Elastocon®

Ageing Ovens

for high precision ageing of rubber and plastic materials

Elastocon have developed and produced high precision ageing cabinets and cell ovens for ageing of polymer materials since 1987.

Benefitting from this long experience our ageing ovens represent a major step forward in the design of such instruments.

Elastocon manufactures a range of ageing ovens for precision ageing of rubbers and plastics under controlled conditions. Our ovens conform to ISO 188, IEC 811 and other ageing standards. Some of the standards are mentioned in the technical specifications.

The ovens are designed to give very low temperature variations in time and space, low or high air speed and controlled air exchange rate. Good control of temperature, air speed and air exchange rate have been shown to be very important to achieve good repeatability and reproduceability when doing heat ageing tests of polymer materials.

Research done in Sweden shows that the air speed is a very important factor, influencing the ageing results by increased evaporation of softeners and antioxidants and by increased oxidation at higher air speeds.

Elastocon ageing ovens have a low air speed, dependant of the air exchange rate only, or specified high air speed (1 m/s) to allow tests to be performed investigating the influence of air speed.

Cabinet oven EB 04-II *with air supply that requires external air and a flow meter that can be set between 3 to 20 changes per hour.*

Cell oven EB 20 *equipped with 6 cells, each with individual temperatures, and flow meters that can be set between 3 to 20 changes per hour.*

Elastocon AB • Tvinnargatan 25 • SE-507 30 Brämhult • Sweden
Phone: +46 33 323 39 00 • E-mail: info@elastocon.se • www.elastocon.com

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Specified requirements for ageing ovens

Ageing ovens is a standardized expression with very well specified requirements for different features that has been proven to be important to have a reliable ageing especially for polymeric materials. Studies have shown the importance of the control of:

- Temperature variations in time
- Temperature variations in space
- Air speed inside the oven
- Air exchange rate and also the presence of the same

The temperature accuracy is very important for heat ageing tests, as a 1 °C error in temperature corresponds to around 10 % error in test time.

Requirement	High precision ageing ovens	Laboratory ovens
Temperature accuracy in time	Yes, high requirements	Yes
Temperature accuracy in space	Yes	No
Specified air speed	Yes	No
Specified air direction	Yes	No
Specified air exchange rate	Yes	No
Specified extra temperature sensor	Yes	No

Comparison of cell ageing ovens and cabinet ageing ovens

	Cell Ageing Ovens	Cabinet Ageing Ovens
Inner volume	Smaller, 100 × 300 mm	Bigger, from 50 up to 120 litres
Suitable for samples, e.g. Dumb-bells	Yes	Yes
Suitable for products	No	Yes
Temperature accuracy in the whole inner space	Yes	Yes
Air speed	Fulfils standard requirements	Fulfils standard requirements
Air exchanges per hour	3–20 changes/hour, adjustable with air flow meter, with individual control for each cell	3–200 changes/hour, adjustable with air flow meter or fixed during production depending on model
Numbers of different temperatures	1–6 (each cell can have their own individual temperature and therefore works as separately ovens)	1
Numbers of different materials that can be aged simultaneous	1–6	1 (you shouldn't have different materials in the same space, they might interfere with each other)
Option for turbulent air flow	Yes, with an additional air stirrer in the bottom of the cells	Yes, EB 26 has a carousel that enables turbulent air flow and higher air speed

Cabinet Ageing Ovens

Cabinet Ovens with excellent temperature stability and distribution achieved by using an inner chamber with a controlled air flow.

These ovens are ideal for ageing finished products and large test pieces of rubber and plastic, which are unsuitable for cell ovens.

Both shelves and rods are supplied with these ovens for accommodating most types of samples. The settings are done on the PLC colour touch screen.

All Elastocon ageing ovens have two temperature instruments, one for controlling the temperature and one for indicating the temperature close to the samples.

Cabinet Oven EB 04-II has low air speed and a flow meter that can be set between 3 to 20 changes per hour, which meets the requirements in ISO 188 method A. It also performs well inside the apparatus requirements in IEC 60811-1-2, IEC 60216-4-1 and other equivalent standards.

The air supply for EB 04-II requires external air. Elastocon offers a silent air compressor, EA 01, if compressed air is missing. EB 04-II has 120 litres useful volume.

