R.B. Automazione

Testing equipment

COAL | COKE

IRON ORES | PELLETS | SINTERS | AGGLOMERATES

R◇B

www.rb-autom.com

ABOUT US

RB Automazione, ISO 9001 certified company, established in Genova in 1978, manufactures instruments for technological test on coal, coke and iron ores.

Our vast experience in the field and technological knowledge allows us to maintain our excellent reputation as a worldwide supplier of testing instruments to the major Blast Furnace and DRI plants, coke plants, iron and steel industries, mines and inspection companies.

We are strongly committed to design and manufacture durable and easy- to-use products with the highest quality and reliability standards meeting customer's expectations. We develop also tailor-made solutions if requested by our end-users.

Our products are supplied worldwide directly or through our knowledgeable representatives and distributors and we offer a reliable after-sales support to assure the best performance of our instruments.

COAL COKE

IRON ORE

AUXILIARY EQUIPMENT & ACCESSORIES

Plastometer PL 2000

ISO 10329, ASTM D2639

General description

The PL 2000 Coal Plastometer is a fully automatic system for determination of fluidity of coal by the Gieseler method according to ASTM D 2639 and ISO 10329 Standards. Both methods described in the Standards give a relative measure of the plastic behaviour of coal when heated at constant rate, under prescribed conditions.
Fluidity of coal is obtained applying a constant torque on a stirrer placed in a crucible loaded with the coal, heating the crucible in a molten solder bath furnace and recording stirrer movement on a dial drum graduated into 100 divisions, D.D.P.M. (Dial Division per Minute) in relation to increase of temperature.
All the analysis procedure, even up and down movement of the crucible, is automatic: the operator needs only to mount the crucible and to start the system.
The double furnace system productivity is considerably increased due to the reduction of heating and cooling waiting times. Once started, PL 2000 will preheat the furnace, check the correct loading of the sample, lower the crucible, restore the start temperature, raise the temperature at uniform rate and carry out the fluidity test.
Drum dial movement is recorded by means of an optical encoder with a resolution of 0.2 D.D.P.M.
Furnace temperature together with fluidity readings are displayed and printed out during the test.

Specifications	
Working temperature	260 ÷ 600 °C
Temp. rise rate set	0.5 ÷ 6.0 °C/min
Stirrer Motor speed	300 or 1,000 rev/min
Hysteresis brake Torque range	15 ÷ 100 g.inch
Solder bath stirrer	in the plastometer head
Crucible movement	fully automatic
Temperature display	°C
Fluidity display	0.2 ÷ 100,000 D.D.P.M.
Fluidity resolution	0.2 D.D.P.M.
Data print interval	60 sec
Alphanumeric printer	non impact type
System diagnostics	automatic at start up
Host computer interface	RS 232 C
Power supply (single furnace)	230 / 120 V 0.8 kVA max
Power supply (double furnace)	230 / 120 V 1.6 kVA max

Double furnace version - PL 2002

Available Versions

The Plastometer PL 2000 is available in Single Furnace (PL 2001) or Double Furnace version (PL 2002).
By the Double Furnace version it is possible to reduce the time wasting waiting for the cooling down of the furnace at the end of the test.
While a fluidity test is running in the first furnace, the second furnace can be preheated at the warm up temperature. At the end of the first test, a second test can be immediately started on the other furnace.

Single Furnace version – PL 2001

Printer Output

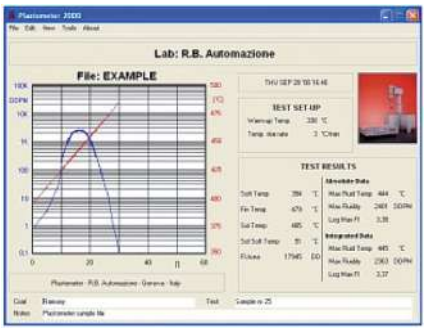
The internal printer returns the results of the test on thermal paper.
Every minute the current values of Time (minutes from the test start), Temperature (°C) and Fluidity (D.D.P.M.) are printed.
At the end of the test, the Test Report is printed according to the international standard.

Electronic Unit

The test control is completely devoted to the electronic unit.
Thermal parameters of the test are set by means of a guided set-up procedure; three digital display groups are available to set warm-up temperature (3 digits), temperature rise rate (2 digits) and maximum temperature (3 digits). A led display group is used to set optional operation set-up.
A further four led display group allows system set-up (Diagnostics, Date and Time set, Calibration and Special functions).
During the test two visualisation units show the current temperature (3 digits), and the current fluidity (6 digits).
The electronic cage includes a thermal paper printer, 24 characters/line, for status messages and current data printing.
A remote host computer interface (RS232C) is included to allow data logging and/or graphic representation of the results.
The archiving software Plastometer Data Manager (PDM) is available as option providing an user friendly interface to archive and graphical print out the test results.

PC archiving Software P.D.M.

The system can be connected to an external computer.
All current test data and end of test report are available on a serial port RS 232 in ASCII format.
The software "P.D.M. – Plastometer Data Manager" provides friendly interface and support for asynchronous RS232 communications to external PC.
Acquisition, archiving, printing and export of test data, together with test set up and sample identification is fully provided.
The software is compatible with Microsoft Windows© environment.



Accessories

The Loading device (PL 2000-90) can be supplied together with the Plastometer PL 2000. All the consumables (as Crucible, Crucible stirrers, Printer paper etc…) are always available in stock.

Item codes	
Single Furnace Automatic Plastometer System	PL 2001 A/B
Double Furnace Automatic Plastometer System	PL 2002 A/B
(A = 230 V – B = 120 V)	
Crucible (not included in PL 2001/2 items)	PL 2000-80
OPTIONS:	
PC Archiving Software	PL 2000- 64
COAL SAMPLE PREPARATION DEVICE	
Static and Drop Weight loading device	PL 2000-90

Dilatometer DL 4000

ISO 349, DIN 51 739, ISO 8264, ASTM D 5515, ISO 23873

General description

DL 4000 Coal Dilatometer is a fully automatic system for determining the swelling properties of hard coal when heated under standard conditions: dilatation and contraction are obtained by inserting a sample of powdered coal, formed under pressure, in a narrow tube topped by a piston and reading the displacement of the piston as a function of the temperature. ISO Standard 349, DIN 51 739, ISO 8264, ASTM D 5515 and ISO 23873 specify slightly different methods for such determination. DL 4000 performs dilatometer tests according to ALL the above mentioned standards: dilatation and contraction of 2 samples, loaded in 2 tubes, are measured at the same time, by means of precision transducers. The Standard Test Method can be easily selected from the front panel before starting a test.
The double furnace version productivity is considerably increased due to the reduction of the heating and cooling waiting times. All the analysis procedure, even the insertion and removal of the tubes into the furnace, is automatic: the operator needs only to load the sample, to place the tubes above the furnace and to start the system.
Once started, DL 4000 will preheat the furnace, insert the tubes into the furnace, restore the start temperature, raise the temperature at uniform rate, and carry out the tests results.
Furnace temperature together with the dilatation and contraction readings are displayed and printed during the test.

