

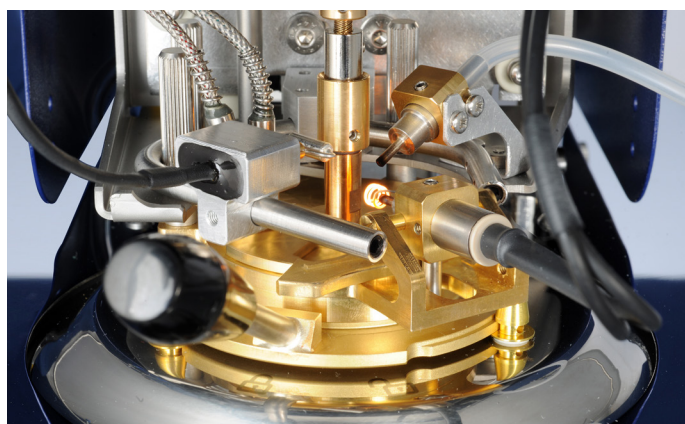
Classifying the flammability of fuels and other materials by their flash point value has been an established practice for more than 100 years. Today mandatory international and national regulations are set by bodies such as the UN, IATA, EPA, EU and Health and Safety executives.

## What is flash point?

Flash point is defined as the lowest temperature of a liquid at which its vapours will form a combustible mixture with air. It is a convenient and reliable classification of the flammability of many substances, there are three main categories;

- Extremely flammable: Flash point below 0° C
- Highly flammable: Flash point below 21 °C
- Flammable: Flash point below 55 °C

A sample of specified volume is introduced to the test cup which is maintained at the test temperature. After a specified time, a test flame is applied and the presence or absence of a flash observed.



## Why measure flash point?

### Quality control

Petroleum and chemical industries often use flash point testing to check for contamination or adulteration of a product. Multiple storage tanks may contain different product which can range in purity. These tanks may use common pipeline systems. The pipeline will be cleaned between product batch but there is a risk of contamination if they are not cleaned thoroughly. Flash point is used to determine whether contamination of a product has occurred.

Changes in flash point indicate that a sample may have been contaminated or adulterated, for example petroleum spirit in engine oil will lower the flash point. Contamination of fuel oil, lubrication oil and hydraulic oil by lighter hydrocarbons can lead to problems with the operation of expensive equipment - for example on ships, at power plants and in construction and mining machinery.



Quality Control



Transport & Storage Regulations



CLP Regulations



Waste Disposal Regulations

### Transport and storage regulations - hazard classification

Flash point is used in shipping and safety regulations to define flammable and combustible materials and classify their hazard potential which has significant cost implications when transporting or storing products.

Many industries use solvents in their products (paints, varnishes) which is used to classify the flash point for the finished product. Some solvents are not highly flammable so establishing the exact flash point can help save money.

Users would be advised to use the Setaflash test method in these circumstances as it quickly provides an accurate flash point value to correctly classify the true hazard nature of a product.

### Waste disposal regulations

EU guidelines and Hazardous Waste Regulations now require rapid hazard classification of a sample (liquids, used oils and solids) before it can be disposed of.

Portable Setaflash small scale flash point testers are widely used in these circumstances for spot checks in the laboratory, on a production line or outdoors. They reduce problems with waste handling and disposal owing to the fact a test requires no more than 4 ml of sample.

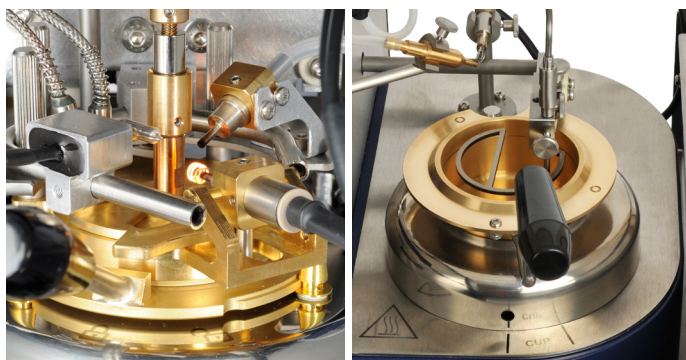
Flash point is measured using either an open cup or closed cup flash point tester. Open cup tests are required in some specifications and regulations, and are intended to mimic conditions in open spaces, whereas closed cup tests are closer to most situations, where space is restricted.