EB 10-II has low air speed and a factory set throttle to give a fixed air exchange rate of 7 or 14 changes per hour, which meets the requirements in ISO 188 method A. It also performs well inside the apparatus requirements in IEC 60811-1-2, IEC 60216-4-1 and other equivalent standards.

EB 10-II has 60 litres useful volume.

Cabinet Oven EB 12-II has high air speed with laminar flow from bottom to top, and a factory set throttle to give a fixed air exchange rate of 7 or 14 changes per hour, which meets the requirements in ISO 188 method B.

EB 12-II also performs well inside the apparatus requirements in ISO 4577 and DIN 53508 P.6.2. The useful volume is 50 litres.

The option EB 04IIW – four pane glass window – can be combined with the option EB 04-IIDS – a door sensor that turns off fan and heating when the door is opened.

All Elastocon ageing ovens have two temperature instruments, one for controlling the temperature and one for indicating the temperature close to the samples.

Cabinet Ageing Ovens

In addition to the carousel the EB 26HT cabinet oven is also equipped with a window in the door, lighting inside the chamber and a door sensor that turns off the fan, heating and carousel when the door opens.

The temperature range is +40 °C to +300 °C.

EB 26HT has high air speed and a fixed air exchange rate of 7 or 14 changes per hour, which meets the requirements in ISO 188 method B.

This oven has a carousel for simple and fast mounting of the samples. The carousel – which rotates during ageing – has room for up to 36 samples. The useful volume is 50 litres.

Rack for ageing ovens, ERACK11. The two lower shelves are extendable and are suited for cell ageing ovens EB 01-II, EB 19 or EB 20. On top is a fixed shelf for ageing cabinets.

EB 27 has 2 flow meters to cover the exchange rates between 3 to 200 changes per hour, but still with low air speed inside the chamber. The oven meets the requirements in ASTM D5423 type 1 and 2, ASTM E145 type IIA and ASTM D573. The useful volume is 120 litres.

Cell Ageing Ovens with four or six cells

The cell ageing ovens are manufactured in 4 or 6 cell configurations, and are available with either single temperature controller or multiple (individual) cell controllers.

The cell ageing ovens have a special design with controlled air exchange rate and low air speed, and meet the requirements in ISO 188 method A, IEC 60811-401, IEC 60216-4-3 and DIN 53508 p. 6.4.

Different cell oven models

EB 01-II 4 cells, one temperature for all cells, +40 to +200 °C

EB 19 4 cells, individual temperature for each cell, +40 to +200 °C

EB 19HT 4 cells, individual temperature for each cell, +40 to +300 °C

EB 20 6 cells, individual temperature for each cell, +40 to +200 °C

EB 20HT 6 cells, individual temperature for each cell, +40 to +300 °C

The cell oven EB 20 equipped with 6 cells, each with individual temperatures and flow meters.

All ageing ovens are controlled from a PLC with a colour touch screen.

EB 01-II and EB 19 have the same appearance and are equipped with 4 cells, with individual flow meters for each cell.

EB 01-II has one temperature for all cells, and EB 19 has individual temperatures for each cell.

Sample Holder
– one holder per cell is included with the cell ovens.

Test Tube Ovens

EB 11-II with 24 test tubes.

EB 28HT with 4 × 6 test tubes and four temperatures.

To the right:
Option EB 11.04 for the test tube ovens – water cooled condensors when testing volatile liquids.

Test tube ovens EB 11-II and EB 28HT are designed for ageing tests according to ASTM D 865 Rubber-Deterioration by Heating in Air (Test Tube Enclosure). The ovens can also be used for testing in liquids according to ASTM D 471 and ISO 1817 Effect of liquids. Glass tubes for both standards are included.

Glass tubes for air cooling are included and water cooling can be supplied as an option.

Accessories for Elastocon's Ageing Ovens

Insert for ASTM

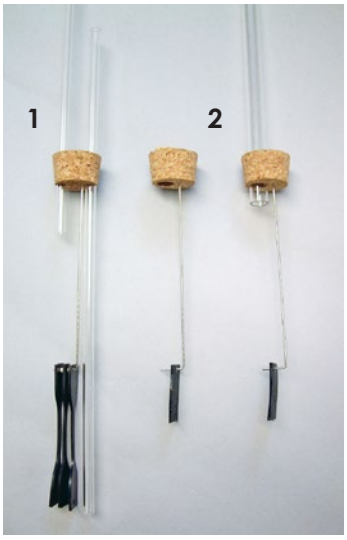
The insert EB 07.01 has three test tubes for testing according to ASTM D865 Heat Ageing and ASTM D471 Testing in liquids, and fits EB 19 and EB 20.

