*Non contractual pictures

Cone Calorimeter

Standards

ISO 5660-1-(2)-3

ASTM-1354

1/ Objectives

Design and manufacturing of the machine to perform tests according to the standard ISO 5660-1-(2)-3 through the Heating release rate (HRR) of the sample placed in vertical or horizontal position.

2/ Description of the test

According to the method described in the standard ISO 5660-1-(2)-3, it is used to know the heat release rate of a sample placed horizontally, controlling the levels of heat source radiation (Kw / m^2) during the test.

To characterize the heat release rate, it is used the measurement of oxygen consumption from the oxygen concentration and the air flow passing through a pip at the time of combustion.

In this test, it also is measured the time to ignition of the sample.

3/ Working principle

This method is based on the fact, that generally, the net heat of combustion is proportional to the amount of oxygen required for this combustion.

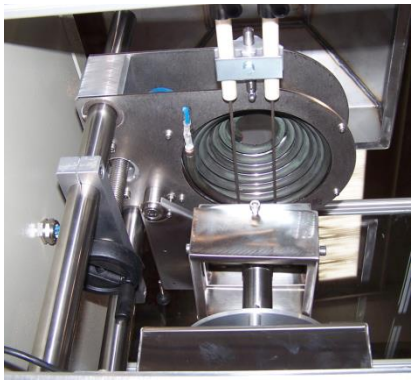
$$1\ kg\ O_2 = 13{,}1 \bullet 10^3\ kJ\ of\ heat$$

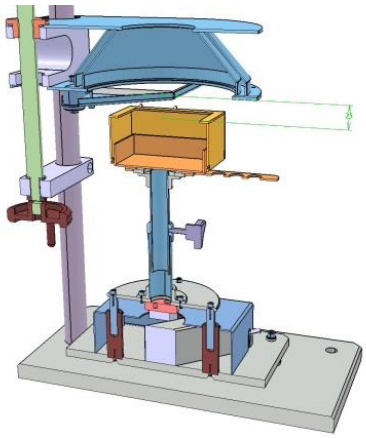
Test samples are being burnt under ambient conditions while being subjected to external irradiation from 0 kW / m^2. At the same time, it is been measured the oxygen concentration and the exhaust gases.

4/ Characteristics of the machine

The construction of the machine is made according to dimensions, structure and layout indicated by standard. The elements of the equipment are:

4.1/ Electrical spreader





The active element is an electric bar heater, capable of providing 5000 W heat, with the nominal electrical voltage. The heater is tightly wound inside a truncated cone. There is a small spacer element.

This cone is made from a sandwich of two steel layers, inside which it is a blanket of 13mm thickness refractory fiber and a nominal density of 100 kg/m^3.

Irradiation from the cone heater is maintained at a predetermined value by controlling the average temperature of 3 thermocouples K distributed symmetrically around the cone. Thermocouples will be in contact, but not welded, with the heating element.

It is used sheathed thermocouples with Inconel, of 3 mm Ø external stem, if the hot junction is exposed, or from 1,0 to 1,6 mm of Ø external stem id the hot junction is sheathed.

The heating element provides irradiation on the surface of the sample up to 100 kW/m^2. This irradiation is uniform (± 2%) in the central area of 50mm x 50mm of the exposed surface.

The shield has a handle for easy handling.

4.3/ Control of irradiation

The control of irradiation is designed to keep the average temperature of the three thermocouples during calibration, at a predetermined level with a value of ± 10ºC.

4.4/ Weight control equipment

The balance or load cell has an accuracy of ± 0,1 g or better (obtained during calibration)

The system can measure up to 500 g, with a response time (10% to 90%) of 4 seconds or less (evaluated during calibration).

The system derives do not exceed 1 g in 30 minutes (evaluated during calibration).

4.5/ Sample holder

The sample holder is designed as a square casserole with a top opening of 106 ±1mm X 106 ±1mm and a height of 25 mm.

The holder is made of stainless steel with a thickness of 2,4 ± 0,15mm. It includes a handle to facilitate insertion and removal, and it also includes a mechanism to ensure the center position and alignment of the sample under the heater cone and on the weight measurement system.

