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AN INVESTIGATION ON INCREASE OF VOLUME OF LUBRICATING OIL USED IN VEHICLES AROUND DHAKA CITY

Md. Ehsan[1], Md. Mahmudur Rahman[2], Md. Hassan Saadi[2]

[1]Professor, Department of Mechanical Engineering, BUET.
[2]Graduates, Department of Mechanical Engineering, BUET.

ABSTRACT
A field survey supported the claim of excessive crankcase dilution causing increase in volume of lubricating oil in the petrol driven vehicles across Dhaka city. The problem was experienced irrespective of vehicle make, model or age and brand of lubricating oil used. A study was carried out in order to identify the source of the problem. Fuel samples collected from Dhaka were tested against base fuels collected from Eastern Refinery, Chittagong, regarding a number of physical properties. The source of the problem lies in adulteration of fuel used, probably associated with undue benefits related to the high fuel price. Among the possible liquids mixed with petrol, condensates collected from natural gas-fields and transmission lines is the most likely candidate. Condensates around 15% by volume probably are being mixed with petrol, which is causing high rate of crankcase dilution of the lubricating oil used in engines run on petrol.

Keywords: Lubricating oil, Crankcase Dilution, Fuel Adulteration, Condensate, Automotive engines.

1. INTRODUCTION
In the recent years an unusual phenomenon have been widely experienced regarding the use of lubricating oil in automotive SI engines in vehicles used around Dhaka city. After use for some period, an unusually large increase of volume of the lubricating oil has been experienced causing crankcase dilution of oil and detoriation of its properties, which may hamper engine performance. The objective of this technical investigation was to – assess the extend of the problem, quantify the level of volume increase, identify whether origin of the problem rests in –lubricating oil, fuel or the engines and try to identify the most possible cause of the problem.

2. EXTENET OF THE PROBLEM
In order to assess and verify the extent of the problem a field survey was carried out around different parts of Dhaka city. 73 samples of data were collected from the major stakeholders – 41 vehicle drivers, 18 auto repair mechanics, 5 lubricating oil sellers and 9 car diagnostic centers. The survey questioner included a number of queries regarding - the extent of the problem experienced, type and age of the vehicle engine, type of fuel used, type of fuel system, type of lubricating oil used etc.

A number of findings were revealed from the information collected through field survey:

- More than 80% of the drivers and almost all the mechanics had experience of the problem.
- The problem was almost entirely present in petrol driven vehicles only and rarely noticed by drivers using diesel fuel and CNG alone.
- The problem was present across a range of engine models of a number of manufacturers.
- The problem was experienced both in new and used vehicles.
- Among the petrol drive engines it was present in both types – using carburetor and using electronic fuel injection fuel systems.
- The problem was present in engines using different brands of lubricating oils commonly used in Bangladesh.

In order to make a quantitative assessment two petrol driven vehicles were monitored in BUET auto shop. The lubricating oil capacities of their engines were around 3.5 liters. After driving about 1400 km the lubricating oil volume increased by about ½ liters in both of the vehicles. The viscosity of the lub oil also reduced significantly.

3. PROBABLE REASONS OF EXCESSIVE CRANKCASE DILUTION
Crankcase dilution to a limited extent is a phenomena experienced by any internal combustion engine. Low volatility components present in the fuel often are slow to vaporize after injection/intake into the cylinder. Some of these low volatility compounds and water formed during combustion can be condensed/deposited on the relatively cooler parts of the combustion chamber and cylinder wall. They can be absorbed or mixed with lubricating oil film and swept down into the crankcase by the normal

scraping action of the piston's oil control rings. Some may be transferred to the crankcase with blow-by gases. The key feature of crankcase dilution is whether the amount is significant to causes any deterioration in the lubricant's performance. With most of the standard lubricating oils normal crankcase dilution creates only very small change in lubricant volume within their recommended replacement period [1].