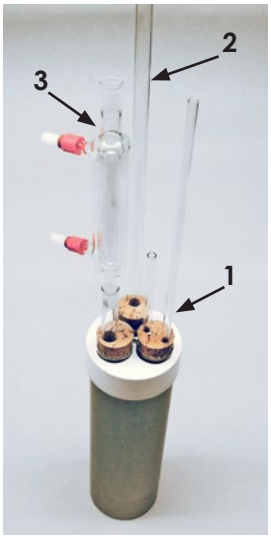
The glass tubes can be supplied with a grounded joint for a stopper or for a water cooler.

The glass tube system is also very suitable for testing in liquids according to ISO 1817.

The images on the right show three configurations.

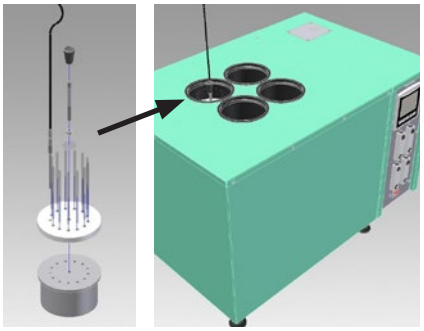
1. *ASTM D865 Heat ageing*
2. *ASTM D471 Liquids with air cooler (with and without glass tube in the first image)*
3. *ASTM D471 Liquids with water cooler (optional)*





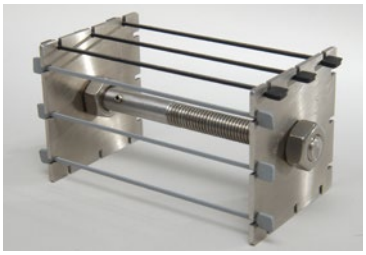
Right: Stand EB 01.01 is a stand to support the sample holder for cell ageing ovens while mounting test pieces for ageing.

Elastocon offers a test tube rack, EB 31, with room for 15 test tubes. The rack is perfect for our test tube ovens.



Left:
Insert for Heat Stability test, EB 07.02
Insert for cell ovens for testing of Heat Stability of PVC according to IEC 60811-405.

Compression Set Rig EV 03, according to ISO 815-1.



Tension Set Rig EV 04, according to ISO 2285.

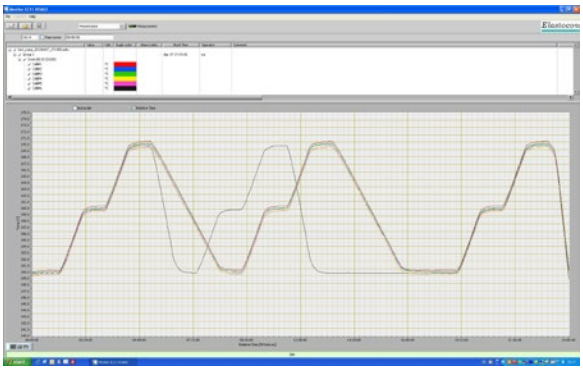
Monitoring oven temperatures

Monitor Plus EC 11 is a software for recording data from different sensors, measuring e. g. temperature, humidity, force, pressure.

In the software it is possible to set alarm limits. The software has three main windows, one to see actual temperature values and corresponding curves, one for comparing historical data and one for setting the communication with the amplifiers.

Connection to Elastocon's ovens to record the temperature, is done by an Ethernet cable to your local network.

Sensors for temperature, humidity, pressure, displacement, V, mA etc are connected to a data box with amplifiers. Each data box can have 1 to 24 inputs for different sensors. One or more data boxes are connected via a network connection to a computer running the Monitor Plus software. Several data boxes can be situated in different rooms and be connected to the logging computer via the company network.



EC 11.01 is a viewer software making it possible to view the results from any computer in the network.

