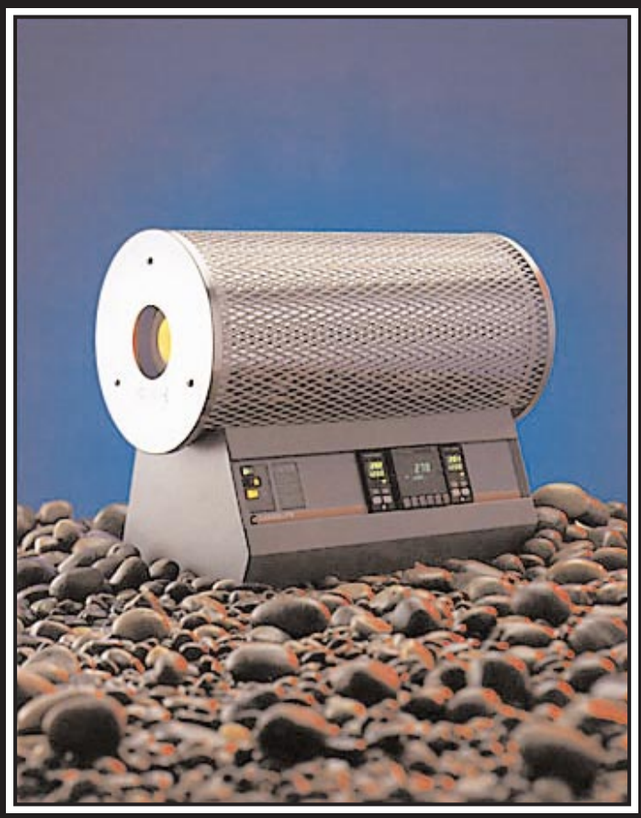
FB-11

RANGE OF TUBE *furnaces*



complete temperature CONTROL

- EXTENSIVE RANGE INCLUDING ROTATING AND VACUUM MODELS
- TEMPERATURES UP TO 1800°C
- EXCELLENT TEMPERATURE UNIFORMITY
- HORIZONTAL AND VERTICAL MODELS
- SINGLE AND THREE ZONE VERSIONS
- HINGED DESIGNS FOR EASY REMOVAL OF PROCESS TUBES
- WORK TUBE ADAPTORS FOR ATMOSPHERE APPLICATIONS

CARBOLITE®

introduction

Carbolite's extensive range of tube furnaces is probably the most comprehensive available from a single source and includes wire heated tube furnaces to 1200°C, silicon carbide heated furnaces to 1600°C and molybdenum disilicide heated elements for furnaces up to 1700°C. Tube furnaces at 1800°C are heated by lanthanum chromite or molybdenum disilicide.

Many specialist models are incorporated in the range, including vacuum and rotating, rotary reactor furnaces and those specifically designed for the calibration of thermocouples.

Carbolite tube furnaces offer precise temperature control, excellent temperature uniformity and the best solution for heating small work pieces. To achieve the most uniform temperature, both ends of the tube should be fitted with tapered ceramic end plugs or radiation shields.

Many models combine an integral control system, but most are also available with separate control systems particularly suitable for vertical use, either with a stand or in a test rig.

Single and three zone control models are included in the range with the availability to have multi-zone control on custom built units.

Many processes demand the use of a tube furnace from simple combustion techniques - ideal for carbon determination and organic analysis - to more sophisticated applications requiring accurate and uniform heating.

As in all areas of our production, custom built units are also available to specifically meet your requirements.

*S*afety features

include either double skin construction or an outer mesh guard which promotes natural air cooling and protects the operator from hot surfaces. In the event of thermocouple malfunction, the control system automatically cuts power to the heating elements.

*E*nergy efficient

Low thermal mass insulation, combined with high quality heating elements and the latest microprocessor digital control systems, ensures maximum reliability and performance.,

*R*eadily accessible controls,

thermocouples, insulation and heating elements allows for easy maintenance.

*V*ertically loaded

tube furnaces need careful design of the sample support system and effective tube end insulation to prevent heat losses and convection air currents. Please discuss your application with us.