## Closed Cup (CC)

Pensky-Martens, Tag, Setaflash (CC)

Closed cup tests aim to simulate the situation of a liquid spill in a closed environment. If the liquid is at, or above, its flash point then a fire or explosion is a possibility when exposed to a potential ignition.

In closed cup tests the sample is placed inside a sealed (closed) test cup and the ignition source is introduced to measure the temperature at which the sample ignites ('flashes'), known as its flash point.



> PM-93 Closed Cup test area

> Cleveland Open Cup test area

## Open Cup (OC)

Cleveland, Setaflash (OC)

Open cup tests simulate the potential ignition of a liquid spillage in uncontained conditions, for example a pool of liquid spilt on the floor. Fire point, combustibility and sustained burning tests all use open cup instruments. Fire point may be considered as the lowest temperature of the liquid at which vapour combustion and burning commences when an ignition source is applied and continues to burn after the removal of the ignition source. Combustibility and sustained burning tests are usually carried out at a fixed temperature and test for continuous burning of the test specimen.

An open cup instrument will always give a higher flash point than a closed cup as the open cup allows free loss of vapours to the atmosphere above the instrument. Closed cup test are usually specified due to improved precision.

## Test methodology

Non-equilibrium - Pensky-Martens, Tag, Cleveland

The term non-equilibrium means the vapour is not in equilibrium with the liquid. Non-equilibrium flash point tests are when the liquid is heated at a steady rate of temperature increase while the ignition source is applied at regular intervals.

**Advantages:** It is well suited to automation, instrumentation is universally available and standardised for a wide range of products.

**Disadvantages:** Each time the flame is dipped, some of the valuable components may escape which can give artificially high flash points or spoil precision. The temperature of the liquid and vapour can significantly vary in the cup. Non-equilibrium tests require a large sample size of 50 to 80 ml per test.



> Setaflash Series 3 Small Scale

## Equilibrium - Setaflash

Traditional equilibrium flash point tests which use any cup in a water bath, ensure that the liquid and a vapour of the sample are in temperature equilibrium by adopting a complex procedure and a very slow heating rate.

The Setaflash Small Scale method overcomes the laborious processes associated with the other methods by utilising a 2 ml or 4 ml sample which achieves 'rapid equilibrium' between the vapour and the liquid in a cup and gives a reliable flash point result in just one or two minutes.

**Advantages:** Improved precision compared to non-equilibrium methods. The Setaflash instrument range offers low cost, fast measurement for a flash/no flash result which is widely used by many industries.

**Disadvantages:** Traditional testers can involve a laborious process especially when larger amounts of sample are needed to produce a representative sample. This type of instrumentation is not universally available.

The appropriate method for your sample is usually cited in a product specification or regulation, and in certain circumstances a referee test method may be stated, this method should be the first choice. If a number of alternative test methods are specified then the choice will be influenced by other factors such as sample size requirements, speed of testing or precision.

When specifically testing for contaminants, certain test methods and procedures are more appropriate than others. In general an equilibrium test method is recommended for testing samples that may contain traces of volatile contaminants.

## Setaflash Small Scale

ASTM D3278; ASTM D3828; ASTM D4206; ASTM D7236; ASTM D8174; ASTM E502; CLP Regulations; DEF STAN 91-91; EPA 1020 A & B; IP 523; IP 524; IP 534; IP 602; ISO 3679; ISO 3680; ISO 9038; EPA 1020 B; CLP Regulations



> Setaflash Series 3

> Setaflash Series 8

These methods cover petroleum products and biodiesel liquid fuels across the range of -30 to 300 °C using a small scale closed cup tester.