Specifications	
Working temperature range	250 ÷ 600 °C
Temp. rise rate set	0.5 ÷ 6.0 °C/min
Displacement transducers	LVDTs
Tubes movement	fully automatic (not in "K" Version)
Temperature display	°C
Dilatation display	- 50 % ÷ + 300 % (normal samples)- 100% ÷ + 600 % (short samples)
Dilatation resolution	1%
Data print interval	60 seconds
Alphanumeric printer	non impact type
System diagnostics	automatic at start up
Host computer interface	RS 232 C
Power supply (single furnace)	230 / 120 V – 1.8 kVA max
Power supply (double furnace)	230 / 120 V – 3.6 kVA max

Double furnace version DL 4002

Single furnace version DL 4001

Available Versions

The Dilatometer DL 4000 is available in Single Furnace version (DL 4001) or in Double Furnace version (DL 4002).
With the Double Furnace Version is possible to reduce the time wasting waiting for the cooling down of the furnace at the end of the test.
While a dilatation test is running in the first furnace, the second furnace can be preheated at the warm up temperature. At the end of the first test, a second test can be immediately started on the other furnace. The Dilatometer DL 4000 can be supplied also as K Version: a less expensive unit designed without the automatic loading mechanism. The Dilatometer K version can be supplied in Single (DL 4001K) or Double Furnace (DL 4002K) version.
A special High Temperature Version (DL 4001HT) is also available and allows to test the samples up to 1000 °C. This procedure is not described in any Standard but is useful for research purpose to investigate the behaviour of the coal over 600 °C.

Printer Output

The internal printer returns the results of the test on thermal paper. Every minute the current values of Time (minutes from the test start), Temperature (°C) and Dilatation (%) for tube A and B are printed. At the end of the test the Test Report is printed according to the international standard. The test report includes the automatic classification of the sample (Positive Dilatation, Negative Dilatation or Contraction Only) together with the G Factor.

Electronic Unit

The test control is completely devoted to the electronic unit. Thermal parameters of the test are set by means of a guided set-up procedure; three digital display groups are available to set warm-up temperature (3 digits), temperature rise rate (2 digits) and maximum temperature (3 digits). A led display group is used to set optional operation set-up (host computer data transmission enable, standard selection etc). A further four led display group allows system set-up (Diagnostics, Date and Time set, transducers calibration and special functions).
During the test three visualisation units show the current temperature (3 digits), and the current % contraction/dilatation (3 digits plus sign), for both A and B tubes. The electronic cage includes a thermal paper printer, 24 characters/line, for status messages and current data printing.
A remote host computer interface (RS232C) is included to allow data logging and/or graphic representation of the results. The archiving software Dilatometer Data Manager (DDM) is available as option and give a user friendly interface to archive and graphical print out the test results.

PC Archiving Software D.D.M.

The system can be connected to an external computer.
All current test data and end of test report are available on a serial port RS 232 in ASCII format. The software "D.D.M. – Dilatometer Data Manager" provides friendly interface and support for asynchronous RS232 communications to external PC.
Acquisition, archiving, printing and export of test data, together with test set up and sample identification is fully provided.
The software is compatible with Microsoft Windows© environment.

Accessories

Item codes	
Single Furnace Automatic Dilatometer System	DL 4001 A/B
Double Furnace Automatic Dilatometer System	DL 4002 A/B
Single Furnace Automatic Dilatometer System K Version	DL 4001 K A/B
Double Furnace Automatic Dilatometer System K Version	DL 4002 K A/B
(A = 230 V – B = 120 V)	
TUBE and PISTONS: (not included in DL 4001/2 items)	
TUBE and PISTON - Type S - according to ISO 349, ASTM D 5515	DL 4000-80
TUBE and PISTON - Type L - according to ISO 8264, ISO 23873, ASTM D 5515, DIN 51739	DL 4000-82
OPTIONS:	
PC Archiving Software	DL 4000- 64
COAL SAMPLE PREPARATION KITS	
Coal sample preparation Kit according to ISO 349, ASTM D 5515	DL 4000-84
Coal sample preparation Kit according to ISO 8264, ISO 23873, ASTM D 5515, DIN 51739	DL 4000-86
Coal sample preparation Kit Multistandard	DL 4000-88

CRI - CSR Test System

ISO 18894, ASTM D 5341 and IS 4023 Meth.B

General description

The CRI CSR Test System is an automatic device for determination of the Coke Reactivity Index (CRI) and Coke Strength after Reaction (CSR).
This test device is fully compliant with the specifications in ISO 18894, ASTM D 5341 and IS 4023 Meth. B Standards.
Both indexes C.R.I. and C.S.R. are probably the most important parameters used for assessment of the quality of metallurgical coke.
Many coke plants and blast furnaces around the world use CSR as a specification just as important as cold strength, size, and chemistry.
From experiences of several laboratories involved in CRI and CSR tests it has been pointed out that the reliability of the results greatly depends on temperature and reaction gas flow rate accuracy in terms of:

- Accuracy of test temperature (1100 °C) during all reaction time.
- Isothermal temperature distribution in the coke sample.
- Accuracy of CO_2 reacting gas flow rate (5.0 nl/min).

To obtain best test reproducibility, therefore, the system, includes as standard:

- High accuracy temperature programmer and controllers.
- Multizone oven with temperature independent controls for best sample isothermal distribution.
- High accuracy automatic mass flow meter and control device for CO_2.

Single Oven CRI Test System

Double Oven CRI Test System

Available Versions

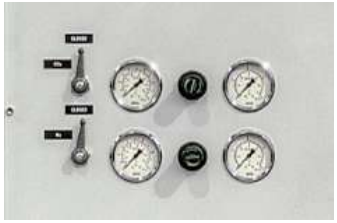
CRI Test System is available in three versions:

Single Oven System
To perform one test at time.

Double Oven System
To improve the number of tests that can be performed. At the end of the test in the first oven it is possible to start immediately a new test on the second oven. It is not necessary to wait for oven cooling down as in single oven system.

Dual Oven System
To allow simultaneous operation of two ovens running, fully independently, two tests at a time. The system is provided with independent Carbon Dioxide and Nitrogen lines, together with independent temperature control and programming units.

Dual Oven CRI Test System



Test process is carried on by the system with no needs of any action by the operator.

Optional continuous weighing system is available to display and to record weight change of the sample during the test.

According to Standards, a double drum tumbler device, with automatic counter, is supplied to perform the CSR test (TB 5000).

Reaction Tube Cooling System can be optionally supplied to reduce the cooling down time of the Reaction tube at the end of the test (CS 2000).