*C*ontrolled heating

and cooling can be obtained by the use of a programmer which ensures that the possibility of thermal shock is minimised.
Radiation shields can sometimes be used as insulation plugs for vacuum or dust free applications. Both of these are carefully designed to avoid steep temperature gradients and thermal stresses which could crack the tube. Please ask for recommended heating rates or guidance if required. It is advisable to either pre-heat the sample before loading or heat the sample and furnace simultaneously. Carbolite, in common with other manufacturers of tube furnaces, does not accept responsibility for tube failures resulting from loading cold crucibles and samples into hot ceramic tubes

*C*lean and dustfree worktubes

to prevent contamination of samples.

*T*emperature indicators

A digital temperature indicator can be built into the furnace for use with a probe thermocouple. Alternatively, the indicator can be supplied in a separate housing with mains lead and thermocouple socket to be used as a portable temperature checker. A thermocouple probe can be inserted into the work tube to measure the temperature close to the workpiece (please see safety note).

Typical Tube Furnace Applications Include:

- Gas analysis
- Materials research
- Sintering and firing of ceramics
- Crystal growing
- Continuous strip and wire heating
- Doping of silicon wafers
- Powder metallurgy
- Calibration of thermocouples
- Thermal degradation
- Superconductor research

Flexibility

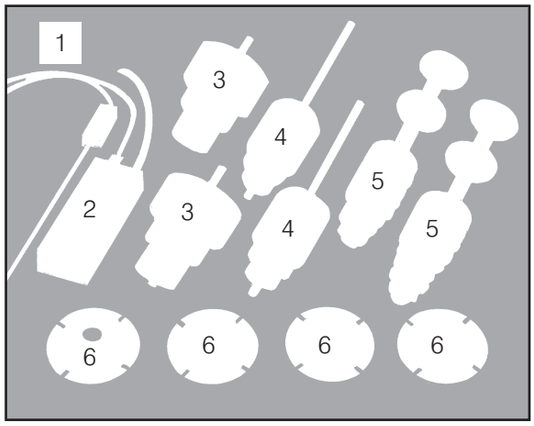
A wide range of optional accessories includes:

- wall mounting brackets
- 'L' stand allowing vertical and horizontal operation
- selection of worktubes including:
  - impervious aluminous porcelain (IAP)
  - mullite
  - recrystallised alumina (RCA)
  - metallic (APM)
  - sillimanite
  - silica
- spares kits
- chart recorders
- ceramic insulation plugs
- radiation shields
- calibration certificates
- work tube seals for vacuum/controlled atmosphere applications
- overtemperature protection
- probe thermocouple for calibration and accurate measurement of workpiece temperature
- separate control boxes
- timeswitch
- process timers
- gas flowmeters
- gas safety systems
- furnace tables with heat resistance surfaces

Options

Safety:

Ceramics can become slightly electrically conductive at high temperatures and therefore tube furnaces should be switched off before loading and unloading.



1. Probe Thermocouple
2. Temperature Indicator
3. Type C Insulation Plugs
4. Type D Insulation Plugs
5. Radiation Shields
6. Worktube End Flanges

Wire wound tube furnaces to 1200°C

The majority of these models utilise a resistance wire heating element, which is wound around the outside of a ceramic worktube making it an integral part of the heating element. If the tube is required to contain an atmosphere or is likely to be contaminated by spillage, a separate work tube should be used. The thermocouple is located in a protected position between the outside of the work tube and the heating element, allowing the full work tube diameter to be used and protects the thermocouple from mechanical damage.

The GTF 12/--/1090 and GZF 12/--/1090 are of a different construction and use modular heating elements of coiled wire embedded in moulded ceramic fibre cylinders. These elements do not touch the tube allowing it to be replaced or alternatively allow the use of a heat resisting metal worktube.

MTF 12/38/400/91

MTF 9/15/130/91

The CTF and GTF models are similar in appearance to the TZF 12/75/700 shown on the front cover.

