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ANALYSIS OF ADULTERANT KEROSENE IN DIESEL BY KINEMATIC VISCOSITY MEASUREMENT

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ABSTRACT

Quantitative determination of adulterant in petroleum products viz diesel, petrol and kerosene is great challenge to police, revenue and forensic department. The literature methods are tedious, time consuming with large scope for errors. Viscosity measurement of known admixtures of diesel and kerosene at 40°C give linear plot. The viscosity comparisons of unknown sample with known admixtures directly give percentage of kerosene in diesel. Admixtures of kerosene in diesel in the ratio 10:90, 20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20 and 90:10 were prepared and 2 ml of sample of known admixture and unknown was injected to sample cell at 40°C. The Kinematic viscosity was measured twice if relative standard deviation is below 2% the instrument shows valid result and gives the actual values of kinematic viscosity. The intercept of viscosity of unknown sample on straight line graph of known admixture directly give the percentage of kerosene in diesel.

KEY WORDS

Adulteration, Forensic, Kinematic Viscosity, Diesel, Kerosene

INTRODUCTION

Adulteration in consumer products is great menace to the Nation. Petroleum products like petrol (motor spirit), diesel (HSD) etc. are most widely adulterated due to their heavy demand, high prices and occasional supply scarcity. The purity of fuels is governed by IS1460 [1]. Diesel is the most widely used fuel in heavy vehicles and is often adulterated with cheaply available domestic kerosene fuel. Kerosene (calorific value 45 KJ/g) is made available in subsidize rate to economic class as cooking fuel and industrial fuel by Indian government. But blackmailers mix this kerosene with diesel. The mixing of kerosene with diesel plays havoc in automobile machine resulted into damage of internal engine spares and causes decreasing fuel efficiency of the machine. The overlapping properties of kerosene and diesel attracted illegal mixing of kerosene in high priced diesel for monitory gains. Diesel fuels are petroleum derived complex mixture of hydrocarbons C_9-C_{19} with calorific value 45 KJ/g, distillation range is approximately 140-400°C and do not contain any olefins. Diesel in India contains 15-30% aromatics and 70-85 % saturated aliphatic. Aromatics present are having polynuclear rings and very small concentration of individual hydrocarbons. On the other hand saturated aliphatics contain considerable amount of individual hydrocarbons [2-4].

Adulteration is a criminal act, therefore the Government authorities like Police and Food & Civil supply Departments monitors the quality of petrol and diesel from dealers by random

collection of samples and screening it for adulteration in Forensic and other authorized laboratories. In most of the Laboratories the samples were analyzed based on ISI specifications using physical parameters which are quite inaccurate and defective. Unfortunately, adulterated diesel samples with 30% kerosene get passed on the basis of these specifications and methodology. There is no 100% accurate and efficient method or technique in literature for qualitative adulterant estimation of diesel or kerosene. The ISI specifications have no meaning unless the percentage adulteration is specified in sample.

In recent past, several worker claim new accurate methods for quantification of diesel and also received good response. These methods included determination of physical parameters like distillation range, specific gravity, opacity measurement of intrinsic modulated fiber optical density [5] etc. or theoretical interpretation of certain physical methods involving mathematical calculations are cumbersome and time consuming [6].

The hydrocarbons in diesel (C_9 to C_{19}) and kerosene (C_6 to C_{16}) are overlapping hence has potential for adulteration. The performance of diesel engine is the function of compression ratio, injection time and the mechanism of fuel resulting ignition delay occurrence. Advance analytical instruments like gas chromatography, mass spectrometry, distillation analyzer and flash point etc. help the measurement of adulterations in diesel [7].

Many methods have been developed till date for the determinations of adulterants in different fuels. As per ISI specification, No. IS 1460:1995, the most common methods utilized are odor and distillation range. The kerosene have typical odor generally detectable by smelling. The public distribution (PDS) product is dyed with blue dye, where as the one used for industrial purpose is colorless. ISI have specified density range for kerosene and diesel which are overlapping and hence definite conclusion cannot be drawn. Other methods include flash point determination, is not useful for determination of adulteration [8].

A gas chromatographic and specific gravity criterion for rapid study of adulterations in diesel with kerosene is described in literature [9]. But as Specific gravity for diesel samples varies from 0.800 to 0.850 and that of kerosene varies 0.780 to 0.820 are quite overlapping.