Specifications

OVEN:	
Heating elements:	Silicon carbide elements (20 elements)
Heating Zones:	5 heating zones
Max operating temperature:	1200 °C
Maximum operating Power:	20 kW
External thermocouple:	"K" type (inconel shielded)
Inner chamber diameter:	140 mm
REACTION TUBE:	
Reaction tube type :	"Single wall" Type A
Material:	Inconel 600
Inner diameter:	78 mm
Internal thermocouple:	Triple "K" type (inconel shielded)
GAS CONTROL UNIT:	
Flow rate measuring devices	Digital Mass Flow Meters
Reaction Gas composition	100 % CO_2
Reaction Gas Flow rate:	5 nl/min
Purge Gas composition:	100% N_2
Purge Gas Flow rate:	3 – 10 nl/min
SAMPLE WEIGHING UNIT:	
Max Weight:	30 kg
Resolution:	0.1 g
MAIN POWER:	380 V 3 Ph + Neutral (20 kW max)

Vertical electric oven

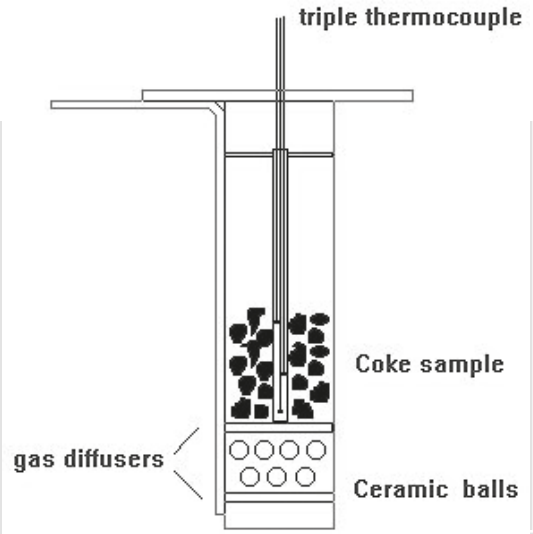
The electric oven consists of a steel structure placed on a frame and including the silica insulation material.
Twenty silicon carbide high temperature heating rod elements are placed horizontally in a stack and are grouped in 5 heating zones to provide separate power control. Replacement of heating elements is fast and easy with no need of refractory maintenance so that oven life is very long.
Inner high temperature chamber is protected by a quartz tube.
The oven can be equipped, as an option, with a weighing system to provide continuous monitoring of coke sample weight during reduction test.

Control Panel

Control panel includes complete top quality control and monitoring instrumentation. Temperature of coke sample is driven by digital programmer and by multiloop digital controller to obtain the best isothermal test condition.
A temperature alarm controller assures oven safety cutting off power in case of over temperature.
Automatic inlet of Nitrogen and Carbon dioxide is provided according to temperature program.
Gas flow control is obtained by a digital mass flow meter for CO_2 and by a rotameter for N_2 (as option a mass flow meter also for N_2 is included).
Manual gas control is also possible for checking purpose.
Optional weighing system allows continuous monitoring of sample weight.
A Touch screen recorder and data logger, and Ethernet connection, provides local and remote recording of test data.

Reaction Tube

Reaction tube is manufactured according to ASTM and ISO Standard dimensions and materials: all parts operating at high temperature are made of INCONEL 600 steel alloy to obtain long tube life.
A copper tube coil assures cooling down of exhaust gases. The reaction tube can be hung to the optional roof electric tackle to provide safe and easy insertion and removing into the furnace.



TB 5000 for CSR determination

Tumbler device for CSR test consists of a wall mounting double drum system. TB 5000 allows to run two sample tests simultaneously.
The unit is equipped with:

- Electric motor and gear box
- Variable frequency drive (TB 5000 –ISO)
- Digital pre-set counter (to set up total number of revolutions)
- Positioning feature (for a slow motion for loading/unloading purpose)
- Safety cage
- Safety switch on the door
- Emergency Stop button

In the ISO Version the high accuracy in the revolution speed is assured by the Variable frequency drive that allows a fine adjustment of the speed to 20 ± 0,1 r.p.m.

Auxiliary Equipment

Reaction tube lifting electric tackle

- For insertion and removing of the reaction tubes
- Vertical electric movement
- Two controlled speeds – low / fast movement
- Manual horizontal movement on rail
- Max. weight 60 kg
- Remote control
- Rail included
- Power 230 V 50 Hz

Reaction tube tripod
Model:

- TR 2000 – For CRI-RDI reaction tubes

Reaction tube cooling devices

- Digital Temperature controller
- Ventilation Fan
- Auto stop at preset temperature
- Power 230 V 50 Hz

Model:

- CS 2000 – For CRI-RDI reaction tubes

Reaction tube tripods

Reaction tube lifting tackle

Reaction tube cooling devices

Sample preparation devices

Auxiliary equipment for Sample Preparation can be provided together with main instrumentation.
Available devices, described at page 25, are:

- Jaw Crusher for coke
- Sample Splitter
- Testing screen machine (with screening trays)
- Sieving Machine (with sieves)
- Sieves (for manual sieving)
- Thermostatic Oven
- Digital laboratory scale

Cold Compression Strength (CCS) Test RB 1000

ISO 4700, ASTM E 382 and IS 8625

General description

According to ISO 4700, ASTM E 382 and IS 8625 Standards, RB 1000 is a fully automatic system for determination of the crushing strength of fired iron ore pellets and reduced iron ore pellets.
The equipment consists of a loading unit, with an automatic handler and feeder for the samples and an electronic unit for indication, printing and statistic calculation of crushing strength test data.
Following options are also available:

- Continuous sample dimension measuring device for determination of crushing load by sample contraction logic.
- PC software for crushing test data acquisition together with each test load curves data and statistic analysis.
- Calibration system based on an external certified 10kN load cell complete of signal conditioning unit.

RB 1000 CCS Test System

Compression rammer and sample handler

System Features

The loading device, with a capacity of 1,000 daN (~1,000 kg), works at constant compression speed (5, 10, 15 or 20 mm/min). The low speed is kept only during the compression period. High speed movement of the compression plate is provided in the approach and return phases to reduce total test time.
The load measuring system is equipped with an electrical self-calibration procedure, performed periodically. Data are displayed and printed both in kilogram or in decaNewton with a resolution of 1 kg or 1 daN respectively.

Automatic feeder

A continuous feeder consists in a vibrating pot in which the pellets can be put in bulk.

Operating Mode

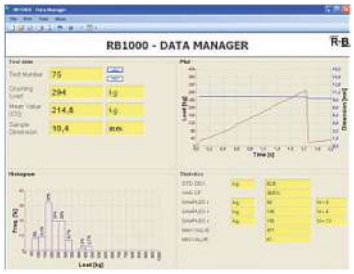
The equipment can be operated in MANUAL or AUTO Mode. In MANUAL mode the operator moves down the press and determines the load at which the test piece undergoes complete breakage.
In AUTO Mode the electronic unit identifies automatically the crushing strength as the maximum load in a “LOAD DECREASE CRUSHING LOGIC” or a “TIME BASE CRUSHING LOGIC” with programmable parameters.
AUTO Mode allows using the system not only for routine purpose but also as a research tool.

Electronic Unit

The electronic unit drives the compression process and provides to display and to print the crushing strength values and to calculated statistic data. The available statistics are: minimum and maximum value, number of tests with values under different thresholds, mean value, standard deviation and variation coefficient.
The electronic cage includes a thermal paper printer for status messages and current data printing.
A remote host computer interface (RS232C) is included to allow data logging and/or graphic representation of the results.
The optional archiving software RB 1000 Data Manager is available as option providing an user friendly interface to archive and graphical print out the test results.

