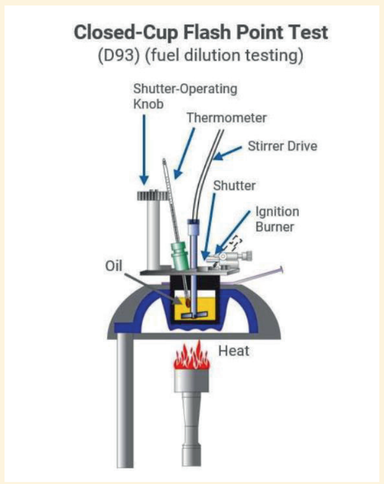

Closed Cup Testing to Determine the Flash Point of Flammable Liquids

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Introduction

When using, storing, or transporting a fuel or lubricant safety precautions must be considered. One property that is essential to ensure safety is a combustible liquid's flash point. The flash point is described as the lowest temperature at which the liquid's vapor will ignite with the presence of an ignition source. Analysis of a flammable liquid's flash point can provide pivotal information in whether the liquid is safe for use.

The Pensky–Martens Closed-Cup Test

Testing for a combustible liquid's flash point in a closed-cup is often favored in the industry. By performing a closed-cup test, all vapors let off by the liquid will be contained. This simulates a situation where a stored liquid is accidentally introduced to an ignition source in a container. The closed-cup test also has the tendency to yield lower flash points due to the closer proximity of the ignition source to the sample and due to the lack of disturbances since the cup is closed. Advancements in equipment have allowed for closed-cup testing of the flash point to become automatic.

Figure 1. Koehler Instrument's K71000 Automatic PMCC Flash Point Analyzer

Instruments, such as the one pictured in Figure 1, are able to accurately determine a combustible liquid's flash point automatically. At the start of testing the sample is heated and stirred at a pre-specified rate, a brass cup is used to hold the sample. At regular intervals, stirring is halted and the ignition source, gas or electric, is directed into the cup. The test concludes once the ionization ring detects the presence of a flash. The temperature recorded at the conclusion of the test represents the liquid's flash point. By utilizing The Pensky-Martens closed-cup test, in accordance to test method ASTM D93, an automated Pensky-Martens closed-cup instrument is capable of determining the lowest flash point temperature of fuels, lubricating oils, and homogenous liquids (ASTM D93 A), liquids containing suspended solids as well as liquids that tend to form a surface film during testing (ASTM D93 B), and the flash point of biodiesel in the temperature range of 60 to 190°C (ASTM D93 C).

Diluted Oils With Fuels Analysis

It is known that fuel dilution of engine oils lowers flash point. The refined oils can be incredibility dangerous if misused. In this study, engine oils (mineral and synthetic) were mixed with two types of fuels (gasoline and diesel) to determine whether the mixture is safe for use based on flash point results. The test method DIN 51758 was used. This method undergoes a closed cup Pensky–Martens test.

