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**Petroleum and related products —  
Determination of spray ignition  
characteristics of fire-resistant fluids —**

**Part 2:  
Spray test — Stabilized flame heat  
release method**

*Produits pétroliers et produits connexes — Détermination  
des caractéristiques d'inflammation des fluides difficilement  
inflammables en jet pulvérisé —*

*Partie 2: Essai de pulvérisation — Méthode par dégagement de  
chaleur d'une flamme stabilisée*



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Preview



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 15029-2 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

ISO/TS 15029 consists of the following parts, under the general title *Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids*:

- *Part 1: Spray flame persistence — Hollow-cone nozzle method*
- *Part 2: Spray test — Stabilized flame heat release method* [Technical Specification]

# Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids —

## Part 2: Spray test — Stabilized flame heat release method

**WARNING** — The use of this part of ISO 15029 may involve hazardous materials, operations and equipment. This part of ISO 15029 does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this part of ISO 15029 to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

### 1 Scope

This part of ISO 15029 specifies a method by which the fire hazards of pressurized sprays of fire-resistant fluids can be compared. Two sizes of propane flame are used to ignite and stabilize combustion of an air-atomised release of fluid and measurements related to the rate of heat release, length of flame and density of smoke are taken to give quantitative information on the fire behaviour of the fluid.

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3170:2004, *Petroleum liquids — Manual sampling*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

ISO 6743-4:1999, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 9162:—<sup>1)</sup>, *Petroleum products — Fuels (class F) — Liquefied petroleum gases — Specifications*

IEC 60584-1:1995, *Thermocouples — Part 1: Reference tables*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### **stabilised spray flame**

point at which the rate of energy release, flame length and other combustion properties, are steady as a function of time, so that sensible time-averaged values can be calculated

#### 3.2

##### **flame length**

distance in millimetres from the vertical centre line of the gas burner to the furthest downstream point reached by the visible flame

1) To be published (revision of ISO 9162:1989).

**3.3  
flame length index**

function of the flame length and propane flow rate

**3.4  
ignitability factor**

corrected value, to the nearest integer, of a function of heat release at a specific propane flow rate

**3.5  
smoke density**

smoke density, as a function of smoke opacity in the flue pipe before and after introduction of the test fluid

NOTE See ISO 5659-2:2012, term 3.8 "optical density of smoke".

**4 Principle**

A pre-conditioned flux of the test fluid is delivered to a test chamber through a twin-fluid atomiser. Compressed air, supplied to the nozzle at a controlled rate, is used to produce an atomised spray, which is exposed to a defined flame of a gas burner present throughout the test. The gas flame acts to produce, by input of heat at a steady rate, a stabilized spray flame (3.1), so that combustion properties, such as the rate of energy release and flame length, (3.2) are sufficiently steady over time to allow time-averaged values to be measured.

Temperatures are measured both at the entry to the combustion chamber and in the exhaust, with the burner operating first without, and then with, release of the test fluid. The flame length (3.2) and smoke opacity of the exhaust are also measured. Calculations of functions, such as flame length index (3.3) ignitability factor (3.4) and smoke density (3.5) are made from these measurements. Sampling of the exhaust can enable the production rate of other combustion products to be determined. A grading system for the performance of fire-resistant fluids is developed from these determinations and calculations.

**5 Reagents and materials**

- 5.1 **Propane**, high purity (minimum 98%) grade, generally conforming to the requirements of ISO 9162.
- 5.2 **Nitrogen**, oxygen-free, commercial grade.
- 5.3 **Compressed air**.
- 5.4 **Water**, conforming to the requirements of grade 3 of ISO 3696.
- 5.5 **Ethylene glycol**, laboratory grade (mono, 98 % purity).

**6 Apparatus**

**6.1 Test installation**

**6.1.1 General**

The major components of the installation are described in 6.1.2 to 6.1.6.

Figure 1 gives a general layout of the test installation.