RB 1000 Data Manager

The RB 1000 Data Manager is an optional dedicated Software that allows the operator to have an on-line monitoring of test results and to get the print out of Test report as in the Standards. Acquisition, archiving, printing and export of test data, together with graphical representation of the results are fully provided.
The software is compatible with Microsoft Windows© environment.



Load Cell Calibration system

The RB 1000 Load Calibration System is an external comparison tool that allows the users to perform a periodic calibration of the device with a certified load cell. All mechanical parts needed to operates with the load cell are included in the kit. The provided calibration certificate guarantees the precision of the readings.

Specifications	
ELECTROMECHANICAL PRESS	
Compression speed:	5, 10, 15 or 20 mm/min
Max compression load:	1,000 kg / (1,000 daN)
MOTOR SERVO CONTROLLER	
Principle:	static frequency converter
Output voltage:	230 V 3 Ph (PWM Control)
Motor type:	asynchronous 3 Ph motor
ELECTRONIC CONTROL, DISPLAY AND PRINT UNIT	
Display and print resolution	1 kg or 1 daN
Printer	Alphanumeric on thermal paper
Data Digital output	RS 232 C to host computer
Main power:	230 V a.c. ± 10% 50/60 Hz 250 VA max
Main power:	115 V a.c. ± 10% 60 Hz 250 VA max

Multifunction & Multistandard test system MM 6000

For tests according to Standards to be selected among the following:
ISO 7215, ISO 4696-1, ISO 4696-2, ISO 4695, ISO 8371, ISO 4698, ISO 11258, IS 10823, IS 8167, IS 11292, IS 8624

General description

MM 6000 is a completely automatic and user-friendly equipment, able to perform tests on iron ore and coke samples according to several Standard procedures. Instrumentation is based on a Programmable Automation Controller to drive, fully automatically, the test in terms of oven and sample temperatures, reaction and purge gas flow rates and monitoring the sample weight.
The equipment accepts entry of sample data for automatic calculation of test conditions (when requested) based on the parameter values acquired by the instrument. The System is equipped with a touch screen graphic interface with Recording and Data Logging features of main process variables.
The vertical oven is constituted by 5 independent heating zones and the control thermocouple (3 measuring points) is directly placed in the sample for a better isothermal condition during the test.
Reaction gases and Nitrogen (purge gas) flow rates are driven by high precision Mass Flow Meters with automatic selection and by flow rate control. High accuracy weighing device is installed for continuous monitoring of sample weight loss during the test.

The system can be feed by proper premixed reaction gas blends (from bottles stack provided at customer care) or, as option, it can be feed by pure gases and the system will provide for blending on line.

MM 6000 features:
- Friendly set up and controls by touch screen interface
- Accuracy of test temperature during reaction time
- Isothermal temperature distribution in the sample
- High accuracy of gases flow control
- Accuracy of sample weight (resolution 0.1 g)

MM 6000 automatic operations:
- Automatic temperature time profile control
- Gases input timing
- Gases flow rate control by mass flow meters
- Continuous monitoring of sample weight
- On line calculation of test results as reduction values

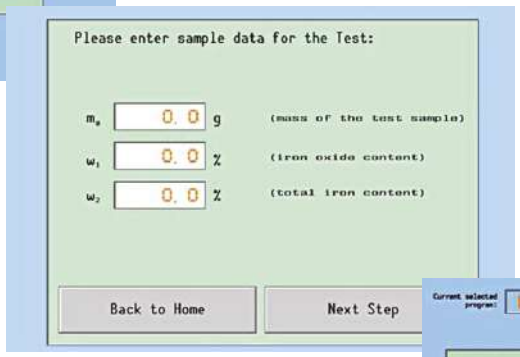
Vertical electric oven

The electric oven consists of a steel structure placed on a frame and including the silica insulation material.
Twenty silicon carbide high temperature heating rod elements are placed horizontally in a stack and are grouped in 5 heating zones to provide separate power control. Replacement of heating elements is fast and easy with no need of refractory maintenance so that oven life is very long.
Inner high temperature chamber is protected by a quartz tube.
The oven can be equipped, as an option, with a weighing system to provide continuous monitoring of coke sample weight during reduction test.

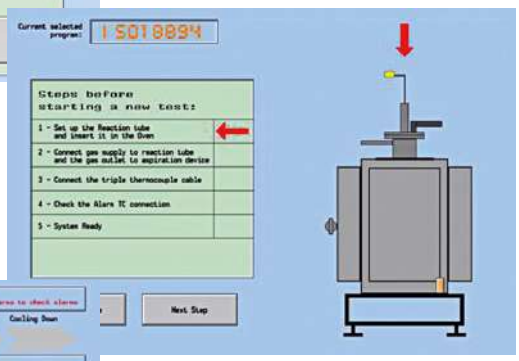
Control Panel

A Multi-Function Control Panel, with function of recorder, viewer and programmer is able to drive oven temperature, gases and other events according to the test procedures.
All the messages, alarms and information on the status of the system are displayed on the Touch Screen unit.
Reaction gases mixes and Nitrogen (purge gas) are driven by electro valves and Mass Flow meter by automatic selection and flow rate control.

... test selection ...

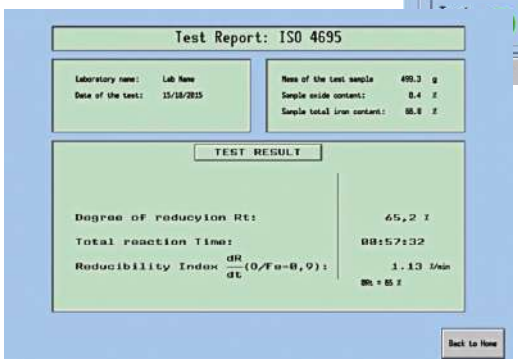


... data entry ...



... automatic checking system status step by step ...

... monitoring of system and test data ....



... visual test report ...

