CARBOLITE®
Leading Heat Technology

Coke Reactivity
ISO 18894 (CRI-CSR)

part of VERDER scientific

General principles

ISO 18894 Method for Measuring Coke Reactivity Index (CRI) and Coke Strength after Reaction (CSR).

Technique for determining lump coke reactivity in carbon dioxide gas at elevated temperatures and its strength after reaction in carbon dioxide gas by tumbling in a cylindrical chamber referred to as the 'I - tester'.

When coke lumps descend in the blast furnace, they are subjected to reaction with counter current CO2 and to abrasion as they rub together and against the walls of the furnace. These concurrent processes physically weaken and chemically react with the coke lumps, producing an excess of fines that can decrease burden permeability and result in increased coke rates and lost hot metal production. This test method is designed to indirectly measure this behaviour of coke in the blast furnace.

A dry coke sample of designated size and origin is reacted with CO2 gas in a retort at a specified elevated temperature for a specified length of time. Two indices, coke reactivity index (CRI) and coke strength after reduction (CSR) are determined using the reacted coke residue. The weight retained after reduction determines the CRI. The weight retained after sieving the tumbled reacted coke in a designated number of revolutions over a designated turning rate determines the CSR.

Technical specification

Maximum temperature
1100ºC

Heating zones
Three, with an overall heated length of 700mm

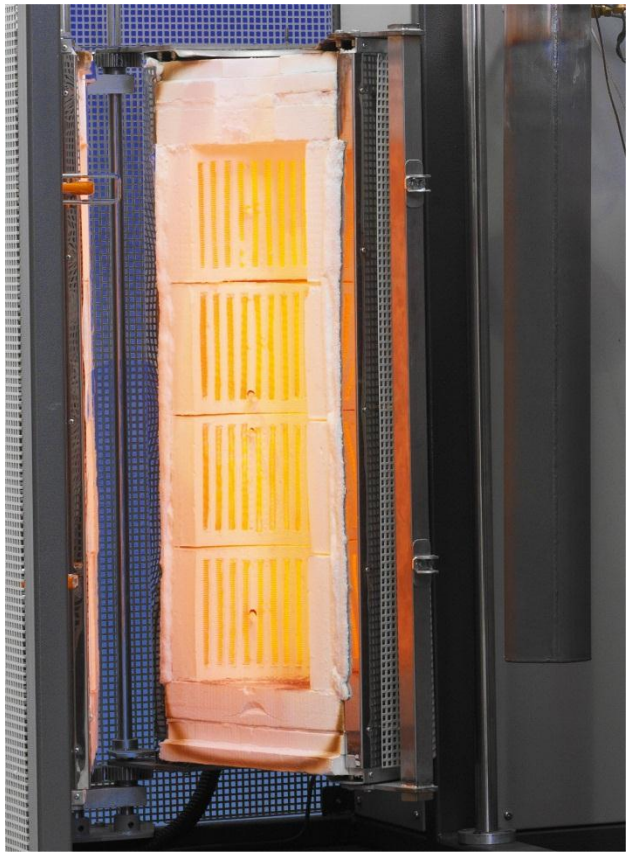
Construction
A painted steel frame supports the furnace and retort hanger. A rolled stainless steel supports the furnace inner insulation package. A mesh double skin allows the passage of hot air and helps in keeping the outer case cool. The framework is painted in Carbolite's standard grey.

Overall dimensions
Height 1800mm x width 1625mm x depth 1100mm. These dimensions are approximate only – if they are critical this should be highlighted prior to order placement.