The procedures may be used to determine whether a product will or will not flash at a specified temperature (flash/no flash method A), or the flash point of a sample (method B). When used in conjunction with an electronic thermal flash detector, these methods are also suitable for flash point tests on biodiesel such as FAME.

Small scale testers are also used for shipping and safety regulations such as CLP to define flammable and combustible materials and classify them.

## Pensky-Martens Closed Cup (PMCC)

ASTM D93; IP 34; ISO 2719

These test methods cover the determination of the flash point of petroleum products in the temperature range from 5 to 400 °C by a manual or automated PMCC apparatus. They are also used to determine the flash point of biodiesel in the temperature range of 60 to 190 °C by automated PMCC apparatus.



## Tag

ASTM D56; ASTM D3934; ASTM D3941; ASTM E502; IP 491; IP 492; ISO 1516; ISO 1523

These test methods cover the determination of the flash point by tag manual and automated closed testers, of liquids with a viscosity below 5.5 mm<sup>2</sup>/s (cSt) at 40 °C, or below 9.5 mm<sup>2</sup>/s (cSt) at 25 °C, and a flash point below 93 °C.



## Cleveland

ASTM D92; ASTM D8254; IP 36; IP 403 (obs); ISO 2592; DIN 51 376; NF T60-118; JIS K 2265-4; AASHTO T48

These test methods describe the determination of the flash point and fire point of petroleum products by an automated open cup apparatus. It is applicable to all petroleum products and determines flash point and fire point at temperatures up to 400 °C.



The instrument incorporates a heater, a removable test cup, interchangeable gas and electric hot-wire ignitors mounted on an automatic sweep arm, a platinum resistance thermometer (PRT) to measure the sample temperature, an ionisation ring to detect a flash/fire, a snuffer and a fire extinguisher. A draught screen around the test area ensures accurate results.

C-92 Statistical Quality Control (SQC) software provides detailed analysis of test results, calculated mean, standard deviation, standard error, repeatability and plot of results in accordance with ASTM D6299 Statistical Standard.

The test method chosen must follow the stated requirements, however if this requirement is flexible then choice may be biased towards safety, cost, speed of test and even instrument availability. Below are important factors to consider before making your choice.

## Safety features

The need to heat and ignite potentially flammable liquids in a laboratory is naturally of concern and in many instances the use of a naked flame is prohibited. ASTM D3828 Small Scale flash point tests reduce the risk by using a small sample of just 2 or 4 ml, by comparison ASTM D93 Pensky-Martens methods use 75 ml.

Most test methods now permit the use of an electric ignition source as an alternative to the traditionally used gas flame with some flash point testers providing users with a choice of either. To satisfy laboratory safety requirements it is becoming increasingly important to ensure electronic ignition is available with reliable and proven performance.

## Fire extinguishing systems

A fire extinguishing system is now mandatory for all ASTM D93 Pensky-Martens flash point testing apparatus manufactured after 2016. This is for safety purposes to minimise risks where the sample catches fire in an automatic instrument due to sample mislabelling, operator error or during testing of an 'unknown' substance. In these instances a fire can cause consequential accidents, peripheral damage as well as damage to the instrument itself.



Latest designs of instruments such as the Seta PM-93 now provide automatic fire extinguisher systems which, separately from temperature sensors used to monitor the sample and control instrument performance, will automatically and immediately activate an integral extinguisher in the event of flame or fire being detected around the test cup.

Other safety features now recommended include a first dip before sample heating and an automated dip at every 10 °C, these additional safeguards check for the presence of excess volatile components and are included in the latest ASTM D93 Pensky-Martens method.

The C-92 has been designed with superior safety in mind with a number of safety devices and features, including a snuffer plate which automatically deploys at end of a test to extinguish the burning sample, or can manually be deployed at any time. The optical fire sensor provides another level of fire protection with inert gas being deployed around cup and cup area if persistent fire is detected. If the sensor detects a fire at any other point, the built in fire extinguisher deploys.

## Ease of use

In today's laboratory it is not unusual for technicians to run several tests simultaneously and the concept of monitoring a test and making intervention at certain parts of the test procedure may not be practical or desired, so simplicity of use and automation are often key features required by users.