Multifunction and Multistandard capability

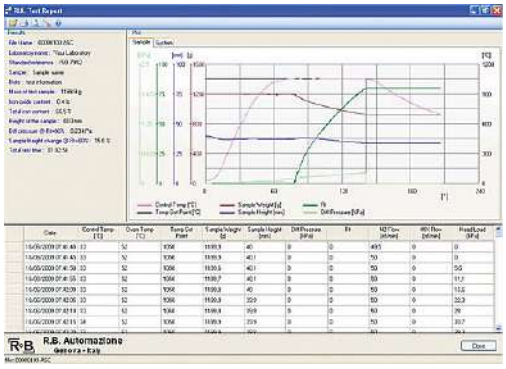
The system can be tailored according to Customer requests performing one or more different procedures. Standard procedures, as Reducibility, Relative Reducibility, Disintegration, Decrepitation and Free Swelling, can be selected in below table, where main parameters are listed.
For each standard, proper gas mix line should be included in the control panel and proper program, able to automatically drive the test, should be embedded.
Moreover, auxiliary devices as continuous weighing system and tumbler can be provided

STANDARDS	Test Temperature (C°)	Reduct. Time (min.)	Sample Mass (g)	Reaction Gas MIX	Reaction Gas Mix composition (%)				Gas MIX Flow rate (nl/min)	N_2 Purge gas Flow rate (nl/min)			Needed Devices		
					N_2 %	CO %	CO_2%	H_2 %		warm up	soaking	cooling	Continuous Weight Gauge	Tumbler TB 3000	Volume Gauge
Iron ore samples															
ISO 11258 (R40 R90) Reducibily Direct Reduction	800	90	500	Mix F	10	30	15	45	50	25	50	25	Yes	-	-
ISO 4695 (RI) Reducibility Index	950	max 240	500	Mix C	60	40	-	-	50	25	50	5	Yes	-	-
ISO 4696-1 (RDI-1) Disintegration Index	500	60	500	Mix A	58	20	20	2	20	5	20	5	-	Yes	-
ISO 4696-2 (RDI-2) Reduction Degradation	550	30	500	Mix B	70	30	-	-	15	5	15	5	-	Yes	-
ISO 4698 (FS) Free Swelling	900	60	18 pellets	Mix B	70	30	-	-	15	10	15	5	-	-	Yes
ISO 7215 (R180) Relative Reducibility	900	180	500	Mix B	70	30	-	-	15	5	15	5	Yes	-	-
ISO 8371 (DI) Decrepitation	700	30	500	--	-	-	-	-	-	-	-	-	-	-	-
IS 10823 Sect.1B-Static Relative Reducibility	500	60	500	Mix B	70	30	-	-	20	10	20	5	option	Yes	-
IS 11292 Relative Reducibility	900	180	500	Mix B	70	30	-	-	15	5	15	5	Yes	-	-
IS 8167 Reducibility	950	max 180	500	Mix B	70	30	-	-	50	5	15	5	Yes	-	-
IS 8624 Swelling	900	60	18 pellets	Mix B	70	30	-	-	15	10	15	5	-	-	Yes
Coke samples (*)															
ISO 18894, ASTM D 2639, IS 4023 meth.B for CRI CSR	1100	120	200	CO_2			100		5	10	10	10	-	Yes	-

(*) MM 6000 can be also equipped with proper hardware and software to run CRI-CSR Test as per ISO 18894, ASTM D 5341 and IS 4023.

Pellets Volume Measuring Device VM 6000

According to the specification in the standard procedure ISO 4698 (Swelling test), the Pellets Volume measuring device allows to perform the measurement of the volume of iron ore pellets before and after the thermal tests.
The equipment consists in liquid bath vessel in which the 18 pellets are placed. A graduated scale gives the value of the volume of pellets with a resolution of 0,1ml.



MM 6000 Test Printing Tool

Printing Tool - PC Software

The Printing Tool is a Windows© software that allows to print, save and store all data of performed tests.
At the end of the test procedure, a new file is stored in the external memory USB stick.
Test results are displayed in both text and graphical format. A spreadsheet layout is also available.
The printing feature of the Software allows to print out the test results as prescribed in the ISO procedures.

MM 6000 Specifications

OVEN	
Maximum operating Power:	20 kW
Max operating temperature:	1200 °C
Heating Zones:	5 heating zones
Heating elements:	Silicon carbide elements (20 elements)
External thermocouple:	"K" type (inconel shielded)
Inner chamber diameter:	140 mm
REACTION TUBE	
Reaction tube type :	"Single wall" Type C
Material:	AISI 310
Inner diameter:	75 mm
Internal thermocouple:	Triple "K" type (inconel shielded)
GAS CONTROL UNIT	
Flow rate measuring devices:	Digital Mass Flow Meters
SAMPLE WEIGHING UNIT	
Max weight:	30 kg
Resolution:	0,1 g
MAIN POWER:	380 V 3 Ph + Neutral (20 kW max)

Tumbler system TB 3000

According to ISO 4696-1, ISO 4696-2, IS 10823 and IS 8167, the sample is tumbled after the reaction in the oven.
Number of revolutions is pre-set on a digital counter showing remaining revolutions to the end of tumbling.
Automatic stop at end of test is provided. The units are protected by a safety cage with switch on the door.
Please refer to the Tumbler System product page for further information.

Static Multistandard Test System SM 4000

For tests according to Standards to be selected among the following:
ISO 4696-1, ISO 7215, ISO 4696-2, ISO 4698, ISO 8371, IS 10823, IS 11292, IS 8624

General description

The system is designed to perform tests on iron raw material as ore pellets, lumps, sinter etc. according to several Standards.
All Test procedures can be performed by same oven and same control system, equipped with proper gas flowmeters and proper temperature programs.
Vertical oven is based on 5 separate heating zones with individual temperature control systems and is driven by means of solid state power units and temperature controllers and programmers.
Reaction tubes, made in high temperature alloys, include multiple thermocouples and gas inlet and outlet fittings, providing Standard test conditions.
The Oven can be equipped with a continuous weighing device showing and recording sample weight on digital display and logging unit.
The system needs to be feed by proper premixed reaction gas blends and pure nitrogen in bottles stack provided at customer care.

SM 4000 features:
- Accuracy of test temperature during reaction time
- Isothermal temperature distribution in the sample
- High accuracy of gases flow control
- Accuracy of sample weight (resolution 0.1 g)

SM 4000 automatic operations:
- Automatic temperature time profile control
- Gases input timing
- Gases flow rate control by mass flow meters
- Continuous monitoring of sample weight

STANDARDS	Test Temperature (C°)	Reduct. Time (min.)	Sample Mass (g)	Reaction Gas MIX	Reaction Gas Mix composition (%)				Gas MIX Flow rate (nl/min)	N_2 Purge gas Max Flow rate (nl/min)	Needed Devices		
					N_2 %	CO %	CO_2%	H_2 %			Continuous Weight Gauge	Tumbler TB 3000	Volume Gauge
Iron ore samples													
ISO 4696-1 (RDI-1) Disintegration Index	500	60	500	Mix A	58	20	20	2	20	20	-	Yes	-
ISO 4696-2 (RDI-2) Reduction Degradation	550	30	500	Mix B	70	30	-	-	15	15	-	Yes	-
ISO 4698 (FS) Free Swelling	900	60	18 pellets	Mix B	70	30	-	-	15	15	-	-	Yes
ISO 7215 (R180) Relative Reducibility	900	180	500	Mix B	70	30	-	-	15	15	Yes	-	-
ISO 8371 (DI) Decrepitation	700	30	500	--	-	-	-	-	-	-	-	-	-
IS 10823 Sect.1B-Static Relative Reducibility	500	60	500	Mix B	70	30	-	-	20	20	option	Yes	-
IS 11292 Relative Reducibility	900	180	500	Mix B	70	30	-	-	15	15	Yes	-	-
IS 8624 Swelling	900	60	18 pellets	Mix B	70	30	-	-	15	15	-	-	Yes
Coke samples (*)													
ISO 18894, ASTM D 2639, IS 4023 meth.B for CRI CSR	1100	120	200	CO_2			100		5	10	-	Yes	-

(*) SM 4000 can be also equipped with proper hardware and software to run CRI-CSR Test as per ISO 18894, ASTM D 5341 and IS 4023.