Model	MTF 9/15/130	MTF 10/15/130	MTF 10/25/130	MTF 12/25/250	MTF 12/25/400	MTF 12/38/250	MTF 12/38/400	CTF 12/65/550	CTF 12/75/700	CTF 12/100/900	GTF 12/--/1092
Max Temp (°C)	900	1000	1000	1200	1200	1200	1200	1200	1200	1200	1200
Tube Inside dia (mm)	15	15	25	25	25	38	38	65	75	100	150(m)
Heated Length (mm)	130	130	130	250	400	250	400	550	700	900	1090(n)
Overall Length (mm)	180	150	150	300	450	300	450	600	750	950	1270
Uniformity measured at temp °C	800	900	900	1100	1100	1100	1000	1100	1100	1100	–
Uniform Length (± 5°C)	30	30	45	80	200	95	135	230	265	640	(e)
Heat up (mins) (k)	7	5	10	15	25	30	25	45	45	90	(c)
Horiz. or Vert. use	Option	Option	Option	Option	Option	Option	Option	Option	Option	Option	Option
Max. Power (kW)	0.4	0.4	0.4	0.7	1.0	1.0	1.5	2.0	3.0	4.5	7.0
Holding Power (kW) (d)	0.1	0.1	0.1	0.2	0.3	0.2	0.3	0.6	0.8	1.0	3.0
Nett weight (Kg)	2kg	3kg	3kg	10kg	15kg	10kg	15kg	25kg	28kg	35kg	60kg
External height (mm)	180	265	265	375	375	430	430	525	525	525	660
External width (mm)	90	150	150	370	450	370	450	625	775	975	1335
External depth (mm)	180	175	175	375	375	375	375	360	360	360	440

Note:
(c) Heat up rate will vary with worktube size and material.
(d) Holding power at 100°C below maximum, tube ends insulated.
Work tube length = overall furnace length.
(e) Uniformity will vary greatly depending on the size and material of the worktube.
(k) To 100°C below maximum temperature.
(m) Maximum diameter 150mm. Smaller tube sizes available.
(n) Other heated lengths available 910,728,546,364mm

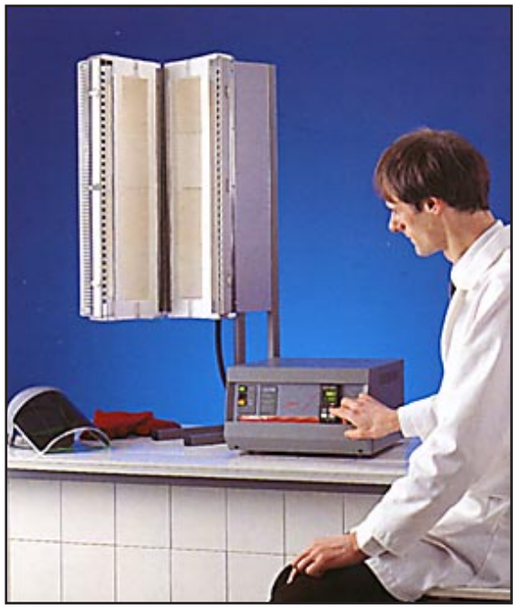
Split tube furnace

These furnaces are manufactured in two halves and are hinged together for easy loading or placing around a work piece or worktube. This design offers the flexibility to place the furnace around a fixed item - such as a pipe with flanges which are too large to pass through a solid tube furnace, or around a sample which is fixed into a materials test rig.

Whilst the HST models are ideally suited for horizontal use, they can also be used in the vertical position with the addition of an 'L' stand (see options). The VST (vertical) models have the same internal diameter, but smaller external dimensions and are primarily designed to fit within test rigs.

Both models have extended insulation beyond the heated length which provides the opportunity to accept any tube diameter (up to the maximum listed) by cutting away part of the unheated insulation. A three zone version of a vertical split furnace is model TVS which is also hinged and gives improved uniform length with three zone control (see section on 3-zone tube furnaces).