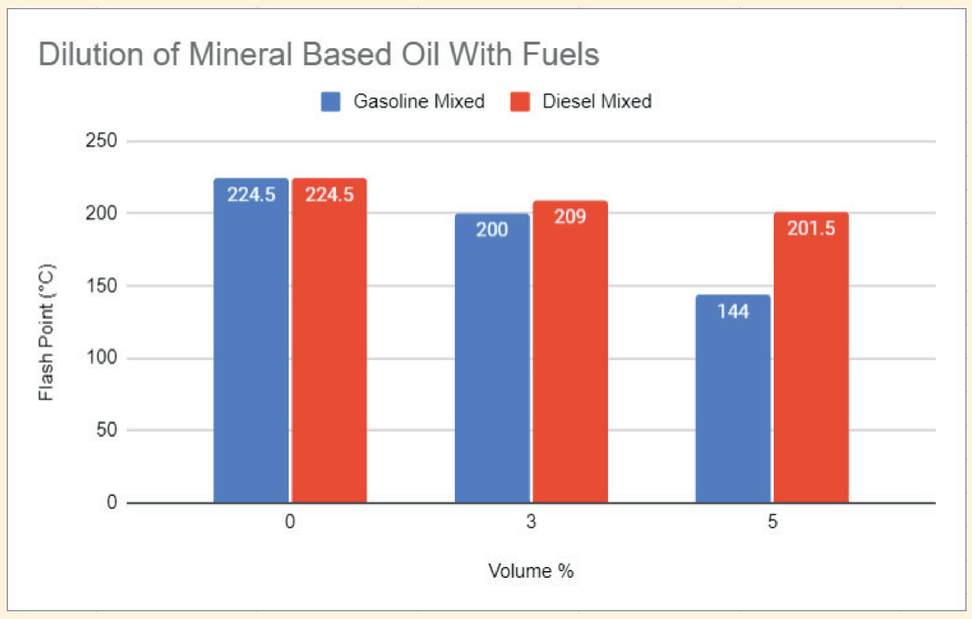

Figure 2. Mineral based oil flash point observations

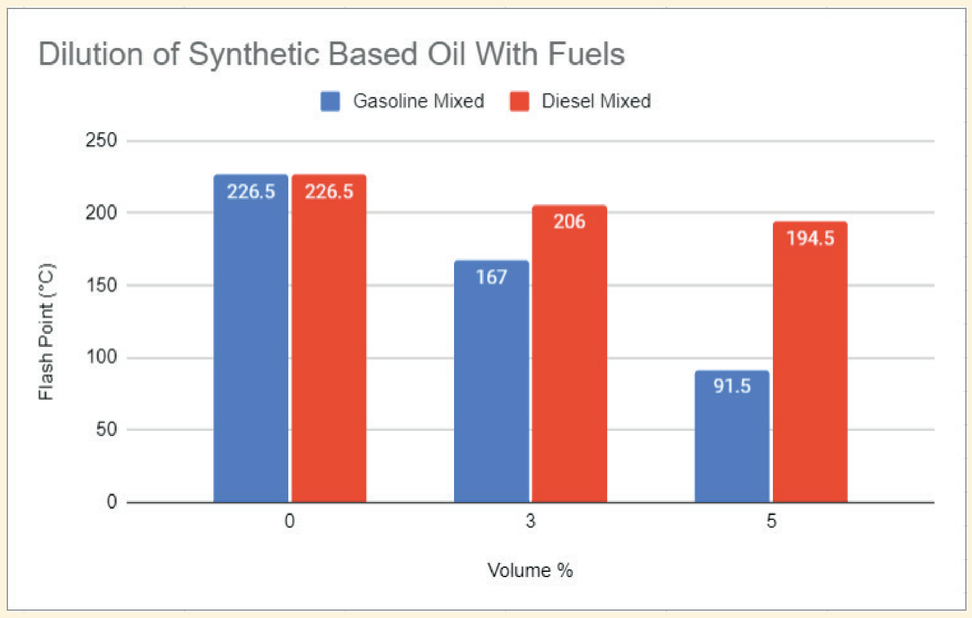

Figure 3. Synthetic based oil flash point observations

Dilution with gasoline, in both types of oils, has a greater effect on flash point than dilution with diesel. In addition, the flash points of the oils decreased with the addition of more gasoline or diesel fuel. If fuel dilution is suspected the user must be very cautious in whether the oil should be reused or not. As pictured by these results, fuel dilution can cause the flammability limits of an oil to drastically decrease which becomes a major safety concern.

Flash Point of Used Oils Analysis

Analysis of a used oil using its flash point can indicate specific characteristics that are unknown to the user. The 3 major factors that will affect a oil's flash point are changes in the oil's chemistry, additions to the oil, and subtractions from the oil.

Changes in Oil Chemistry

Thermal cracking of a base oil occurs when the oil is exposed to extreme temperatures. At these temperatures pressure induced thermal degradation or micro-dieseling occurs. This pyrolysis reaction causes the oil to break down and become more volatile, thus lowering the oil's flash point.

Additions to Oils

Along with the dilution of oils, other add-ons to an oil is often a contaminant. When the flash point is lower than the true value this implies that the oil has been introduced to a low boiling point constituent such as organic solvents or natural gases. Water contamination in oils is tricky to work with as the flash point may be raised or lowered. Water has been studied and determined to raise an oil's flash point because of the emulsions that are made but due to instrument errors, it will sometimes produce a false result causing a lowering in flash point. Coal dust and glycol (antifreeze products) have also been experimented with and determined to create volatile substances that will raise an oil's flash point.

Subtractions From Oils

Subtractions from oils come from evaporation. Whether the oil has been exposed to high operating temperatures or is being used under a vacuum volatilization may occur. This process is best described as dissolved low boiling point components being evaporated off. The evaporated substances are often termed as 'light-ends'. Due to the low volatility of some compounds, it is important to remember to seal and store oils correctly to prevent any loss. Any evaporation that occurs will result in an inaccurate test as the oil is no longer the same sample. These subtractions will result in a higher flash point of the oil, but possibly lower performance.

Conclusion

The Pensky-Martens closed-cup test has allowed for the accurate, efficient, and wide-range testing of a fuel's or lubricant's flash point. Testing for the flash point provides valuable information regarding the flammability limit of a desired combustible liquid. The flash point can serve as important analytical data to assist with troubleshooting when determining the cause of insufficient performance in oils.

Acknowledgments & References

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