Technical specifications, Cabinet Ageing Ovens

	EB 04-II	EB 10-II	EB 12-II
Temperature range, °C:	+40 to +200	+40 to +200	+40 to +200
HT-version, °C:	+40 to +300	+40 to +300	+40 to +300
Temp. control, +40 to +100 °C, °C:	±0,5	±0,5	±0,5
+101 to +200 °C, °C:	±1,0	±1,0	±1,0
+201 to +300 °C, °C:	±1,5	±1,5	±1,5
Temp.variation in time,°C:	±0,25	±0,25	±0,25
Temp.variation in space, %:	±0,5	±0,5	±0,5
Temperature sensors:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
Air speed, m/s:	<0,001	<0,001	1± 0,5
Air changes, changes/hour:	3 to 20	7 or 14*1	7 or 14*1
Useful volume, l:	120	60	50
Dimensions, inner, w × h × d, mm:	550 × 550 × 400	450 × 450 × 300	450 × 450 × 250
Dimensions, external, w × h × d, mm:	910 × 820 × 720	810 × 720 × 620	810 × 720 × 620
Dimension, window, 4 glass, mm:	200 × 300 (option)	200 × 300 (option)	200 × 300 (option)
Illumination of the inner chamber:	24 V, 10 W halogen*2	24 V, 10 W halogen*2	24 V, 10 W halogen*2
Sample rod positions:	24	15	15
Sample rods:	12	10	15
Shelf positions:	3	3	–
Shelves:	2	2	–
Weight, kg:	115	86	91
Voltage, V/phase/freq:	220–240/1/50–60	220–240/1/50–60	220–240/1/50–60
Power, W:	3100	2 100	2 200
Connections:	Compressed air	–	–
Standards:	ISO 188 method A, IEC 60811-1-2, IEC 60216-4-1	ISO 188 method A, IEC 60811-1-2, IEC 60216-4-1	ISO 188 method B, ISO 4577, DIN 53508 P.6.2

**1 preset by manufacturer*
**2 only available with the window option*

Note: *EB 04-II needs connection to dry and clean compressed air for the air exchange. The air speed is low and is dependent on the air exchange rate only, as specified in ISO 188, method A and IEC 811.*

The air speed is low and is dependent on the air exchange rate only, as specified in ISO 188, method A and IEC 811.

High and laminar air speed as specified in ISO 188, method B.

Common specifications:

- Controlled from a PLC with a colour touch screen.
- Special design with controlled air exchange rate and low or high air speed.
- The casing consists of steel, powder coated in a bluegreen colour.
- The inner chamber is made of stainless steel.
- Temperature controller with 0,1°C setpoint (PLC).
- Solid state relay for safe control.
- Temperature indicator with sensor in the inner chamber.
- Fixed over temperature fuse.
- Cooling channels in the casing for low surface temperature.
- Controlled cooling fan for the electronics cabinet.
- Alarm history.
- Indication of power failure (PLC).
- Test names can be given in the PLC.
- Run-time meter (PLC).
- Countdown timer (PLC).

Options

EB 04IIW Four pane glass window and lamp illuminating the inner chamber.

EB 04IIDS Door sensor that turns off fan and heating when the door is opened.

EB 04-AP Access Port *(only for EB 04-II)*.

EB-P Ramp function for temperature settings in the PLC.

EA 01 Silent, oil-free air compressor, 105 l/min. Suitable for EB 04-II if compressed air is missing.

EC 11 Monitor Software.

ED 04 Computer, PC.

ED 06 UPS 1000 VA double converter.

Network cable.

EV 03 Compression Set Rig, according to ISO 815-1.

EV 04 Tension Set Rig, according to ISO 2285.

ERACK11 Rack for ageing ovens.

ELASTOCON reserve the right to modify these specifications in part or in whole.