Control Panel

Control panel includes complete top quality control and monitoring instrumentation. Temperature of sample is driven by digital programmer and by multiloop digital controller to obtain best isothermal test condition.
A temperature alarm controller assures oven safety cutting off power in case of over temperature. Automatic inlet of Nitrogen reaction gas are provided according to temperature program. Gas flow control is obtained by digital mass flow meter for reaction gas and by a rotameter for N2 (as option a mass flow meter also for N2 is included).
Manual gas control is also possible for checking purpose. Optional weighing system allows continuous monitoring of sample weight. A Touch screen recorder and data logger, and Ethernet connection, provide local and remote recording of test data.

SM 4000 Specifications

OVEN	
Maximum operating Power:	20 kW
Max operating temperature:	1200 °C
Heating zones :	5 heating zones
Heating elements:	Silicon carbide elements (20 elements)
External thermocouple:	"K" type (inconel shielded)
Inner chamber diameter:	140 mm
REACTION TUBE	
Reaction tube type :	"Single wall" Type C
Material:	AISI 310
Inner diameter:	75 mm
Internal thermocouple:	Triple "K" type (inconel shielded)
GAS CONTROL UNIT	
Flow rate measuring devices:	Digital Mass Flow Meters
SAMPLE WEIGHING UNIT	
Max weight:	30 kg
Resolution:	0,1 g
MAIN POWER:	380 V 3 Ph + Neutral (20 kW max)

Tumbler system TB 3000

According to ISO 4696-1, ISO 4696-2, IS 10823 and IS 8167, the sample is tumbled after the reaction in the oven.
Number of revolutions is pre-set on a digital counter showing remaining revolutions to the end of tumbling.
Automatic stop at end of test is provided. The units are protected by a safety cage with switch on the door.
Please refer to the Tumbler System product page for further information.

Load Reduction tests system LR 8000

The system operates according to one, two or three tests to be chosen among the following: RUL ISO 7992, Clustering ISO 11256, Sticking Tenova HYL

General description

LR 8000 system is an automatic equipment able to operate the tests on iron ore and similar raw materials according to standards ISO 7992 (RUL), ISO 11256 (Clustering) and HYL Sticking.
Determination of Reduction is performed under mechanical Load and it is an iron ore testing method where a sample is isothermally reduced in a fixed bed, at a fixed temperature using proper reducing gas Mix., until a prefixed degree of reduction is obtained.
The equipment is based on a Control Cabinet connected with a vertical oven able to heat the reaction tube at test temperature, controlled by thermocouples placed in the oven wall and inside the reaction tube.
The test process is driven by a PAC unit (Programmable Automation Controller) with an I/O unit devoted to handle inputs and outputs from the probes and transducers of the system.
A Touch Screen user interface provides for a friendly guided instruction before starting the test and gives on-screen information about the status of the system as well as main test parameters during the run of the test.
Test results are available On-Screen and also on an external memory unit (USB) for storage, print and post processing purposes. The printing feature of the provided PC Software allows to print out the test results as prescribed in the Standards.

Vertical Oven

The system is equipped with an Electric Vertical oven of about 12 kW maximum power. The oven design includes 3 horizontal heating zone. Each heating zone is constituted by silicon carbide heating elements electrically connected in series. A quartz tube is placed inside the oven to avoid any contact between the reaction tube and the heating elements. An external alarm thermocouple is placed in the refractory wall to monitor the oven temperature. This thermocouple is connected to the safety temperature circuit in order to avoid any over temperature. The maximum allowed temperature is set to 1200 °C. The vertical electric oven is equipped with a precision weighing system with a resolution of 0,1 g and a full scale value of 32 kg.

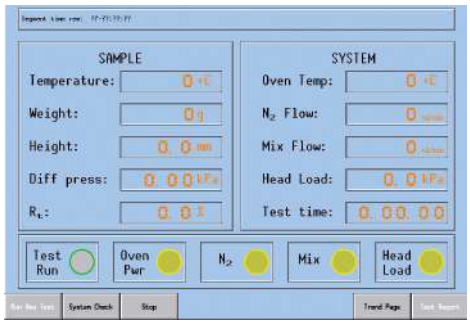
LR 8000

Control Cabinet

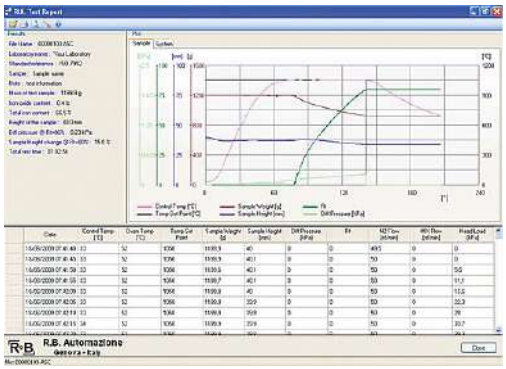
The Control Cabinet is equipped with a PAC unit (Programmable Automation Controller) and Touch-Screen Control System with specific software designed in order to comply with different standards. Recording and Data Logging of all main system variables is available on external memory drive (USB). All the messages, alarms and information on the status of the system are displayed on the Touch Screen unit.
The Touch Screen Unit is directly connected to the I/O Unit where all the signals, coming from the measuring instruments, are collected and processed. The main Page (Home Page) displays the complete information about the status of the system and the following process variables:

- Sample temperature
- Sample weight
- Sample height
- Differential pressure on sample bed
- Degree of reduction Rt
- Oven temperature
- Nitogen (purge gas) flow rate
- Reacting gas Mix flow rate
- Loading pressure over the sample
- Total Test time from the start of the reaction

All these variables are available also in a graphic format in which all parameters are displayed vs. time.



RUL Test System – Home Page



RUL Test Printing Tool

Printing Tool - PC Software

The Printing Tool is a Windows© software that allows to print, save and store all data of performed tests.
At the end of the test procedure, a new file is stored in the external memory USB stick.
Test results are displayed in both textual and graphical format. A spreadsheet layout is also available.
The printing feature of the Software allows to print out the test results as prescribed in the ISO procedures.