HST 12/--/600/808p (shown with optional worktube)



VST 11/--/600 (shown with optional stand)

Model	HST 12/--/400	HST 12/--/600	VST 12/--/200	VST 12/--/400	VST 12/--/600
Max Temp (°C)	1200	1200	1200	1200	1200
Tube Inside dia (mm)	100(a)	100(a)	100(a)	100(a)	100(b)
Heated Length (mm)	400	600	200	400	600
Overall Length (mm)	525	725	250	480	700
Uniformity measured at temp °C	1000	1000	1000	1000	1000
Uniformity measured using specified tube diameter	No tube	No tube	No tube	No tube	No tube
Uniform Length (± 5°C)	(f)	(f)	(f)	(f)	(f)
Heat up (mins) (k)	(h)	(h)	(h)	(h)	(h)
Horiz. or Vert. use	Option	Option	Option	Option	Option
Max. Power (kW)	2.5	3.0	2.0	2.5	3.0
Holding Power (kW) (d)	0.9	1.1	0.8	0.9	1.1
External height (mm)	350	350	350	550	750
External width (mm)	525	725	315	315	315
External depth. (mm)	410	410	360	360	360

Note:
(a) Maximum useable diameter.
(b) Maximum tube inside diameter.
(d) Holding power at 100°C below maximum, tube ends insulated. Work tube length = overall furnace length.
(f) These products may be used for materials testing without a worktube. Uniformity varies with the application.
(h) Information available on request - Heat up rate and uniformity vary with the application.
(k) To 100°C below maximum temperature.

High temperature tube furnaces

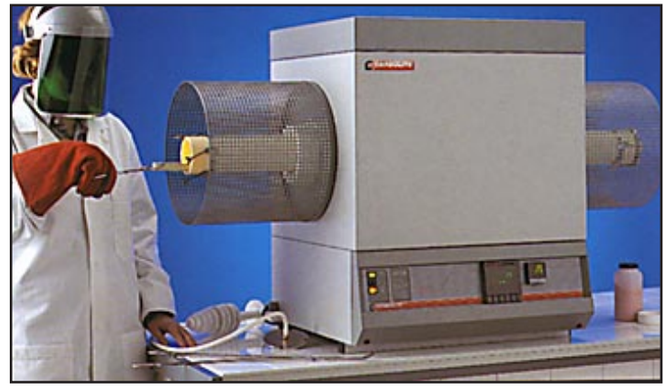
The 1500°C and 1600°C tube furnace ranges utilise silicon carbide (SiC) heating elements arranged in a heated chamber surrounding the work tube, and provide even heating of the tube surface for maximum temperature uniformity. SiC furnaces can be used either horizontally or vertically and are offered with two heated lengths and two temperature ranges.

1700°C tube furnaces use molybdenum disilicide ($MoSi_2$) heating elements suspended down each side of a horizontal tube. At elevated temperatures these heating elements become very soft and therefore the standard furnace is only suitable for horizontal use. Custom built vertical furnaces are available on request.

1800°C tube furnaces (type PVT) use lanthanum chromite heating elements, which generally achieve slower heating rates. These furnaces are for use in the vertical position only, and the elements are suspended around a vertical tube. Again, special custom built tube furnaces at 1800°C are available. Although the elements give off a small amount of chromium vapour the work tube shields all but the most sensitive work pieces from contamination or pink colouration.

STF 15/75/450/808p (shown with optional worktube)

PVT 18/75/350/808p



CTF 17/75/300/902PX (shown with optional worktube)