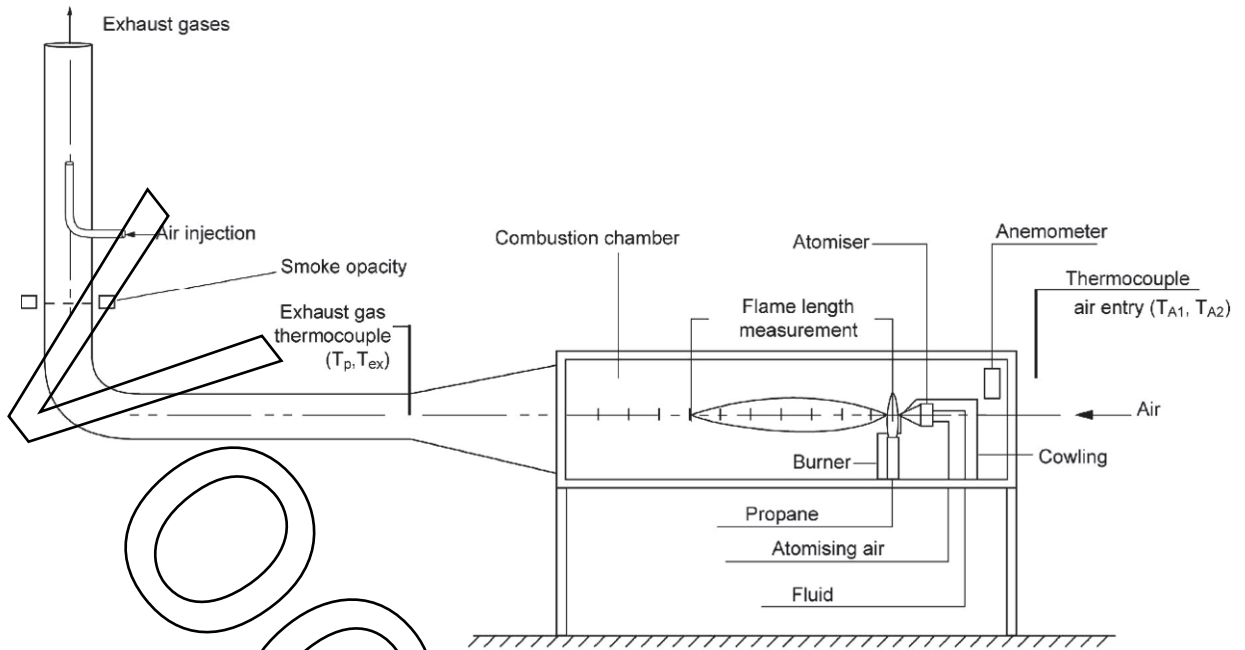


Figure 1 — General view of installation

Figure 2 shows a schematic diagram of a suggested layout of the test equipment detailing the different input streams to the combustion chamber and exhaust duct.