Online fractionation and identification of polycyclic aromatics in diesel fuel can be done by two-dimensional micro bore high-performance liquid chromatography, Capillary gas chromatography [10]. Also, gas chromatographic method for determination of adulteration in diesel samples is described [11-13]. The analysis of diesel were also done by using GC x GC x MS methods [14-17]. Gas chromatography [18, 19], NIR and IR [20] Spectroscopy [21, 22]. And Super Fluid Chromatography [23, 24] etc methods are also used for this purpose. Diesel is mixture of petroleum fractions and there is lot of variation in their percentage, therefore it is quite difficult to conclude adulteration of kerosene in diesel by gas chromatographic methods. Cetane number method needs an engine, which is expensive and generally not available in laboratories, also the amount of sample required is about 5 liters. This method is not useful for detection of adulteration in lower percentages.

In the present work the attempt were made to address the problem using concept of kinematic viscosity. Kinematic viscosity depends on molecular size (length in particular) and magnitude of intermolecular forces. Non-polar organic liquids have low viscosities, while polar solvent due to hydrogen bonding have relatively high kinematic viscosity. The Kinematic viscosity

range specified by ISI for diesel is 2.0 to 7.5 cSt, (Specification for diesel fuel IS: 1460:1974).

MATERIAL AND METHODS

Instrumentation: Make-Anton Paar (Stabinger) viscometer Model No.-SVM3000/G2

Detection temperature: 40°C; Toluene (washing solution)

System suitability: The instrument directly measures kinematic viscosity twice. If the values are stable it gives the actual value of kinematic viscosity. Ten different diesel samples were analyzed at 40°C and the kinematic viscosity was recorded in cSt. At 40°C 2 ml of sample was injected to sample cell and the kinematic viscosity was measured twice if relative standard deviation is below 2% the instrument shows result valid and gives the actual values of kinematic viscosity.

Preparation of test samples

Admixtures of kerosene in diesel were prepared in the ratio 10:90 (10%), 20:80 (20%), 30:70 (30%), 40:60(40%), 50:50 (50%), 60:40(60%), 70:30(70), 80:20(80) and 90:10(90). The suspected adulterated samples i.e. unknown samples were filled in 5ml vials sample and 2 ml of sample was injected to sample cell of the viscometer (Make-Anton Paar (Stabinger) viscometer Model No.-SVM3000/G2).

RESULTS AND DISCUSSION

The commonly used technique is based on testing the specified properties such as octane / cetane number, smoke point and distillation characteristics are lengthy and need large quantities of test material. Present paper deals with the measurement of kinematic viscosity of diesel, kerosene admixtures and suspected adulterated diesel samples. The adulteration in diesel by kerosene lowers the kinematic viscosity.

The values of kinematic viscosity in cSt of ten different samples of diesel (**Table 1**) and kerosene (**Table 2**) were in the range 2.6967 to 2.7817 and 1.2229 to 1.2821 respectively. The admixture of diesel and kerosene were prepared and their kinematic viscosity was measured by same method (**Table 3**). It was observed that the values of kinematic viscosity decreases with increasing in percentage of kerosene in diesel. The plot of viscosity verses percentage of kerosene in diesel was found to be linear **Fig.1**. The equation of the plot was found to be Y= -0.015X +2.78 and values of m and c are -0.015 and 2.78 respectively. The unknown suspected adulterated samples were analyzed by same method and the values of percentage adulteration were found from the plot directly (**Table 4**). The said method was found rapid and largely reliable analytical tool in forensic laboratories.

Table No.1: Kinematic viscosity of ten different of Diesel samples

Sr.No.	Sample at 40°C	Kinematic viscosityin cSt
1	Diesel 1	2.7251
2	Diesel 2	2.7817
3	Diesel 3	2.7493
4	Diesel 4	2.6921
5	Diesel 5	2.7273
6	Diesel 6	2.7652
7	Diesel 7	2.6967
8	Diesel 8	2.7075
9	Diesel 9	2.7268
10	Diesel 10	2.6998

Table No.2: Kinematic viscosity of ten different kerosene samples

Sr.No.	Sample at 40°C	Kinematic viscosity in cSt
1	Kerosene1	1.2516
2	Kerosene2	1.2620
3	Kerosene3	1.2229
4	Kerosene4	1.2821
5	Kerosene5	1.2776
6	Kerosene6	1.2466
7	Kerosene7	1.2546
8	Kerosene8	1.2798
9	Kerosene9	1.2356
10	Kerosene10	1.2598

Table No.3: Kinematic viscosity of ten different samples of diesel and kerosene Mixtures

