

Effect of Benzene and Xylene on Flash Point of Kerosene

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ABSTRACT - Kerosene is widely used fuel in household and agriculture application in many regions of the globe. Flash point is an important measure for engine combustion and as well as safety related measures. Effect of Benzene and Xylene on Flash point is measured in different compositions of each compound, concentration of Benzene and Xylene exhibits direct proportional relationship with flash point of kerosene. Effect on improper combustion and improved efficient combustion due to the presence of aromatics can be studied further.

Keywords; - Benzene, Xylene.

1. INTRODUCTION

Kerosene, also known as paraffin, lamp oil and coal oil (an obsolete term), is a combustible hydrocarbon liquid which is derived from petroleum, widely used as a fuel in industry as well as households. Its name derives from Greek: κηρός (keros) meaning wax, and was registered as a trademark by

Abraham Gesner in 1854 before evolving into a genericized trademark. It is sometimes spelled kerosine in scientific and industrial usage. [1] The term kerosene is common in much of India, Canada, the United States, Argentina, Australia and New Zealand [2] [3] and the term paraffin is used in the United Kingdom, Southeast Asia, East Africa and South Africa. [4] Liquid paraffin (called mineral oil in the US) is a more viscous and highly refined product which is used as a laxative. Paraffin wax is a waxy solid extracted from petroleum.

Kerosene is widely used to power jet engines of aircraft (jet fuel) and some rocket engines, and is also commonly used as a cooking and lighting fuel and for fire toys such as poi. In parts of Asia, where the price of kerosene is subsidized, it fuels outboard motors on small fishing boats.[5] World total kerosene consumption for all purposes is equivalent to about 1.2 million barrels per day.[6]

To prevent confusion between kerosene

and the much more flammable and volatile gasoline, some jurisdictions regulate markings or colorings for containers used to store or dispense kerosene. For example, in the United States, the Commonwealth of Pennsylvania requires that portable containers used at retail service stations be colored blue, as opposed to red (for gasoline) or yellow (for diesel fuel).[7]

1.1 *Properties*

Kerosene is a thin, clear liquid formed from hydrocarbons obtained from the fractional distillation of petroleum between 150 °C and 275 °C, resulting in a mixture with a density of 0.78–0.81 g/cm³ composed of carbon chains that typically contain between 6 and 16 carbon atoms per molecule. [8] It is miscible in petroleum solvents but immiscible in water.

The American Society for Testing and Materials standard specification D-3699-78 recognizes two grades of kerosene: grades 1-K (less than 0.04% sulfur by weight) and 2-K (0.3% sulfur by weight). 1-K grade kerosene burns cleaner with fewer deposits, fewer toxins, and less frequent maintenance than 2-K grade kerosene, and is the preferred grade of kerosene for indoor kerosene heaters and stoves.[9]

Regardless of crude oil source or processing history, kerosene's major components are branched and straight chain

alkanes and naphthenes (cycloalkanes), which normally account for at least 70% by volume. Aromatic hydrocarbons in this boiling range, such as alkylbenzenes (single ring) and alkyl naphthalenes (double ring), do not normally exceed 25% by volume of kerosene streams. Olefins are usually not present at more than 5% by volume. [10]

The flash point of kerosene is between 37 and 65 °C (100 and 150 °F), and its auto ignition temperature is 220 °C (428 °F). [11] The pour point of kerosene depends on grade, with commercial aviation fuel standardized at −47 °C (−53 °F).

Heat of combustion of kerosene is similar to that of diesel fuel; its lower heating value is 43.1 MJ/kg (around 18,500 Btu/lb), and its higher heating value is 46.2 MJ/kg. [13] In the United Kingdom, two grades of heating oil are defined. BS 2869 Class C1 is the lightest grade used for lanterns, camping stoves, wick heaters, and mixed with gasoline in some vintage combustion engines as a substitute for tractor vaporizing oil. BS 2869 Class C2 is a heavier distillate, which is used as domestic heating oil. Premium kerosene is usually sold in 5 or 20 liter containers from hardware, camping and garden stores and is often dyed purple. Standard kerosene is usually dispensed in bulk by a tanker and is undyed.

