Flash and Fire Points by Cleveland Open Cup

Lab Experiment #3

Submitted to:

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II. Results

The findings of this lab included the following results:

Table 2.1: Flash and fire points of materials A and B:

	Flash Point (degrees F)	Fire Point (degrees F)	Predicted Flash Point* (degrees F)
Sample A	140	150	150
Sample B	165	195	150

*Obtained From ***Traffic and Highway Engineering***, p. 741

III. Discussion

Procedure

To obtain the flash and fire points of two asphaltic materials "A" and "B" in this study, the standard Cleveland Open Cup test was used. After preparing the equipment, the cup was filled and the test on sample "A" was begun. After turning the thermometer on, the temperature began to rise quickly until it rose to about 70 F below the anticipated flash point (90 F). The anticipated flash point for both materials was 160 F. After the thermometer had reached 90 F, it was determined that the temperature was rising too swiftly to obtain an accurate flash point temperature. The rate of heating was slowed somewhat, the test flame was lit, and the flame was passed over the top of specimen "A". After passing a number of test flames over material "A", the flash point was determined and recorded. But the flash point of specimen "A" was highly questionable because of its rapid rate of heating (see ***Possible Errors***). Its initial rate of rate of heating was far above the specified 9-11 F per minute.

After a flash point of 140 F was determined and recorded for specimen "A", the material continued to be heated. The test flame was passed over the specimen at 5 degree intervals until the fire point of the material was reached. Once again, for material "A", the rate of temperature increase may have been too rapid to yield an accurate fire point reading.

When testing material "B", more extreme care was taken to regulate the temperature increase of the specimen. Since the initial temperature was about 100 F below the anticipated flash point of the specimen, the rate of temperature increase was regulated at 9-11 F / min. for the entire test. At 95 F, the test flame began to be passed over the asphaltic specimen at 5 F temperature intervals. The thermometer was carefully observed, and as the temperature continued to rise, the flash and fire points were reached. For material "B", the flash and fire points were observed and recorded at 165 F and 195 F, respectively.

The flash and fire points of asphaltic materials are particularly important when working with asphalt at high temperatures, as a small spark or flame could cause a fire or an explosion.

Answers to "Observations and Discussion"

1. Of What Value is this test?

The Cleveland open cup test is useful in determining the flash and fire points of bituminous materials. As Garber and Hoel describe in ***Traffic and Highway Engineering***, the flash point of an asphaltic material is the "temperature at which its vapors will ignite instantaneously in the presence of an open flame." As the temperature on an asphaltic specimen is slowly increased, the "...increase in temperature will cause evaporation of volatile materials from the material being tested, until a sufficient quantity of volatile materials is present to cause an instantaneous flash when the open flame is passed over the surface. The minimum temperature at which this occurs is the flash point." (p. 752). The flash point provides a measure of the temperature at which the material begins to release a significant amount of

volatile gases. At this point, and especially at the fire point, extreme care must be taken as a fire or explosion may occur in the field.

2. Why must the rate of raising the temperature be controlled?

In order to provide an accurate measure of the flash and fire points, the rate of temperature increase must be kept within 9 and 11 F per minute. As our test showed, when the rate of temperature increase is higher, the asphaltic specimen will not have time to heat evenly throughout. The thermometer will not give an accurate reading of the temperature of the specimen and a faulty flash point reading will be the result. In short, the if the procedure of temperature control is not adhered to, the temperature of the asphaltic material will be much less than what the thermometer indicates.

3. Why must the test cup be cleaned before the test begins with an appropriate solvent to remove any oil or traces of gum or residue from previous tests?

If oil or traces of gum or residue from previous tests still remains in the test cup, this material from previous tests will combine with the material being tested. As the two materials combine, a material with somewhat different properties may be the result. If the new material with different properties has a higher flash point than the original material, an inaccurate flash point reading may be the result. An inaccurate flash point reading may result in a fire where that asphaltic material is used.

Uses of the test

First, the *Cleveland Open Cup Test* can be used to determine the flash and fire points of a bituminous material. These temperatures will be the temperatures at which care must be taken in handling the material. Second, the flash point can be used in conjunction with the distillation, kinematic viscosity, and other tests to determine the type of cutback being tested.

Advantages/Disadvantages

The primary advantage of the Cleveland Open Cup test is that it is a relatively easy and short test which determines important properties of a bituminous material -- its flash and fire points. But although the test is a relatively easy test, it does not consider changes in atmospheric pressure and exact rates of temperature increase, both of which may have an impact on the flash point of the asphaltic material. In addition, it does not consider the flash point of an asphaltic material in an enclosed container. The Pensky-Martens Closed Cup test would be more effective in determining the flash point of an asphaltic material in an enclosed container.

Possible Errors

1. When heating material "A", the heating apparatus was set at an improper rate of temperature increase. This caused uneven heating of the specimen (about 30 F per minute instead of the specified 9 - 11 F per minute). This extremely rapid rate of heating caused inaccurate flash and fire point temperature readings.

2. In addition, a slight draft existed in the laboratory, perhaps ventilating some of the vapors which may have caused a flash point. This effect may have made the flash point somewhat higher on the second sample. As mentioned in ***Advantages/Disadvantages***, the barometric pressure may have also had an effect on the flash point of the sample.

Limitations of this Lab

The Cleveland Open Cup test is effective in determining the flash point of asphaltic materials in open-air situations, but drafts and different rates of temperature increase may cause errors in the test.

IV. Conclusions

Properties of the paving material

From the Cleveland Open Cup test, it has been determined that sample "A" has a flash point of 140 F, while sample "B" has a flash point of 165 F. The flash point for sample "A" is suspected to be somewhat low, due to its uneven rate of heating, as discussed in ***Possible Errors***. But the open cup flash point for sample "B" is reasonably accurate. At these temperatures, it is advised that care should be taken when handling the asphaltic material, especially around flames. When the asphaltic materials "A" and "B" are brought close to their flash points, and especially to their fire points, the result may be a fire.

Engineering Significance of this lab

When an engineer is specifying the methods of constructing a highway or other structure which requires an asphaltic material, he or she could use the results of the Cleveland Open Cup test to specify the temperatures at which precautions should be taken when working with an asphaltic material in the field.

In addition, the type of asphaltic material can be determined from using the Cleveland Open Cup test in conjunction with other tests. From the properties of the asphaltic material, an engineer can determine whether this material could be applied to a particular engineering need.

V. Appendix

Information for this test was obtained from the following source:

Garber, Nicholas J. and Lester A. Hoel. ***Traffic and Highway Engineering***. West Publishing Company, 1988.