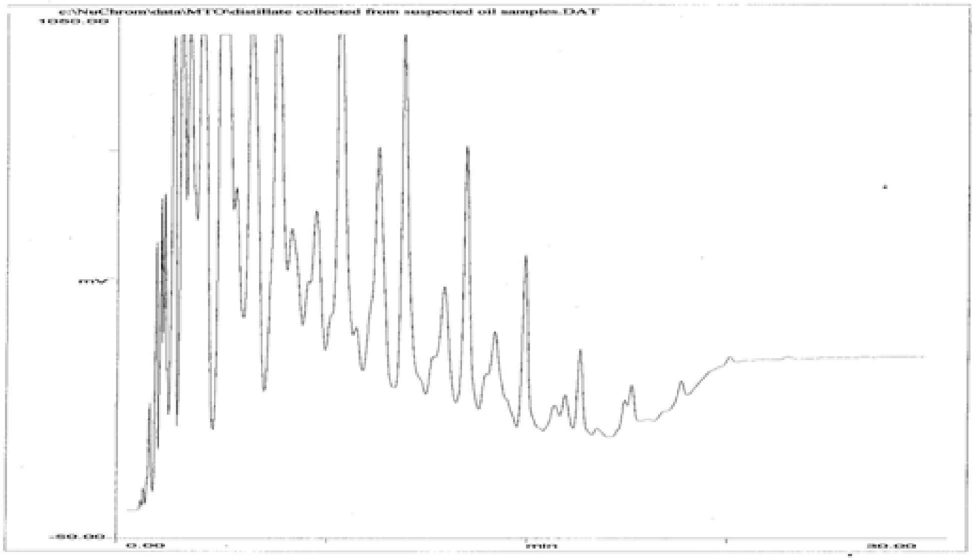

Figure 4. GC chromatogram of distillate collected from suspected adulterated lubricating oil

Conclusion

Measurements of kinetic viscosity, flash point are simple techniques for the determination of adulteration in lubrication oil and gas chromatography is important analytical tool can be used to find the type and percentage of adulterant.

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