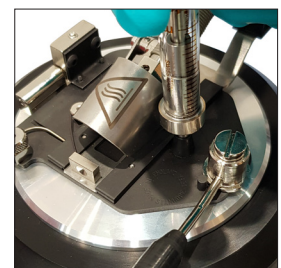
This is especially important if a large number of samples are to be tested and where test throughput is vital in supporting efficient laboratory operations, so in addition to ease of use, speed of use becomes critical. As flash point tests operate by heating a sample, often to relatively high temperatures of 250 °C+, cooling of the test cup prior to the next test is a key operating feature.

Automated Pensky-Martens flash point testers have been designed to provide rapid testing of samples with minimal operator input. The Seta PM-93 allows unsupervised operation which heats the sample at the temperature rate prescribed in the test method whilst also applying ignition and checking for flash automatically.

Setaflash Small Scale point testers operate using gas or electric ignition and are very easy and reliable to use. The simple flash/no flash test requires minimum analytical experience to achieve a reliable result. Small volumes allow rapid and very safe sample handling and Series 3 models weigh just 3 kg, can be powered by battery and are easily carried to the sample.



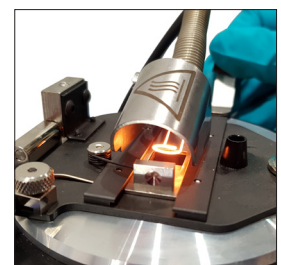
Select test temperature



Inject 2ml sample



Press 



Dip the ignitor, flash detection is automatic

Industry	Application	Temperature range	Seta model
Adhesives and sealants	Testing esters and ketones for certification. Flammability classification for transport regulations	Up to 150 °C	30000-3, 35000-0, 82000-2, 82100-2
Aviation and aircraft	Quality control of incoming fuels and oils. Specification conformance	30 °C to 399 °C	30000-3, 35000-0, 82000-2, 82100-2
Biodiesel	Flash point testing checks that chemicals such as methanol, used in the manufacturing process are below safe levels	130 °C	30000-3, 35000-0, 35300-0, 82000-2, 82100-2
Bitumen and asphalt	Used for shipping and safety regulations and to indicate the possible presence of more volatile or flammable compounds	>200 °C	30000-3, 35000-0, 82000-2, 82100-2
Chemicals	Testing solvents used in production. Safety classification for transport regulations	Below 200 °C	30000-3, 35000-0, 82000-2
Chemical products	Flammability classification for transport regulations	30 °C to 150 °C	35000-0, 82000-2
Crude	Provides an indication about the volatility of crude oil and therefore how safely it may be extracted, transported and stored, and the potential costs involved	Below 0 °C	82100-2
Edible oils and fats	These products are used at elevated temperatures hence flash point is checked to ensure refining processes and safety limits are correctly maintained	Up to 30 °C	30000-3, 35000-0, 82000-2, 82100-2
Energy and power	Turbine and transformer oils are routinely tested for flash point to confirm product integrity from contamination that may affect performance or safety	Up to 20 °C	30000-3, 35000-0, 82000-2, 82100-2
Formulated pesticides	Research and flammability classification for transport regulations	Up to 150 °C	30000-3, 35000-0, 82000-2
Lubricants	Quality control and research. Used oil analysis to detect evaporation/contamination by volatiles under working conditions	30 °C to 399 °C	30000-3, 35000-0, 35300-0
Oil and gas rigs	Quality of samples. Sump contamination of pumphead machinery	30 °C to 399 °C	30000-3, 35000-0, 35300-0, 82000-2
Oil treatment/recovery	Quality control on base oils and checking contamination of used/recovered oils and fuels. Safety classification for transport regulations	30 °C to 399 °C	30000-3, 35000-0, 35300-0, 82000-2
Paints and varnishes	Research, quality control and safety. Flammability classification for transport regulations. Recommended for water-borne paints	Below 100 °C	30000-3, 35000-0, 82000-2, 82100-2
Perfumes, flavours and fragrances	Tests on solvent/water mixtures. Flammability classification for transport regulations and safety in use	Ambient to 110 °C	30000-3, 33200-3, 35000-0, 82000-2, 82100-2
Petroleum and derivatives refining	Testing for QA/contamination where product is pumped through multi-product pipeline. Also used for H&S and transport regulations	30 °C to 399 °C	30000-3, 35000-0, 35300-0
Pharmaceuticals	Checks on manufacture stated flash points	<100 °C	30000-3, 35000-0, 82000-2, 82100-2
Printing inks	Flammability classification for transport regulations	Below 100 °C	30000-3, 33200-3, 35000-0, 82000-2, 82100-2
Road tanker terminals/shipping terminals	Quality control of storage tanks and deliveries. Safety classification for transport regulations	30 °C to 399 °C	30000-3, 35000-0, 35300-0, 82000-2
Synthetic resins	Tests on solvent-resin based base products. Quality and safety classification for transport regulations	15 °C to 150 °C	30000-3, 35000-0, 82000-2, 82100-2
Soap and synthetic detergents	Used for research and testing. Flammability classification for transport	Under 200 °C	30000-3, 35000-0, 82000-2
Transport regulations	Flammability classification for road, rail, air and sea	Extremely flammable <0 °C Highly flammable <21 °C Flammable <55 °C	30000-3, 35000-0, 82000-2, 82100-2
Waste disposal	Tests used to classify waste prior to disposal	Hexane <100 °C Pure oil >300 °C	30000-3, 82000-2, 82100-2