Model	STF 15/--/450	STF 15/--/610	STF 16/--/450	STF 16/--/610	CTF 17/--/300	CTF 17/--/600	PVT 18/50/200	PVT 18/75/350	PVT 18/100/350	PVT 18/125/350
Max Temp (°C)	1500	1500	1600	1600	1700(m)	1700(m)	1800	1800	1800	1800
Tube Inside dia (mm)	75(b)	75(b)	75(b)	75(b)	75(b)	75(b)	50	75	100(a)	125
Heated Length (mm)	450	610	450	610	300	600	200	350	350	350
Overall Length (mm)	900	1200	900	1200	650	950	700	855	870	900
Uniformity measured at temp °C	1400	1400	1500	1500	1600	1600	–	–	–	–
Uniformity measured using specified tube diameter	Ø75 (g)	Ø75 (g)	Ø75 (g)	Ø75 (g)	Ø75 (g)	Ø75 (g)	–	–	–	–
Uniform Length (± 5°C)	350	400	350	400	200	400	(h)	(h)	(h)	(h)
Heat up (mins) (k)	(c)	(c)	(c)	(c)	(c)	(c)	(h)	(h)	(h)	(h)
Horiz. or Vert. use	Option	Option	Option	Option	Horiz.	Horiz.	Vert.	Vert.	Vert.	Vert.
Max. Power (kW)	5.0	6.0	6.0	7.0	5.5	9.0	6.0	8.0	8.0	12.0
Holding Power (kW) (d)	3.8	4.2	4.0	4.5	2.5	3.8	4.0	5.0	5.0	7.0
External height (mm)	640	640	640	640	900	900	850	1000	1000	1000
External width (mm)	830	1130	830	1130	650	950	700	700	700	700
External depth (mm)	420	420	420	420	630	630	810	810	810	810

Note:
(a) Maximum useable diameter.
(b) Maximum tube inside diameter.
(c) Heat up rate will vary with worktube size and material.
(d) Holding power at 100°C below maximum, tube ends insulated. Work tube length = overall furnace length.
(g) Uniformity is measured with the tube diameter shown and tube end insulation fitted in the optimum position.
(h) Information available on request - Heat up rate and uniformity vary with the application.
(k) To 100°C below maximum temperature.
(m) 1800°C versions available. Please Ask.

Three zone tube furnace

Similar in construction to the CTF and MTF models, the TZF offers excellent temperature uniformity as the heated length is divided into three zones, each with its own temperature controller and thermocouple. The power supplied to the end zones is automatically adjusted to compensate for the heat loss at the ends of the tube irrespective of whether the ends are left open or have insulation plugs fitted. This system provides a longer uniform zone temperature than that achieved by using a single zone furnace of the same length. The temperature controllers are usually linked so that they act to keep all three zones at the same temperature; this is known as slave control

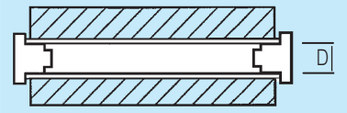
Zoned furnaces are sometimes used to create temperature gradients, but please discuss your application with us to ensure customer satisfaction.

TZF 12/65/55/902PX

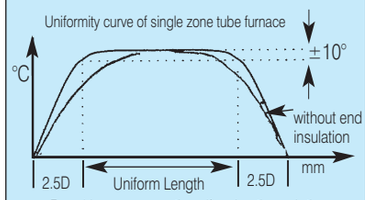
Model	TVS 11/--/600	TZF 12/38/400	TZF 12/65/550	TZF 12/75/700	TZF 12/100/900	GZF 12/--/1090	TZF 15/--/610	TZF 17/--/600
Max Temp (°C)	1100	1200	1200	1200	1200	1200	1500	1700(m)
Tube Inside dia (mm)	100	38	65	75	100 (b)	150(b)	75(b)	75(b)
Heated Length (mm)	600	400	550	700	900	1090	610	600
Overall Length (mm)	700	450	600	750	950	1270	1200	950
Uniformity measured at temp °C	1000	1100	1100	1100	1100	–	1400	1600
Uniformity measured using specified tube diameter	No tube	–	–	–	–	–	Ø50	Ø75
Uniform Length (± 5°C)	(f)	305	390	540	745	(e)	450	400 ± 2.5°C (g)
Heat up (mins) (k)	(h)	25	45	45	120	(c)	(c)	(c)
Horiz. or Vert. use	Option	Option	Option	Option	Option	Option	Option	Option
Max. Power (kW)	3.0	1.5	2.0	3.0	4.5	7.0	8.0	9.0
Holding Power (kW) (d)	1.1	0.3	0.6	0.8	1.0	3.0	4.2	3.8
Nett weight (Kg)	kg	18kg	30kg	32kg	40kg	60kg	44kg	180kg
External height (mm)	750	430	525	525	525	660	640	755
External width (mm)	315	450	625	775	975	1335	1130	900
External depth (mm)	360	375	360	360	360	440	420	555