National and international standards define the properties of several grades of

kerosene used for jet fuel. Flash point and freezing point properties are of particular interest for operation and safety; the standards also define additives for control of static electricity and other purposes.

1.2 Flash point

The flash point is the lowest temperature at which vapours of a volatile material will ignite, when given an ignition source.

The flash point may sometimes be confused with the autoignition temperature, which is the temperature at which the vapor ignites spontaneously without an ignition source. The fire point is the lowest temperature at which the vapor will keep burning after being ignited and the ignition source removed. The fire point is higher than the flash point, because at the flash point the vapor may be reliably expected to cease burning when the ignition source is removed. [14] Neither flash point nor fire point depends directly on the ignition source temperature, but it may be understood that ignition source temperature will be considerably higher than either the flash or fire point.

The flash point is a descriptive characteristic that is used to distinguish between flammable liquids, such as petrol, and combustible liquids, such as diesel. It is also used to characterize the fire hazards of liquids. Depending on the standard used, liquids which

have a flash point less than either 37.8 or 60.5 °C (100.0 or 140.9 °F) are called flammable — whereas liquids having a flash point above that temperature are called combustible. [15].

1.2.1 Measurement

There are two basic types of flash point measurement: open cup and closed cup. [16] In open cup devices, the sample is contained in an open cup which is heated and, at intervals, a flame brought over the surface. The measured flash point will actually vary with the height of the flame above the liquid surface and, at sufficient height, the measured flash point temperature will coincide with the fire point. The best-known example is the Cleveland open cup (COC). [17]

There are two types of closed cup testers: non-equilibrium, such as Pensky-Martens, where the vapours above the liquid are not in temperature equilibrium with the liquid, and equilibrium; such as Small Scale (commonly known as Setaflash), where the vapours are deemed to be in temperature equilibrium with the liquid. In both these types, the cups are sealed with a lid through which the ignition source can be introduced. Closed cup testers normally give lower values for the flash point than open cup (typically 5–10 °C or 9–18 °F lower) and are a better approximation to the temperature at which the vapour pressure reaches the lower flammable limit.

The flash point is an empirical measurement rather than a fundamental physical parameter. The measured value will vary with equipment and test protocol variations, including temperature ramp rate (in automated testers), time allowed for the sample to equilibrate, sample volume and whether the sample is stirred. Methods for

2. EXPERIMENTAL PROCEDURE

2.1 Equipment used

The main instrument used for testing flash point is Pensky-Martens closed cup equipment



Fig.1 Pensky Martens Apparatus

In the Pensky–Martens closed-cup flash-point test, a brass test cup is filled with a test specimen and fitted with a cover. The sample is heated and stirred at specified rates depending on the material that is being tested. An ignition source is directed into the cup at regular intervals with simultaneous interruption of

determining the flash point of a liquid are specified in many standards. For example, testing by the Pensky-Martens closed cup method is detailed in ASTM D93, IP34, ISO 2719, DIN 51758, JIS K2265 and AFNOR M07-019. Determination of flash point by the Small Scale closed cup method is detailed in ASTM D3828 and D3278, EN ISO 3679 and 3680, and IP 523 and 524.

stirring until a flash that spreads throughout the inside of the cup is seen. The corresponding temperature is its flash point.

Pensky–Martens closed cup is sealed with a lid through which the ignition source can be introduced periodically. The vapour above the liquid is assumed to be in reasonable equilibrium with the liquid. Closed cup testers give lower values for the flashpoint than open-cup testers (typically 5–10 K) and are a better approximation to the temperature at which the vapour pressure reaches the "lower flammable limit" (LFL).