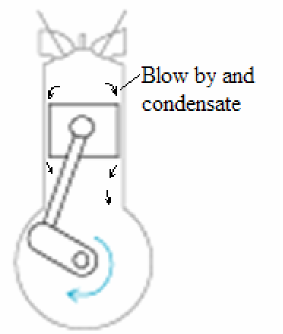

Fig 1: Crankcase dilution inside the engine cylinder

There could be three main reasons for the unusual increase of volume of lubricating oil used in a petrol engine :

- The lubricating oil may be going through some progressive chemical changes causing increase of its volume.
- Fuel may have been leaking or mixing in the lubrication system due to some mechanical fault in the engine system.
- The proportion of low volatile components of the fuel may have been increased by contamination or adulteration causing excessive crankcase dilution.

However the survey revealed that the problem has been experienced in engines using different brands of lubricating oils. It is present in engine models made by different manufacturers and existed both in new and used engines. The problem was not reported by drivers using diesel or CNG alone. Since all engines experiencing the problem are using the petrol/octane fuel available in Dhaka city, the third reason seems to be most likely to be responsible for large volume change of the lubricating oil used. Adulteration of fuel have been reported to be responsible for poor engine performance and exhaust emission in a number of places [2,3,4].

4. QUALITY OF FUEL AVAILABLE IN DHAKA

Fig 2: Location of fuel collection points across Dhaka

Some properties of petrol and octane fuel available in Dhaka were investigated to assess the degree of contamination or adulteration of fuel, if any. The vapor distillation curve and fuel density were measured and physical appearance of fuel was visually observed. Fuel samples were collected from 14 different fuel stations within a span of several days. Figure 2 shows the distribution of these petrol pumps across Dhaka city. Samples of petrol and octane fuels were also collected directly from Eastern Refinery (ER), Chittagong and this was considered as the base fuel (reference) for comparing the properties of fuel collected from the petrol pumps of Dhaka city. In addition fuel depots at Narangang were visited and the market-price of several potential contaminants was observed. The current prices per liter were reported to be – Petrol TK 65, Octane TK 67, Kerosene TK 45, Diesel TK 40, Condensate from gas-fields TK 6, Thinner (spirit) used in painting TK 80.

4.1 Physical Appearance of Fuel Samples

The variation in physical appearance (colour) was readily visible among samples collected from different petrol pumps. Apparently this is more prominent in petrol sample compared to Octane samples collected. Figure 3.a and 3.b exhibits the differences

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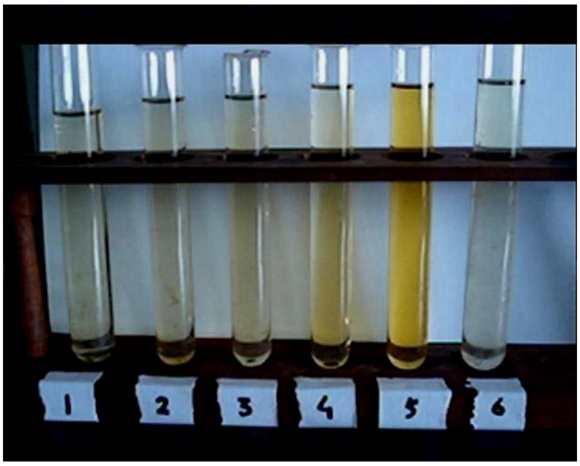

Fig 3.a : Colour comparison of petrol samples

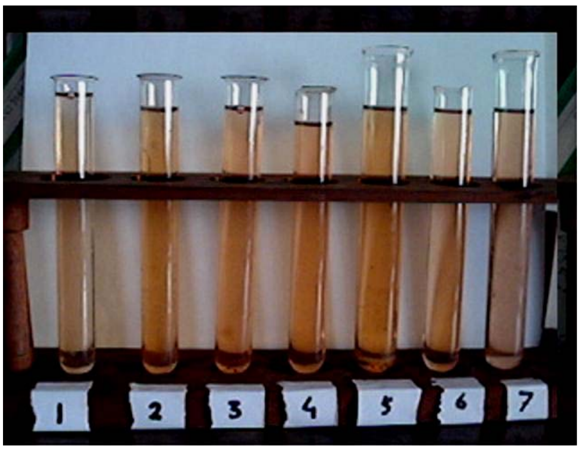

Fig 3.b : Colour comparison of octane samples

4.2 Density of Fuel Samples

The densities of all fuel samples were measured at 20°C. The values were compared to the density of sample from Easter Refinery and measured values of few other fuels. The density of base fuel was about 721 kg/m^3 (g/cc). The petrol samples ranged from 721.2 to 768.7 kg/m^3 and the Octane samples ranged from 731.4 to 759.4 kg/m^3. The sample identifications as show in figure 4 are only indicative. Figure 5 shows the comparative densities of different fuels.