Uniformity

Tube furnace cross section

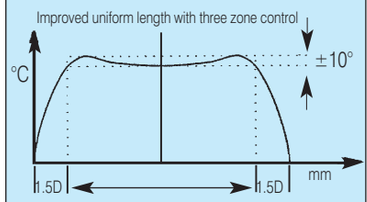


Uniformity curve of single zone tube furnace



For guidance purposes, the uniform length equals the overall length less 5 times the tube diameter.

Improved uniform length with three zone control



For guidance purposes, the uniform length equals the overall length less 3 times the tube diameter.

Note:
(b) Maximum tube inside diameter. Smaller sizes available
(c) Heat up rate will vary with worktube size and material.
(d) Holding power at 100°C below maximum, tube ends insulated. Work tube length = overall furnace length.
(e) Uniformity will vary greatly depending on the size and material of the worktube.
(f) These products may be used for materials testing without a worktube. Uniformity varies with the application.
(g) Uniformity is measured with the tube diameter shown and tube end insulation fitted in the optimum position.
(h) Information available on request - Heat up rate and uniformity vary with the application.
(k) To 100°C below maximum temperature.
(m) 1800°C version available. Please ask.

Vacuum tube furnaces

This range of 1200°C and 1500°C horizontal vacuum tube furnaces, offers vacuum levels of better than 10^{-5} mbar with a clean empty worktube.

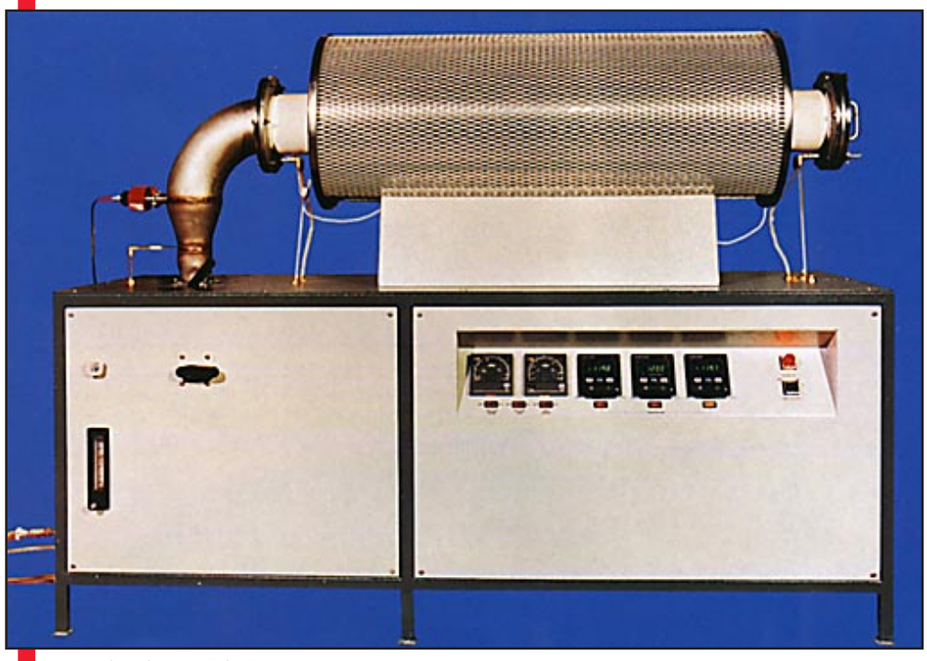
The vacuum system and all controls are housed in the base with one end of the worktube joined to the vacuum system via a stainless steel elbow. Access to the tube is via the other end which is fitted with a removable stainless steel flange. Radiation shields are provided for both ends of the furnace to ensure maximum temperature uniformity with minimum loss of pumping speed.