Heating elements & temperature sensors

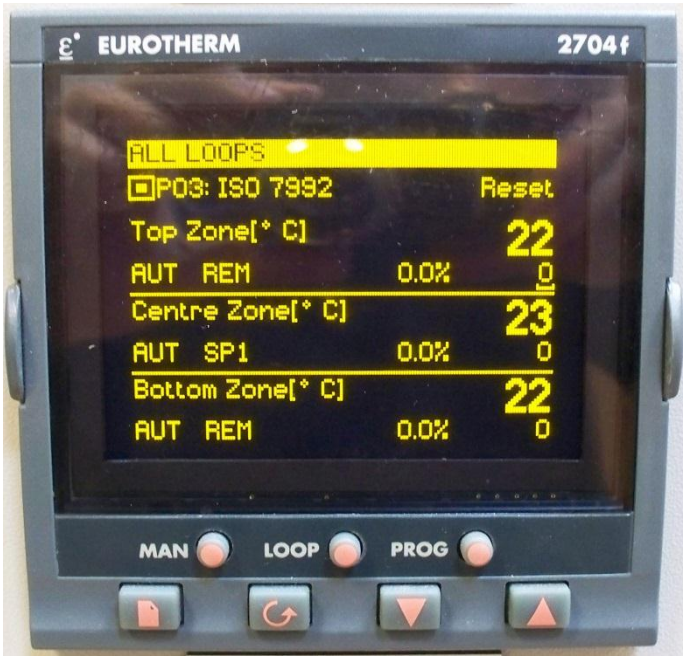
Heating elements
Kanthal AF resistance wire are coiled and vacuum formed into modular heating elements.

Temperature sensors
Type ‘N’ (MI) thermocouples are located within the heating chamber.



Control system

- The Eurotherm 2704 is a complex triple loop process controller.
- Input and output boards enable the process gases to be switched on and off as required.
- The instrument offers sixteen programmable segments, each of which may be configured as a ramp, step or dwell.
- The instrument software is pre-configured for the ISO 18894 test.
- The controller offers straight line process control and high stability.
- The dual display shows both set-point and measured temperatures.



Cascade control

- The standard control system senses the temperature close to the heating elements. Cascade control is used to correct this offset and utilises an additional load loop with a type 'N' thermocouple. The load loop communicates with the element loop, calling for heat according to the load temperature and current program or set-point. The element loop regulates the heat according to element temperature and the requests from the load loop.

Over-temperature control & controls location

- An independent thermocouple and temperature controller monitor the furnace temperature. If an over-temperature condition occurs, power to the heating elements is cut.
- The instrumentation and associated power control equipment are housed within the integral control cabinet

Process control & process gas

Process control

The test profile is controlled by the main temperature controller. Both temperature and gas flow are directed through this instrument. Due to the function of the instrumentation, the equipment is considered to be semi-automatic; the operator is required to load and unload the furnace.

Process gas

Nitrogen and carbon dioxide are required at pressures between 1.0 and 2.0 bar; pipe fittings are provided for customer connection. Propane or natural gas (0.5l/min) is required for a pilot safety burner. Gas purity is the responsibility of the end user and reference should be made to the ISO specification. With the exception of the propane line, the gas supplies are divided and pass through a series of Flostat needle valves and flow meters, allowing flow control of process gas. The gas lines are equipped with non-return valves and rapid response solenoid valves. The gases combine to provide a single gas inlet into the retort. The double skin retort allows pre-heating of the gas prior to entering the reduction tube. An independent purge line enables one retort to cool whilst a second test is started (providing a second retort is available). Whilst low flow alarms are provided, it is the responsibility of the end user to ensure the gas flows are within defined tolerances. Mass flow meters are not used to control gas flow. On/off control of the gas flow is achieved using relay outputs from the process controller. The outputs actuate solenoid valves in the gas lines, allowing automated gas changeover at specific temperatures and time. Manual adjustment of the gas flow may be required during changeover.

Alarm conditions

Audible alarms are provided for the following conditions:

- over-temperature
- low gas flow
- flame failure on the gas burn off

Potentially dangerous alarm conditions will abort the process and render the equipment safe.

Data recording

A Chessell 6100 paperless chart recorder is supplied to record process parameters. The channels are factory configured to record the three zone furnace temperatures and the sample temperature.

Sample retort

The reaction retort is constructed generally from heat resistant inconel. The double skin construction allows incoming gas to be pre-heated. The seals between the inner and outer vessels are a graphite based material. Provision is made for the required probe thermocouple within the retort.

Power control & total power

- Burst firing via zero voltage switching solid state relays driven by a low voltage signal from the controller.
- Three-phase & earth - suitably isolated and fused by the customer.
- Nominal power 10kw.

Optional tumbler

I – Tester/tumbler

The coke test after reaction (CSR) tumbler is a free standing unit and consists of a motor and gearbox assembly which rotates a steel cylinder at 20rpm for a specified number of revolutions.