2.2 Materials Used

Benzene and Xylene are added to Kerosene at various proportions and the changes caused by them on kerosene's Flash Point are measured.

3. PROCEDURE

1. Fill the test cup with the test portion to the level indicated by the filling mark. Place the lid on the test cup and put it in the heating chamber. Ensure that the locating or locking

device is properly engaged and insert the thermometer. Light the test flame and adjust to a diameter of to 4mm or switch on the alternative ignition source. Light the heater flame or switch on the electric heater and supply heat at such a rate that the temperature of the test portion as indicated by the thermometer increases at to, and maintain this heating rate throughout the test. Stir the test portion at a rate of to, stirring in a downward direction.

2. When the test portion is expected to have a flash point of or below, make the first

application of the ignition source when the temperature of the test portion is below the expected flash point, and thereafter at temperature intervals. Cease stirring and apply the ignition source by operating the mechanism on the cover, which controls the shutter and ignition source, so that the source is lowered into the vapour space of the test cup in, left in its lowered position for, and quickly raised to its high position

Table.1.2 Xylene proportion used

S.No	Kerosene added(mg)	Benzene added (%)	Benzene added(g)	Actual benzene content measured (%)
1	52	1.0	0.52	1.02
2	52	0.5	0.26	0.49
3	52	0.3	0.15	0.30
4	52	0	0	0.01

Table.1.1 benzene proportion used

S.No	Kerosene added(mg)	Xylene added	Xylene	Actual Xylene content

		(%)	added(mg)	measured (%)
1	52	1.0	0.52	1.01
2	52	0.5	0.26	0.52
3	52	0.3	0.15	0.29
4	52	0	0.03	0.03

3. When the test portion is expected to have a flash point of above, make the first application of the ignition source when the temperature of the test portion is below the expected flash point, and thereafter at temperatures which are a multiple of. Cease stirring and apply the ignition source by operating the mechanism on the cover, which controls the shutter and ignition source, so that the source is lowered into the vapour space of the test cup in, left in its lowered position for, and quickly raised to its high position.

4. When testing a material of unknown flash point, conduct a preliminary test at a suitable starting temperature. Make the first ignition-source application at above the starting temperature and follow the procedure given in 2 or 3 as applicable.

5. Record, as the observed flash point, the temperature of the test portion read on the thermometer at the time when the ignition-source application causes a distinct flash in the interior of the test cup. Do not confuse the true flash point with the bluish halo that sometimes surrounds the ignition source at applications preceding the actual flash point.

6. When the temperature at which the flash point is observed is less than, or greater than, from the temperature of the first application of the ignition source, the result is not valid. Repeat the test using a fresh test

portion, adjusting the temperature of the first application of the ignition source until a valid determination is obtained, that is where the flash point is to above the temperature of the first application of the ignition source.

4. OBSERVATION

Below table 2.1 and 2.2 shows observation.

5. RESULT

Both benzene and Xylene are showing reduction in flash point of kerosene in a significant value compared to kerosene before addition of Benzene or Xylene i.e. 44 degrees($^{\circ}$ C).

6. CONCLUSION

A small quantity of Benzene or Xylene helps in reduction of Flash point and leading to easy combustion in the engine by decreasing the ignition temperature. Although, keeping environmental norms in mind, we need to optimize the percentage of mixing. These results may help in both the directions, helping in early or improper combustion of kerosene due to presence of aromatics and to improve the combustion efficiency in the presence of these aromatics.

Table.2.1 Xylene on Kerosene

S.No	Kerosene(g)	Xylene content	Flash point (°C)
1	52	1.01	38
2	52	0.52	39
3	52	0.29	41
4	52	0.03	44

Table.2.2 Benzene on Kerosene

S.No	Kerosene(g)	Benzene actual content	Flash point (°C)
1	52	1.02	38
2	52	0.49	40
3	52	0.3	43
4	52	0.01	44

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