Sr.No.	Sample at 40°C	Kinematic viscosity in cSt at 40°C
1	Diesel	2.7752
2	10%Kerosene in Diesel D: K (9:1)	2.6255
3	20%Kerosene in Diesel D: K (8:2)	2.4757
4	30%Kerosene in Diesel D: K (7:3)	2.3256
5	40%Kerosene in Diesel D: K (6:4)	2.1757
6	50%Kerosene in Diesel D: K (5:5)	2.0254
7	60%Kerosene in Diesel D: K (4:6)	1.8753
8	70%Kerosene in Diesel D: K (3:7)	1.7257
9	80%Kerosene in Diesel D: K (2:8)	1.5756
10	90%Kerosene in Diesel D: K (9:1)	1.4259
11	Kerosene	1.2413

Table No.4: Kinematic viscosity of Unknown diesel samples

Sr.No.	Kinematic Viscosity Measured (cSt)	Percentage of kerosene found from the plot
01	2.5057	18.29%
02	2.4150	24.33%
03	2.1171	44.19%

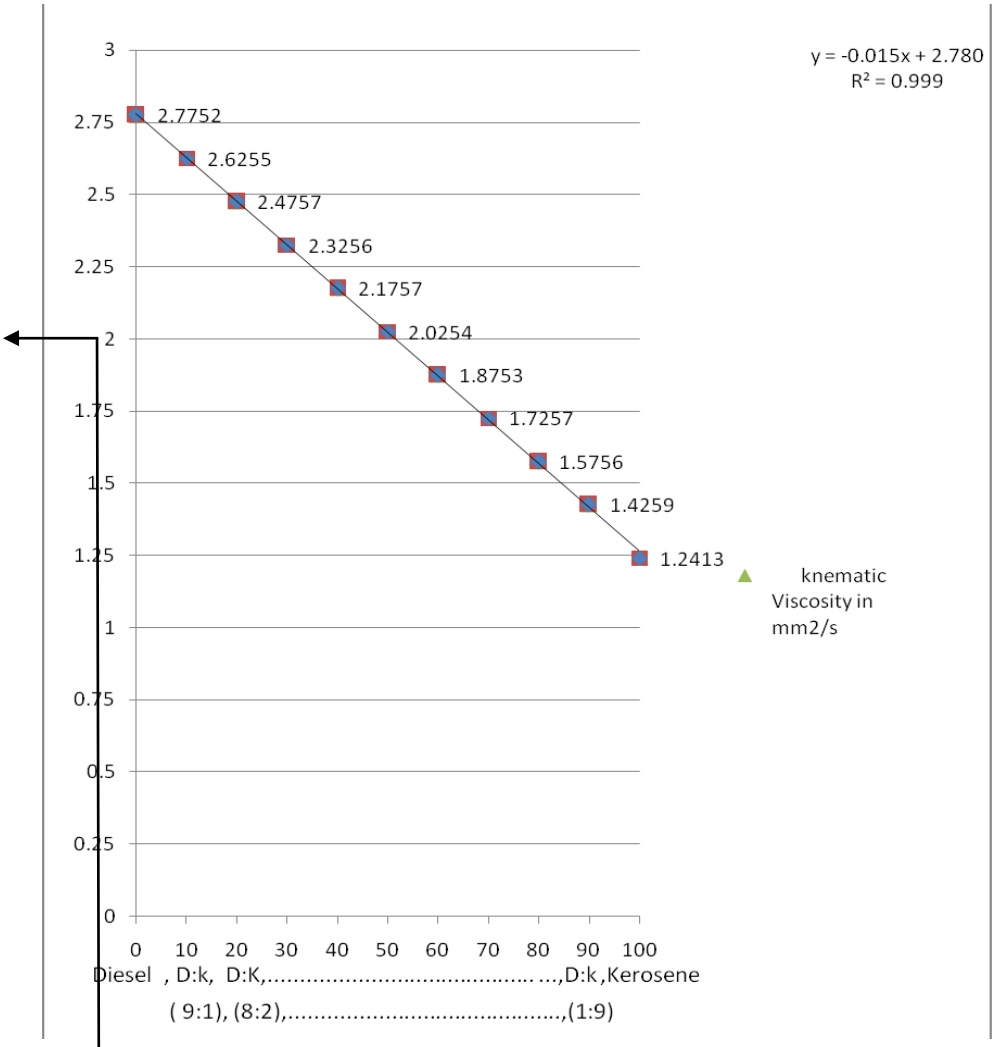

Figure 1: Plot of kinematic viscosity Vs. Percentage of kerosene in diesel

CONCLUSION

Results obtained from the Kinematic Viscosity measurements are comparable with capillary viscometer. The method is simple and reliable and the samples can further reused for next analysis. The detection limit of the method is 0.001Cst and requires only 2 ml sample for analysis with detection time less than 5 minutes.

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