Technical Article

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Advances in Flashpoint Testing: Economic Impact

Flashpoint testing is one of the oldest methods of the ASTM D02 Committee on Petroleum Products and Lubricants, which was formed in 1904. The most prevalent standards are ASTM D56 (Tag Method), D92 (Cleveland Method), and D93 (Pensky-Martens Method).

These classical techniques, commonly referred to as open-cup and closed-cup methods, share a common principle: A test flame is lowered into the vapor space at regular intervals so that the ignition can be observed. Depending on the method, 70–75 mL of sample is used for open- and closed-cup flashpoint determination. Naturally the ignition of a larger specimen carries a fire risk, but this risk can be minimized if the flashpoint analysis is monitored by laboratory personnel.

Table 1 Costs for testing perfume oil (estimated cost: 100 mL perfume oil = $1)

	MINIFLASH TOUCH D6450	Pensky-Martens D93
Cost per test	1 mL = $.01	75 mL = $0.75
Cost per day (30 tests)	$0.30	$22.50
Cost per year (250 days at 30 tests)	$75	$5625

A unique solution to an old problem

ASTM standardization of the classical flashpoint methods has resulted in an increased number of requirements. Flashpoint testing is no longer limited to the refining industry, but is used for other applications and industries, including:

- Analysis of hazardous chemicals for compliance with transportation regulations
- Waste analysis of liquids, used oils, and solids
- Analysis of pharmaceuticals, adhesives, paints, varnishes, and plastics
- Analysis of flavors and fragrances
- Analysis of contamination of fuel oil, lubrication oil, and hydraulic oil by lighter hydrocarbons (e.g., gasoline, diesel on ships, power plants, and construction and mining machinery to protect expensive equipment)
- Analysis of bitumen, asphalt, and tar
- Criminal investigations.

Today, the classical techniques have major drawbacks for most applications:

- Safety regulations prohibit testing with an open flame close to highly flammable liquids. This is even more critical for testing petroleum products in refineries or for analyzing oily wastewater on offshore platforms.
- Flavors, fragrances, and pharmaceuticals usually produce very costly substances. Testing 75 mL for each flashpoint determination may cost a manufacturer thousands of dollars each year.
- Coal tar pitch and bitumen may produce hazardous odors when heated, posing a health risk for employees.
- Forensic analysis typically utilizes trace amounts of fuels and substances, rather than quantities of 75 mL.
- The construction and mining businesses require portable analyzers to test directly in the field if there is no laboratory available.
- Analysis of engine lubrication oil on ship engines necessitates a small, closed analyzer that is fastened securely to reduce the risk of splashes and spills on the open sea. These spills could easily be ignited by the tester's own ignition source.
- Cleaning is messy and time-consuming.

To improve flashpoint testing, a method was developed that eliminates the above problems. The MINIFLASH TOUCH flashpoint tester (**Grabner Instruments**, Vienna, Austria) requires only 1–2 mL of sample for highly repeatable flashpoint tests. The flashpoint is tested by an instantaneous pressure increase inside a continuously closed test chamber resulting from an energy-controlled electric arc. By design, the method protects against fire hazards since there are no open flames or noxious fumes in the testing area. The small sample size and use of thermoelectric temperature control allow flashpoint testing in a compact and portable analyzer. The MINIFLASH TOUCH can be used for testing liquids and solids, and the sample cups are extremely easy to clean. The complete flashpoint test is visible via graphical combustion analysis directly on the analyzer; even small contaminants inside of a sample can be analyzed.

The flashpoint tester follows the regulations of ASTM D6450 and ASTM D7094, which the ASTM committee considers equivalent to the Pensky-Martens ASTM D93A Method. Because of statistical equivalence with the Pensky-Martens Method, the U.S. Department of Transportation has granted special permits allowing the flashpoints of volatile organic liquids to be determined by means of a MINIFLASH TOUCH flashpoint analyzer.

Economic and environmental impact

The impact of the flashpoint analyzer can be measured in terms of cost and labor savings, improved safety, and waste reduction.

Cost/labor savings

Flavor and fragrance laboratories perform on average 30 flashpoint tests per day (250 days per year), or about 7500 tests per year. For example, if 100 mL of perfume oil costs $1, the annual cost of testing with the MINIFLASH TOUCH at 1 mL is $75. In comparison, the classical Pensky-Martens Method (75 mL per test) costs $5625 annually (see *Table 1*).

In a typical laboratory performing just 20 samples per day, the difference between classical flashpoint testing and the MINIFLASH TOUCH method can amount to a savings of 4 hr of laboratory time per day. Savings in laboratory time are calculated from free time during the flashpoint test (a classical

Table 2 Savings in laboratory time at $60/hr

	MINIFLASH TOUCH D6450	MINIFLASH 8-position sampler	Pensky-Martens D93
Sample handling	1 min	4 min	1 min
Measurement time	6 min (free time)	48 min (free time)	6 min (monitoring test)
Cooling time	1 min (free time)	8 min (free time)	3 min (monitoring test)
Cleaning time	0.5 min	4 min	3 min
Labor per test	1.5 min	1 min	13 min
(at 20 tests/day)	30 min	20 min	260 min
Savings per day	$230	$240	$0
Savings per year (250 days at 20 tests)	$57,500	$60,000	$0

Table 3 Reducing waste (source: Berliner Stadtreinigungsbetriebe [BSR], price list June 2010; disposal costs per kg)

	MINIFLASH TOUCH D6450	Pensky-Martens D93
Waste per day (20 tests)	20 mL	1.5 L
Waste per year (250 days at 20 tests)	5 L (~4 kg)	375 L (~300 kg)
Recycling costs (€1.3/$1.8 per kg)	$7.2	$540

flashpoint tester cannot be left alone during testing for safety reasons), fast thermoelectric cooling, and the reduced time required for sample cup cleaning. At an estimated labor cost of $60 per hour, savings in laboratory time can be as high as $60,000 per year when testing with the MINIFLASH 8-position tester (see *Table 2*).

Improved safety

A standard closed-cup flashpoint tester must be monitored continuously during testing to ensure that open flames are extinguished properly.

The biggest costs for the laboratory can be a result of operator errors that culminate in fire incidents. If samples are mixed up or are labeled incorrectly, the flashpoint test might be started at far too high a temperature. A 75-mL sample exploding in a laboratory can cost millions of dollars.

Such incidents using classical methods have been reported. In Australia and Mozambique, naphtha (a clear substance with a very low flashpoint) and jet fuel (a clear substance with a flashpoint of >30 °C) were mistaken for each other. In both cases, the starting temperature was set too high, causing an explosion in the laboratory. In Germany, formaldehyde in resins and polymers led to a fire; in Belgium, gasoline was mixed into lube oil.

In contrast, the MINIFLASH TOUCH practically eliminates this risk of fire hazards, because only a small sample volume is ignited inside a sealed metal sample cup.

Reducing waste

Diesel waste accumulation in the laboratory for 20 flashpoint tests/day is 20 mL per ASTM D6450 and up to 1.5 L for testing per ASTM D93. Two hundred fifty days of continuous testing will yield up to 375 L (~300 kg) of waste with a classical flashpoint tester, but only 5 L (~4 kg) when testing per ASTM D6450. Aside from the impact of reduced waste on the environment, annual recycling costs can be lowered by several hundred dollars when using the MINIFLASH TOUCH (see *Table 3*).

Summary

Flashpoint testing offers the potential for laboratories to optimize testing procedures and lower costs. This potential can be unlocked with a method such as the MINIFLASH TOUCH, which uses a small sample volume.

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