Seta model	Seta part number	Temperature range	Ramp rate	Cup material	Heating/cooling method	Size (HxWxD)/Weight
30000-3	Series 3	Ambient to 300 °C	up to 6 °C/min	Aluminium	Cartridge	195x295x140mm/3kg
31000-0	Series 3 Open Cup	Ambient to 300 °C	n/a	Aluminium	Cartridge	260x280x260mm/5kg
33200-3	Series 3 ActiveCool	10 to 135 °C	2 °C/min	Aluminium	Peltier cell	195x295x140mm/3kg
33220-0	Series 3e ActiveCool	10 to 135 °C	2 °C/min	Aluminium	Peltier cell	195x295x140mm/3kg
33250-3	Series 3 ActiveCool Corrosion Resistant Cup	10 to 135 °C	2 °C/min	Stainless steel insert	Peltier cell	195x295x140mm/3kg
33270-0	Series 3e ActiveCool Corrosion Resistant Cup	10 to 135 °C	2 °C/min	Stainless steel insert	Peltier cell	195x295x140mm/3kg
35000-0	PM-93 Pensky-Martens	Ambient +5 to 400 °C	5.5 °C/min	Aluminium	Forced air	380.5x240x500mm/25kg
35300-0	C-92 Cleveland	Ambient to 400 °C	up to 17 °C/min	Aluminium	Forced air	260x370x450mm/20 kg
82000-2	Series 8 High Temperature	Ambient to 300 °C	2 °C/min	Aluminium	Forced air	300x340x380mm/8 kg
82050-0	Series 8 High Temperature Gas Ignitor	5 to 300 °C	n/a	Aluminium	Forced air	300x340x380mm/8 kg
82100-2	Series 8 ActiveCool	-30 to 135 °C	up to 10 °C/min	Aluminium	Peltier cell	300x340x380mm/8 kg
82110-2	Series 8 ActiveCool Gas Ignitor	-30 to 135 °C	up to 10 °C/min	Aluminium	Peltier cell	300x340x380mm/8 kg
82150-2	Series 8 ActiveCool Corrosion Resistant Cup	-30 to 135 °C	up to 10 °C/min	Stainless steel insert	Peltier cell	300x340x380mm/8 kg
82160-2	Series 8 ActiveCool Corrosion Resistant and Gas Ignitor	-30 to 135 °C	up to 10 °C/min	Stainless steel insert	Peltier cell	300x340x380mm/8 kg