The bottom of the holder is lined with a layer of a refractory fiber blanket of low density (nominal density of 65 kg/m^3), with a maximum thickness of 13 mm.

The distance between the bottom part of the heater cone and the upper surface of the sample can be adjusted. It can be adjusted to 25 ±1mm, except for materials that are deformed before ignition, where this distance is adjusted to 60 ±1mm.

4.6/ Sample retention flame

The frame is made of stainless steel of 1,9 ±0,1mm thickness, box-shaped, with internal dimensions on each side of 111 ±1mm, and a height of de 54 ±1mm. The top opening is 94 ±0,5mm X 94 ±0,5mm.

4.7/ Extraction system of gas and of measurement

The extraction system is carried out with a centrifugal turbine ready to work in high temperatures, with a hood, input and output ducts and an orifice plate meter to determine the flow path.

The distance between the bottom of the hood and the sample surface is 210 ±50mm.

The extraction system allows flow 0,024 m^3/s in normal conditions of temperature and pressure.

Inside the extraction system, it is placed an orifice of 57 ± 3mm diameter between the duct and the hood for the flow measurement.

A ring with 12 holes in the exhaust duct can homogenize the mixture and avoid clogging soot.

The temperature of the extraction is carried out with a sheathed thermocouple with Iconel, 3 mm Ø outer sheath if the hot junction is exposed, or from 1.0 to 1.6 outer sheath Ø if the hot junction is also sheathed, rising the just center of the diameter of the extraction duct, and 100 mm above the plate metering orifice.

The flow rate is determined by the pressure differential measurement through a hole of (57 ± 3mm internal Ø and 1.6 ± 0.3 mm thick).

The sampling apparatus extraction includes:

1/ Pump
2/ Soot filter
3/ 2 moisture traps
4/ Bypass system to divert all flow except the one requested by the analyzer
5/ CO2 trap *(When the equipment has this option)*

(The delay time of O2 analyzer shall not exceed 60s. System to calibrate)

Option *(Consult price)*
CO2 Analyzer

4.8/ Ignition circuit

It is planned a spark plug up to 10 kW with a gap of 3,0 ±0,5mm. The electrode is placed in the most appropriate way for the plug, but the gap must be 13 ±2mm above the center of the sample, except for materials that deform before ignition, where this distance is adjusted to 48 ±2mm.

4.9/ Start counter

A start counter memorizes the time to the nearest second. Accuracy of 1s each 1h.

4.10/ Gas samples treatment

The sampling gases is made in the exhaust duct as standard, and the has passes through a sampling head gas preheated filter of the brand BUHLER and the head by preheated hose to avoid condensation and channeled to gas treatment cabinet. In this cabinet, it is installed decanters, sampling pump, cooling for sample drying, valves, condensate drainage pumps, etc.

The unit is equipped with a special socket for calibration with patterns or mixed gases. This socket is located on the front of the computer and it is of ¼", being very easy the calibration of the analyzer.

The system has a R.H sensor of the sample at the cooling output. If the system detects humidity in the gas sample before entering the analyzer, it stops automatically the system indicating an alarm, to avoid possible damage to the analysis system.

The equipment has a connection for FTIR.

4.11/ Oxygen analyzer

Paramagnetic oxygen analyzer with range from 0% to 25% O_2. The analyzer drift is not more than 50 ppm in a 30-minute period (checked in calibration). The pressure of the current is regulated (below the analyzer) to minimize flow variations. Analyzer readings are compensated with an absolute pressure transducer to reduce variations in atmospheric pressure, considering that the oxygen analyzer is sensitive to pressure output.

Analyzer and pressure transducer must be in an isothermal atmosphere. The temperature must be maintained within a range of ±2ºC regarding a defined value (between 30ºC and 70ºC). The response time of the analyzer, between 10% and 90% of the scale, will be less than 12 seconds. (Checked in calibration)

4.12/ Heat flow meters

The calibration radiometer is placed in an equivalent position to the center of the surface of the test sample. The radiometer is Schmidt – Boetler type with a range of 100 ±10 kW/m², with a sensor measuring 12.5mm diameter and a resistant surface painted in matte black with emissivity

ε = 0,95 ±0,05. Accuracy ±3% and repeatability of ± 0.5%.