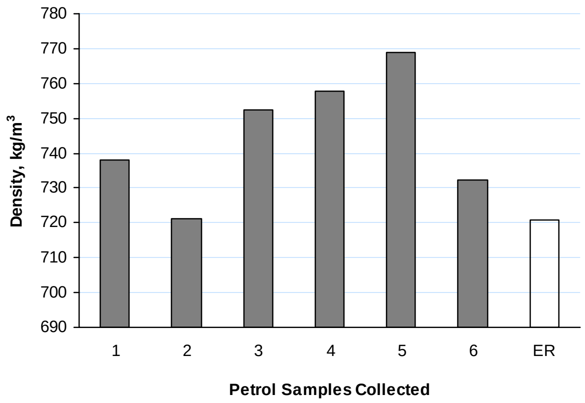

Fig 4a : Comparison of densities of Octane samples.

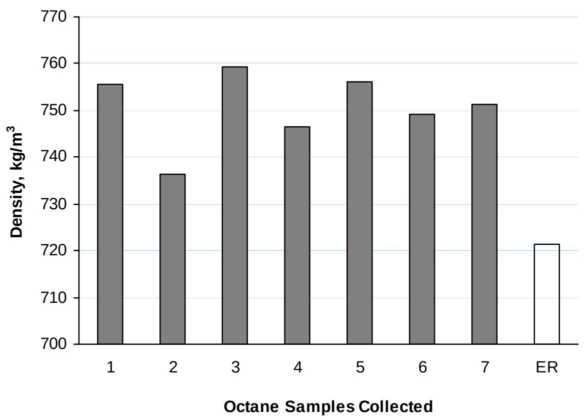

Fig 4b : Comparison of densities of Octane samples.

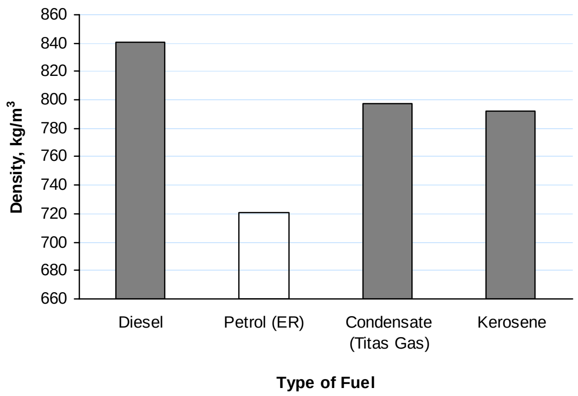

Fig 5: Comparison of densities measured.

4.3 Distillation Curve of Fuel Samples

Distillation is the process of heating a liquid until it boils, capturing and cooling the resultant hot vapors, and collecting the condensed vapors. Distillation is a powerful tool, boiling point of a compound—determined by distillation—is well-defined and thus is one of the physical properties of a compound by which it is identified. Petrol is a complex mixture of large number of components which boil over a range of temperatures [5]. The distillation properties of petrol are determined using a standard laboratory test like ASTM D86. The results can then be plotted to produce a distillation curve as in the typical example shown in figure 6. The results can also be expressed as the percentage of the fuel volume evaporated at a specific temperature. The key characteristics of distillation properties of petrol are described by the percentage of the fuel volume evaporated at 70 ºC, 100 ºC and 150 ºC, and its final boiling point (FBP).

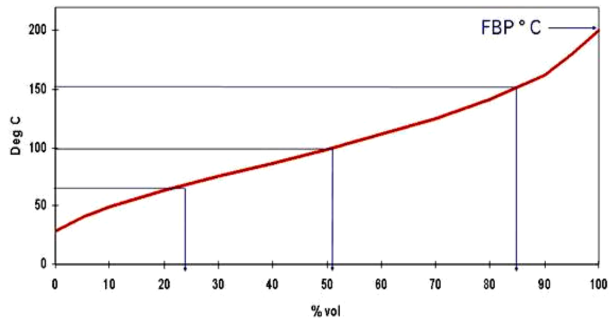

Fig 6: Typical distillation curve for gasoline.