STANDARDS	Test Temperature (C°)	Reduct. Time (reduction %)	Sample Mass (g)	Reaction Gas MIX	Reaction Gas Mix composition (%)				Gas MIX Flow rate (nl/min)	N_2 Purge gas Flow rate (nl/min)			Max sample (m bar)	Max sample height (mm)	Sample loading (kg)	Tumbler TB 7000
					N_2 %	CO %	CO_2 %	H_2 %		warm up	soaking	cooling				
ISO 7992 Reduction Under Load	1050	up 80% red. max 240 min.	1200	Mix D	58	40	-	2	83	50	83	5	20	75	100	-
ISO 11256 Clustering	850	up 95% red.	2000	Mix F	10	30	15	45	40	20	40	20	-	-	250	Yes
TENOVA HYL Sticking	950	up 90% red.	1200	Mix S	10	21	14	55	55	10-15	30	30	-	-	-	-

LR 8000 Specifications

OVEN	
Maximum operating Power:	12 kW
Max operating temperature:	1200 °C
Heating Zones:	3 heating zones
Heating elements:	Silicon carbide elements (12 elements)
External thermocouple:	"K" type (inconel shielded)
Inner chamber diameter:	180 mm
REACTION TUBE	
Reaction tube type :	"Double wall" type
Material:	AISI 310
Inner diameter:	125 ± 1 mm (110 mm for Sticking)
Internal thermocouple:	"K" type (inconel shielded)
GAS CONTROL UNIT	
Flow rate measuring device:	Digital Mass Flow Meter
SAMPLE WEIGHING UNIT	
Max weight:	30 kg
Resolution:	0,1 g
MAIN POWER:	380 V 3 Ph + Neutral (12 kW max)

Dynamic Reducibility test system DR 7000

The system operates according to one, two or three tests to be chosen among the following: LTD ISO 13930, RDI-DR ISO 11257, IS 10823 Sec. 2

General description

DR 7000 system is designed to operate dynamic test according to three different standards:

- ISO 13930 Dynamic test for low-temperature reduction-disintegration - LTD
- ISO 11257 Determination of the low-temperature reduction RDI-DR
- IS 10823 sec. 2 Reduction Degradation

The equipment is based on an electric horizontal oven including two half cylindrical heating elements where the rotating reaction tube is placed.
The control cabinet provides for temperature, gases flow rates and tube rotation motor control.
From experiences of several laboratories involved in these tests, it has been pointed out that results reliability greatly depends on temperature and reaction gas flow rate accuracy, therefore electronic mass flow meter and high quality temperature controller are supplied.
The system needs to be feed by proper premixed reaction gas blends and pure nitrogen in bottles stack provided at customer care.

DR 7000 Dual Version

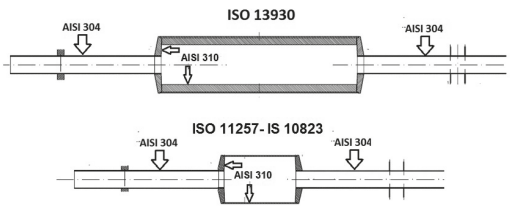
DR 7000

Horizontal Oven

The electric oven consists of a steel structure placed on a basement and including the heating elements and insulation material.
The rotation at the proper revolution speed is provided by means of a gear motor placed inside the basement. A dust separator is placed at the end of gas line in order to collect dust and powdered matter coming from rotating tube.

Control Cabinet

Control Cabinet includes complete top quality control and monitoring instrumentation.
Temperature of sample is driven by digital programmer and controller to obtain best isothermal test condition. A temperature alarm controller assures oven safety cutting off power in case of over temperature.
Automatic inlet of Nitrogen and Reaction gas is provided according to temperature program. The power to the gear motor is also automatically supplied. Gas flow control is obtained by a digital mass flow controller for reaction gas and by a rotameter for N_2 (as option a mass flow meter also for N_2 is included). Manual gas and motor control is also possible for checking purpose.
A Touch screen recorder and data logger, and Ethernet connection, provide local and remote recording of test data.



Reaction Tubes

Reaction Tubes

Reaction tube is manufactured according to ISO Standard dimensions and materials: all parts operating at high temperature are made of heat resistence Stainless Steel to obtain long tube life.
Internal lifters, as required by the standard, are placed inside the tube. A gear wheel on the reaction tube gives the rotation in connection with the geared motor in the basement. Two heat diffusers are placed at the end of the tube in order to reduce temperature of outlet gas flow.

STANDARDS	Test Temperature (C°)	Reduct. Time (min.)	Sample Mass (g)	Reaction Gas MIX	Reaction Gas Mix composition (%)					Gas MIX Flow rate (nl/min)	N_2 Purge gas Max Flow rate (nl/min)	Rotation Speed RPM	Vessel Legth mm	Vessel Diameter mm	Vessel Lifters N.
					N_2 %	CO %	CO_2 %	H_2 %	CH_4 %						
ISO 13930 (LTD) (Low Temperature reduction-Disintegration)	500	60	500	Mix A	58	20	20	2	-	20	20	10 ± 0.2	540	150	4
ISO 11257 (RDI-DR) (Reduction-Disintegration)	760	300	500	Mix E	-	36	5	55	4	13	13	1 0 ± 1.	200	130	-
IS 10823 sect.2 (RDI) (Dynamic Reduction Degradation)	550	60	500	Mix B	70	30	-	-	-	15	3	10 ± 0.5	200	130	4

DR 7000 Specifications

OVEN	
Max operating temperature:	780 °C
External thermocouple:	"K" type Inconel shielded
REACTION TUBES	
Material:	Stainless steel AISI 310
Internal thermocouple:	"K" type Inconel shielded
GAS CONTROL UNIT	
Flow rate measuring devices:	Mass Flow meters
MAIN POWER:	220 V + Neutral (6 kW max)

Tumblers TB 7000, TB 5000, TB 3000

General description

Tumbler Systems are able to mechanically test samples of coke, coal, iron ore, iron ore pellets according to several standards.
These systems are electro-mechanical units where the sample is placed to be tumbled at specific revolution speed for a specific number of revolutions.
The above mentioned test conditions together with the dimension of the tumbling unit are prescribed in the standards.
The mechanical units are provided with high quality gear motors and safety cages to comply with the common safety rules in use. A switch is installed on the door of the cage to immediately stop any rotation of the tumbler in case of opening of the cage during the run of the test.
On TB 7000 units, a positioning function allows to rotate the tumbler at slow speed to help the operator on loading and unloading of the sample in the tumbler. The control cabinet connected to the mechanical unit is equipped with a pre-set counter to set up the number of revolutions at which automatically the test is stopped.

TB 7000

ASTM D 3402, ISO 3271, ISO 11256, ASTM E 279, ISO 556, IS 6495, IS 1354

Tumbler device for coke, iron ore and sinter.
Geared motor unit driven by frequency converter.
Number of revolutions is pre-set on a digital counter showing remaining revolutions to the end of tumbling.
Automatic stop at end of test is provided.
The unit is protected by a safety cage surrounding the equipment with an opening door.
A safety switch is provided on the cage door.
The Equipment can be supplied in different configuration according to the specific standard requirement (see table below).