4.13/ Calibration burner

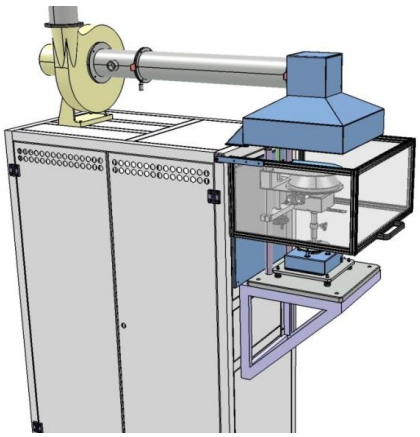
Calibration burner consists of a hollow circular or square, with an area of 500 ±100mm², covered by gauze through which methane is diffused. The tube is wrapped with refractory fiber to provide a uniform flow. The calibration burner is connected to the supply piping, measured of methane of purity at least 99.5%.

Flowmeter accuracy is 2% of the reading corresponding to a heat release of 5 kW. This accuracy is checked for calibration indicated by the standard.

4.14/ Data acquisition and analysis system

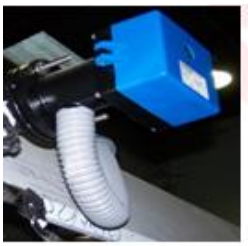
Data acquisition system collects data from the O2 analyzer, from orifice plate, from thermocouples and from the balance. The acquisition system has an accuracy of at least 50 ppm of oxygen for oxygen channel, of 0,5ºC for temperature channels and of 0,01% of full scale for other channels.

The system records a data per second, and it can store at least 720 data per channel.



4.15/ Opacimeter for fumes measurement

Equipment of technical characteristics according to standard for the measurement of smoke opacity with a heat temperature lamp of range 2900 ± 100K. This device is installed in the duct and it consists of a transmitter and a receiver.



4.16/ Protection screens against explosions

Removable screens do not affect any test parameter and they serve to protect against a possible explosion.

5/ Construction

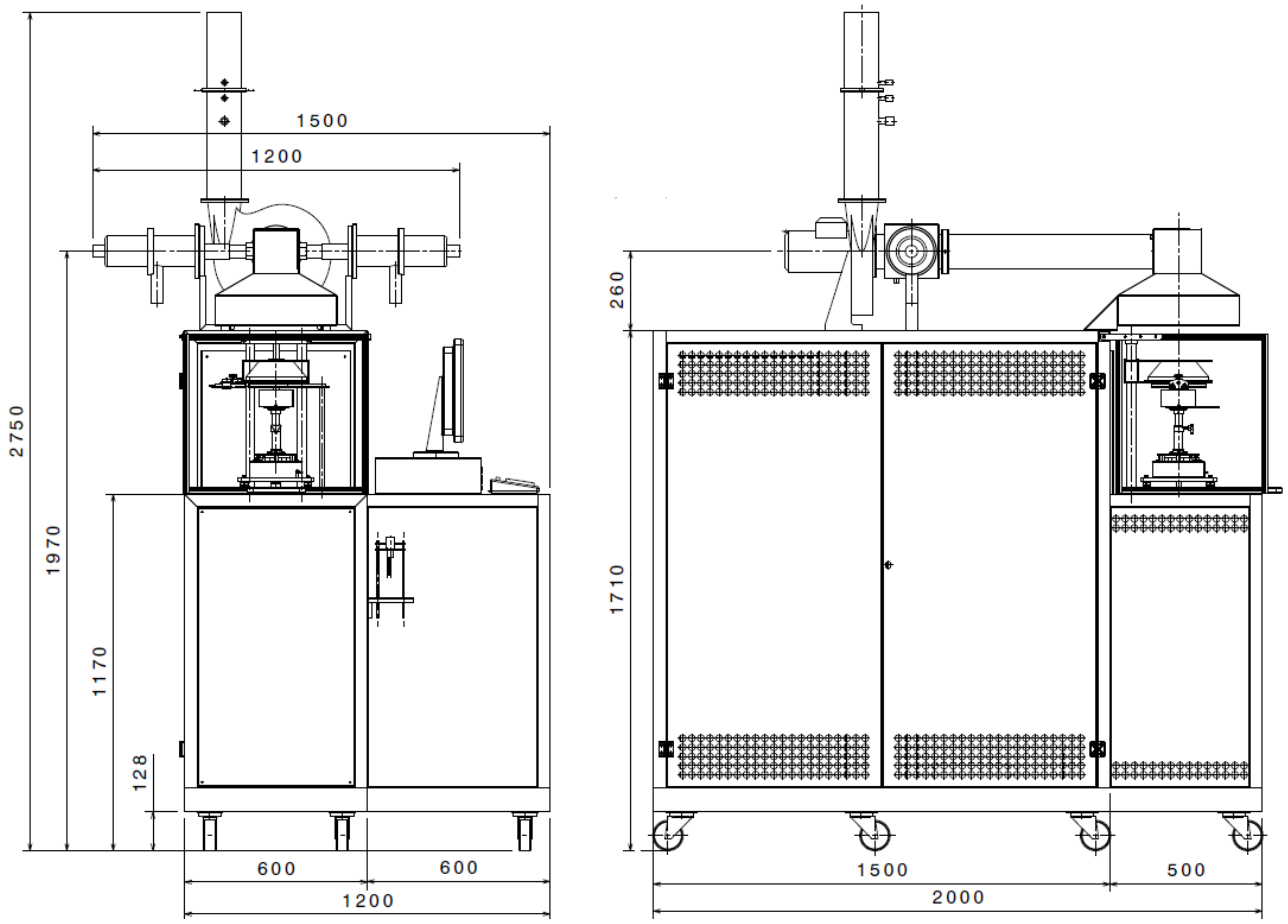
Main structure made of steel tube, which houses the following elements:

1/ An electrical cabinet, which consists of electrical protections, contactors, tools and all the necessary elements for its proper operation.

2/ An auxiliary cabinet in which it is installed all the elements of fluid control, pressure regulators, valves, etc.

3/ On one side of the structure, it is installed the extraction hood, the support of the electric heater, the holder sample, the plate of weight measurement, protection glass, etc.

6/ Dimensions (Approx.)



7/ Description of the systems

7.1/ Electrical system

In the electrical system, it is installed all the elements of protection, maneuver and control for the proper operation of the machine. It is easily accessible, and all items are clearly identified for its easy replacement in case of breakdown.

All the elements of the electrical system are duly isolated protected and signalized according to the Community Standards regarding the chapters of electrical safety and electromagnetic compatibility (emission and immunity).

7.2/ Heater control

Through a thyristors group that allows electronically control the radiation cone.

7.3/ Weight system

Through a precision-guided plate associated with a load cell of range 0-1Kg, accuracy ±0.01% that assures a better accuracy to ±0.1gr.

7.4/ Gas exhaust system

It is made by a centrifugal turbine capable of working up to a temperature of 400ºC and electronically controlled by a frequency converter.

7.5/ Exhaust flow measurement

It is made by using a differential pressure transducer associated with a calibrated orifice place.

7.6/ Extraction temperature

Thermocouple type “K” made of Inconel as standard and installed in the duct as standard.

7.7/ Gas analysis

Oxygen analyzer Siemens brand or similar of a paramagnetic range 0-25%. With this analyzer, it is installed the sampling system heated and all the necessary elements for proper operation of the samples: filters, decanters, dryers Peltier type, etc.

7.8/ Gas flow meter

Flow meter for measurement and methane flow control. Accuracy ± 0.5%.

7.9/ Acquisition system

Acquisition system that allows tasks of acquisition, recording and variables calibration.
Accuracy: 0.005% of full scale.

8/ Control instrumentation

It is made by a PLC from the brand Siemens or similar, which performs the control of maneuvers and test procedure as well as electrical protection and gas.

The PLC is connected to a control computer from the brand H.P. or Dell with screen 17''.

9/ Software

In the control computer, it is installed the software based on our Scada PRODAT-WIN, specially designed for testing according to ISO 5660-1-(2)-3 and ASTM-1354 of a simple and intuitive way:

1/ Test programming
2/ Data acquisition
3/ Results analysis
4/ Curves and results printing
5/ Test control
6/ Issuing reports
7/ Calibration

1/ Test programming
It allows performing defining test variables or test data from a client file / specimen to be performed. This file can be printed as a result document together with the report.