Table 1: Boiling range of typical Refinery Products[5].

Product	°C	°F
Motor Gasoline	30 – 200	80 - 400
Kerosene, jet fuel	170 - 270	340 - 515
Diesel Fuel (#2)	180 - 340	350 - 650
Lube Oils	340 - 540	650- 1000

A manually operated D86-78 Distillation Unit (DU-4), R-type, with condenser tube to the right composed of electric heating assembly and cooling bath, (with a maximum test temperature up to +400°C). The DU-4 consists of a stainless steel cabinet with an inspection window, flask support (adj. in height) equipped with ceramic heating plate carrying 4 encased and gold plated heater rods. Lower part of the heating assembly has electronic heater module m2 -heating energy can be adj. within the range of 0 to 800 watts (220V, 50 Hz). The DU-4 is ideal for the examination of motor gasoline, aviation gasoline, aviation turbine fuel, special boiling point spirits, naphthas, white spirits, kerosene, gas oil, distillate fuel oil and similar petroleum products. Long Life - High Efficiency Heater is used here.

Figure 8a shows the comparison of distillation curves of several petrol samples collected with respect to the base fuel (ER). In all of the samples the distillation curves were shifted to higher temperatures (by 25-35°C) compared to ER petrol, clearly indicating the presence of components of lower volatility. As shown in figure 8b the rise is also present in some of the octane samples but as a whole the trend can not be generalized. This indicates greater degree of adulteration of petrol probably is happening compared to octane.

Fig 7: Distillation-Unit: DU-4 Professional

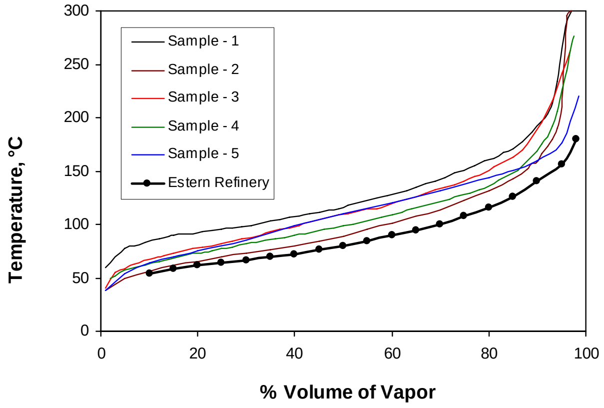

Fig 8a: Distillation curve of Petrol samples.

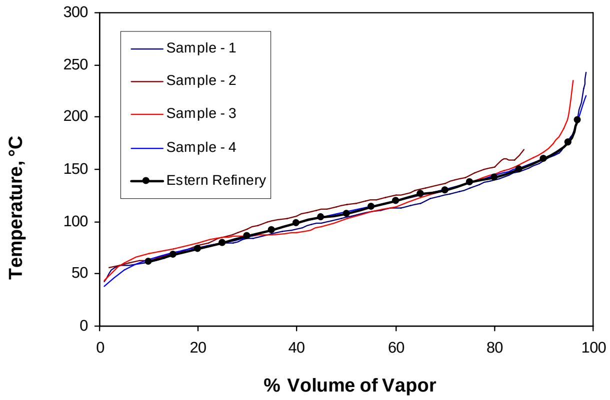

Fig 8b: Distillation curve of Octane samples.

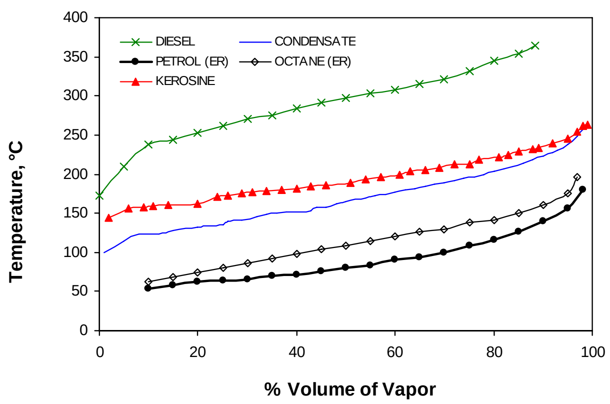

Fig 9a: Distillation curve of different fuels samples.