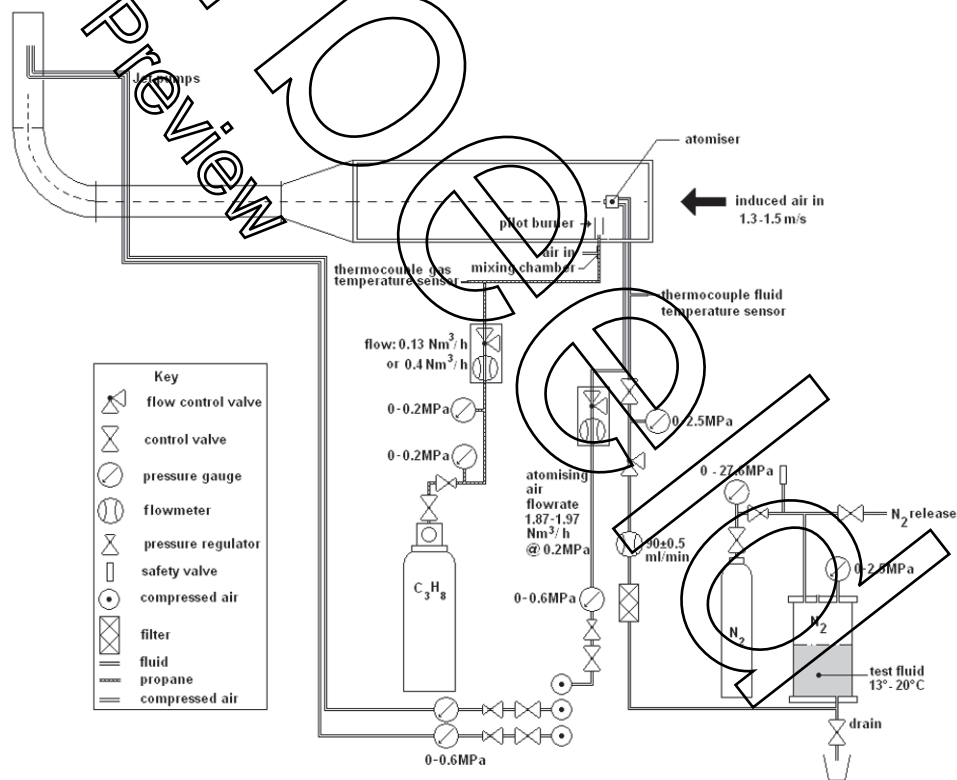


Figure 2 — Schematic diagram of suggested test rig layout



### 6.1.2 Combustion chamber

This shall be fabricated from steel sheet, 8 mm thick, of square cross-section with internal dimensions of  $(2\,000 \pm 5)$  mm x  $(490 \pm 5)$  mm x  $(490 \pm 5)$  mm. The inner and outer surfaces shall be painted with black heat-resistant paint. A clear window of heat-resistant glass, 8,5 mm thick, shall be located in one side of the chamber. The glass shall be  $(1\,920 \pm 10)$  mm x  $(525 \pm 10)$  mm providing an open area of the window of  $(1\,880 \pm 10)$  mm x  $(480 \pm 10)$  mm. The window is hinged from below to allow access to the chamber. The window shall be clamped shut during use and sealed with mineral fibre tape to avoid ingress of air (See Figure 3).

### 6.1.3 Extraction system

The combustion chamber exit shall be connected to a contraction fabricated from steel sheet 1 mm thick, providing a transition from the square to a circular cross-section with an internal diameter of  $250 \text{ mm} \pm 4 \text{ mm}$ . This contraction,  $750 \text{ mm} \pm 10 \text{ mm}$  long, is connected to a horizontal section of flue pipe  $1\,400 \text{ mm} \pm 10 \text{ mm}$  in length which, in turn, may be connected to further exhaust ducting or clearing system that shall be designed to provide stable conditions in the combustion chamber during a test.

The air flow through the chamber is produced by a jet pump mounted in the exhaust duct, producing an air velocity of  $1,4 \text{ m/s} \pm 0,1 \text{ m/s}$  measured  $50 \text{ mm} \pm 2 \text{ mm}$  inside the combustion chamber inlet. The temperature of the air entering the chamber shall be sufficiently constant within the range  $10 \text{ }^\circ\text{C}$  to  $25 \text{ }^\circ\text{C}$ , such that the temperature variation over a period of 30 s shall not exceed  $1 \text{ }^\circ\text{C}$ . The relative humidity of the air shall lie between 40 % and 80 %.

### 6.1.4 Spray delivery system

**6.1.4.1 Reservoir.** The test fluid shall be contained in a steel reservoir of minimum capacity 3 l, designed for an internal pressure of 2,5 MPa at  $20 \text{ }^\circ\text{C}$ . The flow of fluid from the reservoir is provided by means of pressurized nitrogen (5.2) supplied to the upper part of the reservoir, with a valve situated in the nitrogen supply pipe. Means shall be provided to permit complete drainage of the system.