Technical specifications, Cabinet Ageing Ovens

	EB 26HT	EB 27
Temperature range, °C:	+40 to +300	+40 to +200
Temp. control,		
+40 to +100 °C, °C:	± 0,5	± 0,5
+101 to +200 °C, °C:	± 1,0	± 1,0
+201 to +300 °C, °C:	± 1,5	–
Temp.variation in time,°C:	± 0,25	± 0,25
Temp.variation in space, %:	± 0,5	± 0,5
Temperature sensors:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
No. of temperatures:	1	1
Lag time. s:	–	800 (ASTM D5423 Type 2) / 620 (ASTM E145 Type IIA)
Air speed, m/s:	0,5 ± 0,25	0,001 to 0,02
Air changes, changes/hour:		
+40 to +200 °C, changes/hour:	–	3 to 200
+201 to +300 °C, changes/hour:	7 or 14*1	–
Useful volume, l:	50	120
Dimensions, inner, dia × h, mm:	450 × 450 × 250	550 × 550 × 400
Dimensions, external, w × h × d, mm:	875 × 845 × 620	910 × 820 × 720
Dimensions, window, 4 glass, mm:	200 × 300	200 × 300 (option)
Illumination of inner chamber:	24 V, 10 W halogen	24 V, 10 W halogen*2
Sample rod positions:	6	24
Sample rods:	12	12
No. of specimen:	36	–
Shelf position:	–	3
Shelves:	–	2
Weight, kg:	104	115
Voltage, V/phase/freq:	220–240/1/50–60	220–240/1/50–60
Power, W:	2 200	3 100
Connections:	–	Compressed air
Standards:	ISO 188 method B2	ASTM D5423 type 1 and 2, ASTM E145 type II A, ASTM D573

**1 preset by manufacturer*
**2 only available with the window option*

Note: *EB 27 needs connection to dry and clean compressed air for the air exchanges. The air speed is low and is dependent on the air exchange rate only.*

Common specifications:

- Controlled from a PLC with a colour touch screen.
- Special design with controlled air exchange rate and low air speed.
- The casing consists of steel, powder coated in a bluegreen colour.
- The inner chamber is made of stainless steel.
- Temperature controller with 0,1°C setpoint (PLC).
- Solid state relay for safe control.
- Temperature indicator with sensor in the inner chamber.
- Fixed over temperature fuse.
- Cooling channels in the casing for low surface temperature.
- Controlled cooling fan for the electronics cabinet.
- Alarm history.
- Indication of power failure (PLC).
- Test names can be given in the PLC.
- Run-time meter (PLC).
- Countdown timer (PLC).

Options

EB 04IIW Four pane glass window and lamp illuminating the inner chamber *(only for EB 27)*.

EB 04IIDS Door sensor that turns off fan and heating when the door is opened *(only for EB 27)*.

EB-P Ramp function for temperature settings in the PLC.

EB 04-AP Access Port *(only for EB 27)*.

ED 04 Computer, PC.

ED 06 UPS 1000 VA double converter.

EC 11 Monitor Software.

Network cable.

EV 03 Compression Set Rig, according to ISO 815-1.

EV 04 Tension Set Rig, according to ISO 2285.

ERACK11 Rack for ageing ovens.

ELASTOCON reserve the right to modify these specifications in part or in whole.

Technical specifications, Cell Ageing Ovens

	EB 01-II	EB 19	EB 20
Temperature range, °C:	+40 to +200	+40 to +200	+40 to +200
HT-version, °C:	–	+40 to +300	+40 to +300
Temp. control,+40 to +100 °C, °C:	±0,5	±0,5	±0,5
+101 to +200 °C, °C:	±1,0	±1,0	±1,0
+201 to +300 °C, °C:	±1,5	±1,5	±1,5
Temp.variation in time,°C:	±0,25	±0,25	±0,25
Temp.variation in space, %:	±0,5	±0,5	±0,5
Temperature sensors:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
No. of temperatures:	1	4	6
No. of cells:	4	4	6
Air speed, m/s:	<0,001	<0,001	<0,001
Air changes, changes/hour:	3 to 20	3 to 20	3 to 20
Useful volume, l:	4 × 2,4	4 × 2,4	6 × 2,4
Dimensions, inner, dia × h, mm:	100 × 300	100 × 300	100 × 300
Dimensions, external, w × h × d, mm:	760 × 500 × 510	760 × 500 × 510	960 × 500 × 510
Weight, kg:	45	55	74
Voltage, V/phase/freq:	220–240/1/50 (110–120/1/60)	220–240/1/50 (110–120/1/60)	220–240/1/50 (110–120/1/60)
Power, W:	900	900	1300
Standards:	ISO 188 method A, IEC 60811-401, IEC 60216-4-3, DIN 53508 p. 6.4	ISO 188 method A, IEC 60811-401, IEC 60216-4-3, DIN 53508 p. 6.4	ISO 188 method A, IEC 60811-401, IEC 60216-4-3, DIN 53508 p. 6.4