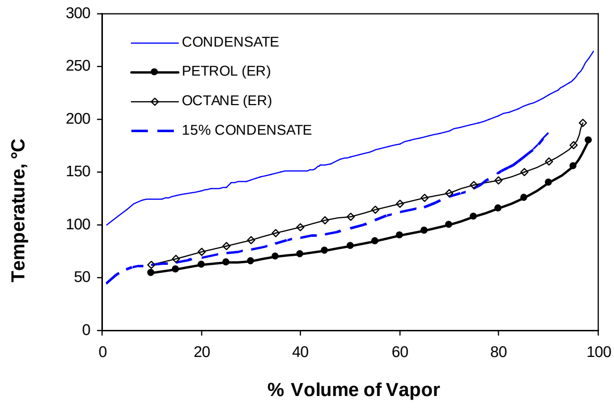

Fig 9b: Distil. curve of 15% Condensate with Petrol.

Figure 9a shows the distillation curve of ER petrol and ER octane and the relative position of curves of - Titas Condensate, Kerosene and Diesel. Figure 9b shows the comparison of the distillation curves of ER petrol, ER octane, Titas Condensate and an artificial mixture of 15% condensate with ER petrol. The curve for the mixture lies very close to the curves of the petrol samples of figure 8a.

5. DISCUSSION OF RESULTS

Study of visual colour strongly indicated possible adulteration of petrol fuel samples. The density measurements in most cases were higher than the base fuels, but densities varied through a range. This indicated the presence of components of higher densities being mixed and the fact that the degree of adulteration probably differs from pump station to pump stations in Dhaka. The rise of the distillation curves are very conclusive of mixing of fluids of lower volatility in case of petrol samples. Addition of less volatile liquids shifts the distillation curve higher in temperature scale, causing some of these components to remain liquid inside the combustion chamber during combustion, which gradually dilutes the lubricating oil. In case of octane samples there is indication of adulteration in some samples, but not sufficient to conclude regarding a generalized trend. It is very difficult to positively identify which or which of the fluids have been used for adulteration of petrol. Visually petrol is available coloured in yellow, diesel is orange-brown, kerosene is blue but condensate not recognized as a end-user fuel is almost colourless. Adulteration using Diesel would result in higher effect in distillation curve and using in small proportion would not give the desired economic benefit. Kerosene is also relatively costly it would require additional de-colouration to achieve visual similarity. Looking at the potential fluids - that can be mixed with petrol, the level of rise in the distillation curve experienced and very importantly their relative cost, condensates collected from gas pipelines available in the market seems to be a very likely candidate. To verify such a possibility an artificial mixture of 15% titas-condensate by volume with ER petrol was made and the density and distillation curve of the mixture was tested. As shown in figure 9b the distillation curve of the mixture lies in a region very close to distillation curves measured from collected petrol samples from different places of Dhaka city. The density of the mixture was found to be 733 kg/m^3, similar to the range of petrol samples. Detailed chemical or Photo-thermal analysis [6,7] of the fuel samples and contaminated lubricant could be more assuring but those were beyond the scope of this investigation. The physical properties of the mixture indicate very high possibility of condensates being used in the order of 15-20% by volume for petrol fuel adulteration. This may be giving some financial benefit to certain quarters, but causing excessive crankcase dilution and detoriation of lubrication performance and hence compromising the engine life. The contaminated lubricating oil (SAE 20W50) collected from the vehicles monitored in BUET auto shop measured a drop of viscosity to less than 100 mm^2/s (centistokes) from more than 400 mm^2/s at fresh condition, over about 1400 km of vehicle run, which is really concerning if unattended.

6. CONCLUSIONS

The problem of excessive crankcase dilution is widely present in the petrol driven vehicles across Dhaka city, irrespective of vehicle make, model or age and brand of lubricating oil used. The source of the problem lies in adulteration of fuel used, probably associated with undue benefits related to the high fuel price. Among the possible liquids mixed with petrol, condensates collected from natural gas-fields and transmission lines is the most likely candidate. Condensates around 15% by volume probably are being mixed with petrol, which is causing high rate of crankcase dilution of the lubricating oil used in engines run on petrol.

7. ACKNOWLEDGEMENT

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