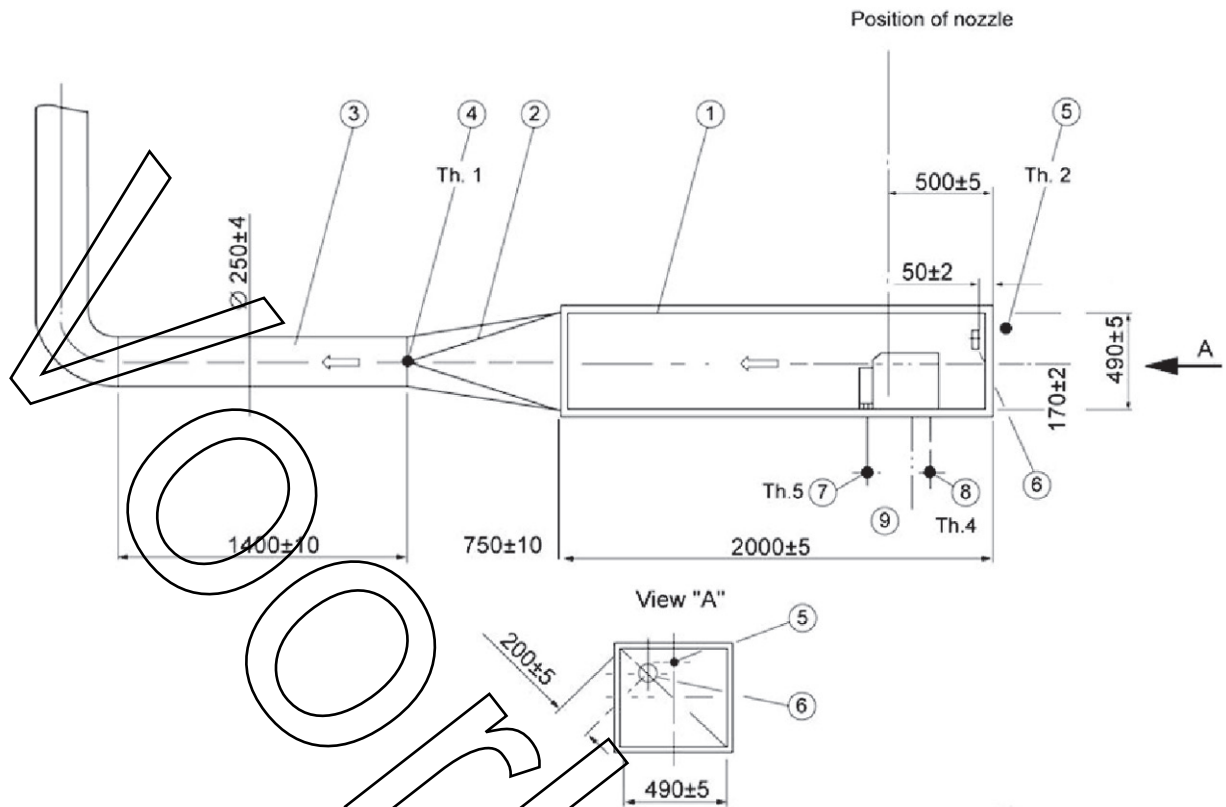
**6.1.4.2 Test fluid delivery.** The fluid volume flow rate can be measured with a suitable flowmeter and controlled to  $90 \pm 0,5 \text{ ml/min}$  by means of a needle valve. The fluid temperature is maintained between  $10 \text{ }^\circ\text{C}$  and  $25 \text{ }^\circ\text{C}$ , and measured by a thermocouple located immediately before the fluid nozzle. The fluid is delivered to the atomiser<sup>2)</sup> through nylon and/or steel piping with an internal diameter of  $7,5 \text{ mm} \pm 2,5 \text{ mm}$ , rated at 2 MPa and the flowmeter shall be located  $350 \text{ mm} \pm 150 \text{ mm}$  downstream of the valve.

**6.1.4.3 Compressed air.** Compressed air shall be supplied, via a suitable mesh filter to remove droplets and particulates at a steady flow rate of  $1,92 \text{ Nm}^3/\text{h} \pm 0,05 \text{ Nm}^3/\text{h}$  at a pressure of 0,2 MPa. The flow rate shall be measured by a variable area flowmeter having a flow range of  $0,4 \text{ Nm}^3/\text{h}$  to  $3,0 \text{ Nm}^3/\text{h}$ , located  $3\,500 \text{ mm} \pm 500 \text{ mm}$  before the spray jet at a pressure of 0,2 MPa, and controlled by a valve installed downstream of the flowmeter. The temperature of the atomising air shall be between  $10 \text{ }^\circ\text{C}$  and  $25 \text{ }^\circ\text{C}$ .

2) Type 1/4JBC-12B, manufactured by Spraying Systems Co. (<http://www.spray.com>) and supplied by CT Limited, Guildford, Surrey, UK is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 15029 and does not constitute an endorsement by ISO of this product.



Dimensions in millimetres



**Key**

- |   |                          |   |                            |
|---|--------------------------|---|----------------------------|
| 1 | combustion chamber       | 6 | anemometer                 |
| 2 | contraction              | 7 | propane gas thermocouple   |
| 3 | flue pipe                | 8 | atomizing air thermocouple |
| 4 | exhaust gas thermocouple | 9 | fluid inlet pipe           |
| 5 | ambient air thermocouple |   |                            |

**Figure 3 — Combustion chamber and exhaust system**

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