Common specifications:

- Controlled from a PLC with a colour touch screen.
- Special design with controlled air exchange rate and low air speed.
- The casing consists of steel, powder coated in a bluegreen colour.
- The inner cells are made of aluminium.
- Temperature controller with 0,1°C set point (PLC).
- Temperature indicator with sensor in each cell (PLC).
- Fixed over temperature fuse.
- Flowmeters with needle valves, for setting the air exchange rate.
- The air speed is low and is dependent on the air exchange rate only, as specified in ISO 188 method A and IEC 811.
- Alarm for low air pressure (PLC).
- Built in air pump.
- Cooling channels in the casing for low surface temperature.
- Temperature controlled cooling fan for the electronics cabinet.
- Indication of power failure (PLC).
- Run-time meter (PLC).
- Countdown timer (PLC).
- Microfilter for the air which removes 99,99 % of all particles over 0,1 µm.
- EB 19 and EB 20 also available as high temperature versions up to 300 °C.

Options

EB-P Ramp function for temperature settings in the PLC.

EC 11 Monitor Software.

ED 04 Computer, PC.

ED 06 UPS 1000 VA double converter.

Network cable.

EB 01.01 Stand to support the sample holder for cell ageing ovens while mounting test pieces for ageing.

EB 07.01 Insert with three test tubes for testing according to ASTM D865 Heat Ageing and ASTM D471 Testing in liquids. Fits EB 19 and EB 20.

EB 07.02 Insert for cell ovens for testing of Heat Stability of PVC according to IEC 60811-405.

EV 03 Compression Set Rig, according to ISO 815-1.

EV 04 Tension Set Rig according to ISO 2285.

ERACK11 Rack for ageing ovens.

Examples of temperature combinations between cells with individual temperature, °C:

Cell no 3	Cell no 4	Cell no 3	Cell no 4	Cell no 3	Cell no 4
40	70	50	70	60	200
Cell no 1	**Cell no 2**	**Cell no 1**	**Cell no 2**	**Cell no 1**	**Cell no 2**
100	200	200	200	200	200

ELASTOCON reserve the right to modify these specifications in part or in whole.

Technical specifications, Test Tube Ovens

	EB 11-II	EB 28HT
Temperature range, °C:	+40 to +200	+40 to +300
Temp. control,		
+40 to +100 °C, °C:	± 1,0	± 1,0
+101 to +200 °C, °C:	± 2,0	± 2,0
+201 to +300 °C, °C:	–	± 3,0
Temp.variation in time,°C:	± 0,5	± 0,5
Temp.variation in space, %:	± 0,5	± 0,5
Temperature sensors:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
No. of temperatures:	1	4
Test Tubes:	24	4 × 6
Test Tube-dimensions		
dia × h, mm:	38 × 300	38 × 300
Dimensions, external,		
w × h × d, mm:	760 × 820 × 510	760 × 820 × 510
Weight, kg:	88	70
Voltage, V/phase/freq:	220–240/1/50 (110–120/1/60)	220–240/1/50 (110–120/1/60)
Power, W:	900	900
Standards:	ASTM D865, ASTM D471, ISO 1817	ASTM D865, ASTM D471, ISO 1817

**1 preset by manufacturer*
**2 only available with the window option*

Common specifications:

- The ovens are controlled from a PLC (with a colour touch screen).
- The casing consists of steel, powder coated in a bluegreen colour.
- The inner chamber is made of stainless steel.
- Temperature controller with 0,1°C setpoint (PLC).
- Solid state relay for safe control.
- Temperature indicator with sensor in one test tube (EB 11-II), four test tubes (EB 28).
- Fixed over temperature fuse.
- Cooling channels in the casing for low surface temperature.
- Controlled cooling fan for the electronics cabinet.
- Alarm history.
- Indication of power failure.
- Test names can be given in the PLC.
- Run-time meter (PLC).
- Count up and down time (PLC).

Options

ED 04 Computer, PC.