2/ Data acquisition
This screen lets you start and stop the test, as well as display the colors of the variables of the tests in numerical level or curve x/t. It will also indicate at all times the status of all equipment and the alarms that may occur.

3/ Results analysis
This module allows editing the results of the tests performed and representing them in curve or table mode. It also has an editor for error correction.

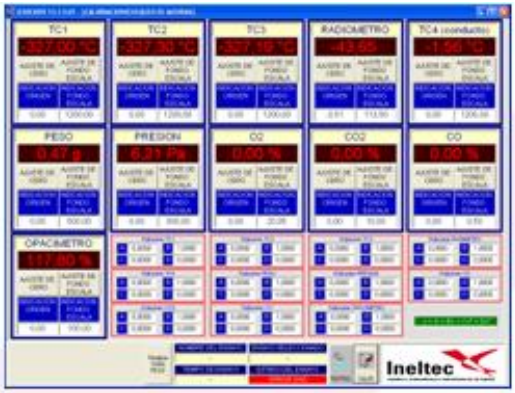
4/ Curves and results printing
It can be programmed different types of characters as well as text in any language; it allows different print forms of curves or tables, and store “N” types of print formats.

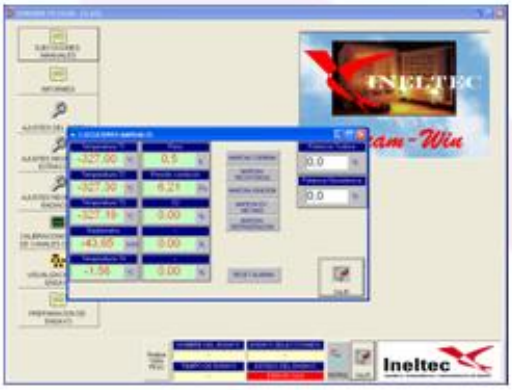
5/ Test control
A model of test variables allows displaying the test at real time and change simultaneously to manual mode for performing manually control all elements.

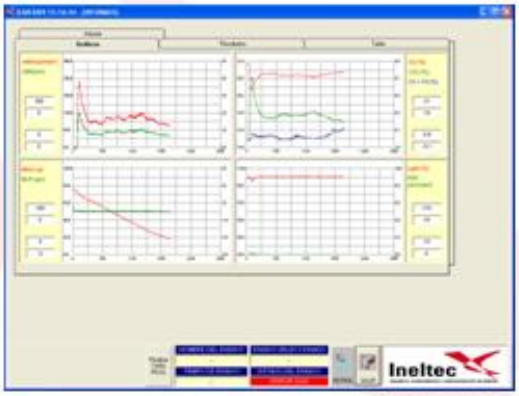
6/ Issuing reports
It allows performing different types of reports in where it is automatically recorded values of the test done. It is also possible to modify parts of the report.

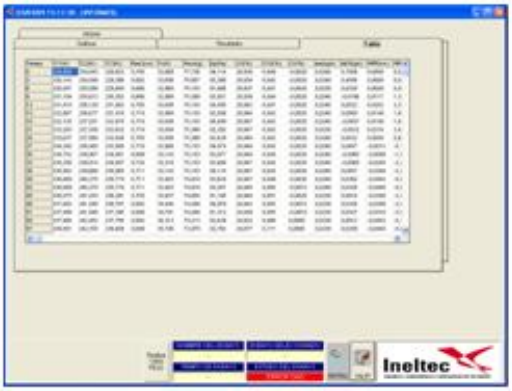
7/ Calibration
This screen allows the calibration of all elements, of acquisition channels, of acquisition times, etc.

Pantallas de ejemplo del Software









10/ Guarantee

This equipment and all its elements have a guarantee of 2 years against any manufacturing default (check the general conditions of sales).

11/ After sales service

It is carried out directly by the Technical Service. Availability of an optional INELTEC Maintenance Contract.

12/ Technical documents

1/ Operation manual

2/ List of materials

3/ Electrical drawings

4/ CE Marked, CE Declaration of conformity