Specification:

Drums int. dimensions	Diameter: 1000 or 910 or 914 mm Width: 500 or 455 or 457 or 1000 mm
Revolution speed:	24 ± 1 or 25 ± 1 R.P.M.
Revolutions pre-set:	1 ÷ 99999
Supply:	230 V 50/60 Hz

TB 7000

	TB 7000-A	TB 7000-B	TB 7000-C	TB 7000-D	TB 7000-E
Standard	ASTM D 3402	ISO 3271 ISO 11256 IS 6495	ASTM E 279	(Micum /Irsid Test) ISO 556 IS 1354	(Half Micum Test) ISO 556 IS 1354
Sample	Coke	Iron ores	Iron ore pellets	Coke	Coke
Internal diameter	910mm	1000mm	914mm	1000mm	1000mm
Internal width	455mm	500mm	457mm	1000mm	500mm
No. of lifters	2	2	2	4	4
Revolution speed	24 ± 1	25 ± 1	24 ± 1	25 ± 1	25 ± 1

TB 5000

ASTM D 5341, ISO 18894, IS 4023

Tumbler device for CSR test consists of a wall mounting double drum system. This configuration allows to perform two sample tests at the same time. Automatic stop at end of test is provided. The unit is protected by a safety cage with switch on the door. Variable frequency drive (TB 5000 –ISO). Number of revolutions pre-set on a digital counter showing remaining revolutions to test end.
Automatic stop at end of test is provided. The unit is protected by a safety cage with a safety switch on the door.

Specification:

Drums int. dimension:	Ø 130 x 700 mm
Revolution speed:	20 R.P.M.
Revolution speed accuracy (ASTM D 5349):	± 1 RPM
Revolution speed accuracy (ISO 18894):	± 0. 1 RPM
Revolutions pre-set:	1 ÷ 99999
Supply:	230 V 50/60 Hz

TB 5000

TB 3000

ISO 4696-1, ISO 4696-2, IS 10823

Tumbler device for Reduction Disintegration tests consists of a table double drum system.
This configuration allows to perform two sample tests at the same time.
Number of revolutions is pre-set on a digital counter showing remaining revolutions to the end of tumbling.
Automatic stop at end of test is provided.The unit is protected by a safety cage with switch on the door.

Specification:

Drums int. dimension:	Ø 130 x 200 mm
Revolution speed	30 ± 1 R.P.M.
Revolutions pre-set :	1 ÷ 99999
Supply :	230 V 50/60 Hz

TB 3000

Accessories and options

Reaction tube lifting tackle

- For insertion and removing of the reaction tubes
- Vertical electric movement
- Two controlled speeds – low / fast movement
- Manual horizontal movement on rail
- Max. weight 60 kg
- Remote control
- Rail included
- Power 230 V 50 Hz

Reaction Tube Tripods

Models:

- TR 2000 – For CRI, MM 6000, SM 4000 reaction tubes
- TR 4000 – For LR 8000 reaction tubes

Reaction Tube Cooling Devices

- Digital Temperature controller
- Ventilation Fan
- Auto stop at preset temperature
- Power 230 V 50 Hz

Models:

- CS 2000 – For CRI, MM 6000, SM 4000 reaction tubes
- CS 4000 – For LR 8000 reaction tubes

Sample Preparation Devices

Jaw Crusher

Mouth opening 100 x 60 mm
Jaw opening 10 - 25 mm
Capacity about 120 kg/h (coke)
Power: 0.75 kW, 380 V, 50 Hz, 3 Ph
Dimensions: mm 950 x 450 x 550(h)
Net weight: 90 kg

Code: PD - JC

Sample Splitter

Stainless steel sample splitters
Complete with 3 sample pans
No. chutes: 8
Channel opening width: mm 50
Sample max dimension: mm 40
Sample capacity: dm^3 14
Net weight: kg 23

Code: PD - SS

Testing Screen Machine

High capacity mechanical screen shaker
Capacity about 30 litres of sample
Power: 250 W, 220 V, 50 Hz, 1 Ph
Dimensions: mm 584 x 787 x 850(h)
Net weight: 170 kg

Code: PD - TM

Screening Trays

For testing screen machine PD-TM
Square mesh different opening
Dimensions: mm 457 x 660 x 75
Net weight: 9 kg

Code: PD - ST

Sieving Machine

Motorised sieve shaker - digital set up
For 200 / 300 mm diameter sieves
Sieve capacity n. 7 + bottom pan
Approx dimensions: 540 x 400 x 1100 (h)
Power: 250 W, 220 V, 50 Hz, 1 Ph
Net weight: 75 kg

Code: PD - SM

Sieves

For sieving machine PD-SM
Square meshes different opening
Dimensions: Diameter mm 300
Net weight: 0.5 kg

Code: PD - SV

Thermostatic Oven

Internal volume: 66 l
Display: digital
Temperature controller: PID
Temperature range: +50 ÷ +250
Internal walls: stainless steel
Power: 220 V - 1.8 kW

Code: PD - TO

Laboratory Digital Scale

Weighing range: 7.5 kg
Sensivity - Resolution: 0.1 g
Platform dimension: diameter 233 mm
Power: 220 V

Code: PD - DS

Standard Reference List

ISO International Organization for Standardization		page
ISO 10329	Coal -- Determination of plastic properties -- Constant-torque Gieseler plastometer method	2
ISO 11256	Iron ore pellets for shaft direct-reduction feedstocks -- Determination of the clustering index	18,22
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ISO 11258	Iron ores for shaft direct-reduction feedstocks -- Determination of the reducibility index, final degree of reduction and degree of metallization	12
ISO 13930	Iron ores for blast furnace feedstocks -- Determination of low-temperature reduction-disintegration indices by dynamic method	20
ISO 18894	Coke -- Determination of coke reactivity index (CRI) and coke strength after reaction (CSR)	6
ISO 23873	Hard coal -- Method for the measurement of the swelling of hard coal using a dilatometer	4
ISO 3271	Iron ores for blast furnace and direct reduction feedstocks -- Determination of the tumble and abrasion indices	22
ISO 349	Hard coal -- Audibert-Arnu dilatometer test	4
ISO 4695	Iron ores for blast furnace feedstocks -- Determination of the reducibility by the rate of reduction index	12
ISO 4696-1	Iron ores for blast furnace feedstocks -- Determination of low-temperature reduction-disintegration indices by static method -- Part 1: Reduction with CO, CO2, H2 and N2	12, 16
ISO 4696-2	Iron ores for blast furnace feedstocks -- Determination of low-temperature reduction-disintegration indices by static method -- Part 2: Reduction with CO and N2	12, 16
ISO 4698	Iron ore pellets for blast furnace feedstocks -- Determination of the free-swelling index	12, 16
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ISO 556	Coke (greater than 20mm in size) - Determination of mechanical strength	22
ISO 7215	Iron ores for blast furnace feedstocks-- Determination of the reducibility by the final degree of reduction index	12, 16
ISO 7992	Iron ores for blast furnace feedstocks -- Determination of reduction under load	18
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DIN Deutsches Institut für Normung

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DIN 51739	Determining hard coal Dilatation	4

ASTM American Society for Testing and Materials

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ASTM D 5341	Standard Test Method for Measuring Coke Reactivity Index (CRI) and Coke Strength After Reaction (CSR)	6
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IS 8167	Determination of reducibility index of iron ore oxides, lump ores, sinter and Pellets	12
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IS 8624	Method for determination of swelling index of iron ore Pellets (mtd 13: ores and raw materials)	12, 16
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