ED 06 UPS 1000 VA double converter.

EC 11 Monitor Software.

Network cable.

EC 11.04 Water cooled condensors when testing volatile liquids.

EB 31 Test tube rack with room for 15 test tubes.

ELASTOCON reserve the right to modify these specifications in part or in whole.

Important recommendations for all instruments!

For the best performance of the instrument, we recommend the following working environment:

- Standard laboratory temperature of either 23 °C ± 2° or 27 °C ± 2°.
- Humidity not more than 90 % RH – non condensing.
- For long term logging instruments secure the power to the computer with a double converting UPS, for reducing electrical disturbances and power failure (ask Elastocon for recommendations or quotation).
- Other environmental aspects: Pollution degree 2 – Laboratory environment

Information about ageing of polymers

Durability testing

The durability of polymer materials is affected by a number of environmental factors in combination with the mechanical stresses that are caused by the use of the product itself.

Influencing factors

It was well known from an early stage in the development of polymer materials that factors like heat, sunlight, oxygen in air and humidity in general accelerate the degradation of rubber. Mechanical loads, erosion,impurities, micro-organisms and other special influences occur depending on the application of the material.

Accelerated ageing

Normally there is no time to wait for a test under real conditions. It could in actual fact take decades to get the natural results. Accelerated ageing is therefore used. This means the factors that cause natural ageing are reinforced. This could take place both outdoors – in a desert or tropical rain forest – and indoors in ovens, climate chambers or weather simulators.

Unfortunately this is often done with no proper critical analysis. The ageing process is accelerated far too much. The material is literally grilled. The accelerating ageing process then becomes completely different from the natural process. The result is incorrect predictions of the actual durability.

The philosophy of ageing processes

The functional environment must first of all be carefully analysed, so that the most important degradation factors in each application are identified. Using the available knowledge, it is then determined how far the acceleration can be taken.

The available knowledge and facts are seldom sufficient in order to determine the maximum permissible acceleration or to translate the results into an exact number of years under real conditions.

The acceleration has therefore to be carried out in moderation and using rules of thumb.

If durability testing is to be carried out seriously, long testing times – a year is not uncommon – must be expected. It is surely always better to wait a long time for a more correct result than to get an incorrect one quickly.

What to remember about the ageing process

In all ageing processes it is especially important to keep a constant temperature and in certain cases a constant relative humidity in air. This is because the speed of a chemical reaction is roughly doubled for a temperature increase of 10 °C – and ageing is in most cases a chemical reaction.

Normally, the highest deviation of ±1 °C is allowed. In all ageing, and especially for long testing times (up to a year and more can occur), it is extremely important to be sure that the temperature has been maintained within the permitted tolerance during the whole testing procedure.

Another important factor is the flow of air. During the ageing process, the oxygen in the air is used up and degradation products are formed. In order to make the testing reproducible, the oxygen concentration must be kept at a constant level, and the degradation products ventilated off. In order to meet these requirements, the air must be changed between 3 and 10 times per hour. The device must therefore be equipped with an air supply and flow meters. The air speed must also be low otherwise the oxidation rate can increase and Plasticisers and antioxidants be ventilated off.

Ageing polymer

When rubber materials ages with time, this normally show it in increased stiffness and reduced elongation. Easily oxidised materials, as for example natural rubber, become softer for longer ageing times.

When a rubber material ages, among other things, the following reactions take place:

a) **Oxidative degradation,** caused by oxygen, which creates breaks in the polymer chain.

b) **Thermal degradation,** caused by thermal movements in the polymer chains,which cause breaks in the polymer chain.

c) **Additional cross-linking** caused by the remains of curing agents. In curing systems with high sulphur content, polysulphide and disulphide links can break up and form new crosslinks of the di- and nonosulphide type.

The changes in a polymer material when ageing can be examined by testing for several properties. The most common way to test the effect of ageing on a rubber material is to do a tensile test and measure the change in hardness.

The total ageing effects are most apparent in the decrease in elongation at break. The additional cross-linking is most apparent in the increase in hardness and increase in tensile strength.

Elastocon®

Elastocon AB
Tvinnargatan 25 • SE-507 30 Brämhult • Sweden
Phone: +46 33 323 39 00 • E-mail: info@elastocon.se
www.elastocon.com