These furnaces include two stage sliding vane rotary pump, water cooled oil diffusion pump, high vacuum baffle valve, roughing/backing valve(s) and Pirani and Penning gauges.

A number of special options is available including gas systems, automatic/semi-automatic vacuum systems, air cooled diffusion pump, cooling water failure alarm, lower vacuum (10^{-2} mbar) and special vertical and custom built designs.

Model		HVT 12/50/550	HVT 12/60/700	HVT 12/80/700	HVT 15/50/450	HVT 15/75/450
Max Temp (°C)		1200	1200	1200	1500	1500
Tube Inside dia	(mm)	50	60	80	50	75
Heated Length	(mm)	550	700	700	450	450
Uniform Length (± 5°C)		(h)	(h)	(h)	(h)	(h)
Heat up (mins) (k)		(h)	(h)	(h)	(h)	(h)
Horiz. or Vert. use		Horiz	Horiz	Horiz	Horiz	Horiz
Max. Power (kW)		3.0	4.0	5.5	6.0	6.0
Holding Power (kW) (d)		1.6	1.8	2.8	4.8	4.8
External height	(mm)	1450	1450	1450	1565	1565
External width	(mm)	1700	1700	1700	1700	1700
External depth	(mm)	600	600	600	600	600

Note:
(d) Holding power at 100°C below maximum, tube ends insulated.
Work tube length = overall furnace length.
(h) Information available on request - Heat up rate and uniformity vary with the application.
(k) To 100°C below maximum temperature.



Horizontal Vacuum Tube Furnace

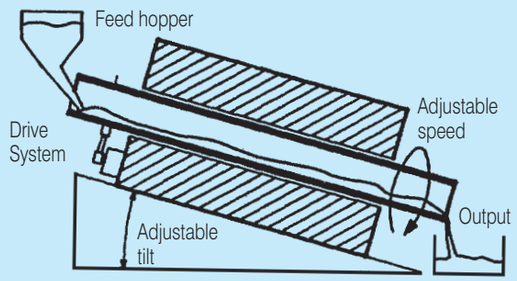
Rotating tube furnace

This type of furnace allows powders to be heated and agitated inside a furnace by using a rotating drive systems. This ensures that all the powder is exposed to the atmosphere and provides laboratory scale simulation of industrial rotary calcining kilns. Known as the Rotary Reactor, this furnace is available in two standard sizes, for a full technical specification, please contact our sales office.

Other standard tube furnaces can be fitted with various options, including plain tubes in ceramic, quartz or heat resisting metal alloys*, shaped vessels in metal or quartz incorporation agitation blades, tilting mechanisms to control the powder throughput (with input and output hoppers for continuous operation), variable speed drives and atmosphere control systems.

* Suitable for use with GTF 12/--/1090 and GZF 12/--/1090 only.

Illustration of rotating tube furnace operation



Other products within the range include:

- Economy furnaces to 1100°C.
- Wire heated box furnaces to 1300°C, including rapid heating versions to 1200°C.
- High temperature box furnaces, including elevator versions, to 1800°C.
- Ashing and burn off furnaces.
- Furnaces for precious metals evaluation.
- Specialist range of coal and coke test equipment for laboratory and pilot plant scale.
- Range of ovens to 300°C and incubators to 80°C.
- High temperature ovens to 600°C.
- Clean room ovens and sterilisers.
- Custom built industrial furnaces and ovens.

temperature control systems

A choice of control systems is available including controllers which simply heat up the furnace and hold at one temperature indefinitely and more complex programming systems. Access to parameters is simple and easy to understand and is customised to present only those parameters which need to be viewed or adjusted.

Carbolite 201 Controllers

The 201 is a three term PID microprocessor controller with the facility of an adjustable single ramp rate to set point, either up or down. It is a high precision instrument exclusive to Carbolite and is jointly designed by Eurotherm and ourselves. This partnership allows us to offer a high performance controller with minimal overshoot at an economical cost.
The measured temperature is provided by large LED's located behind a wipe clean membrane panel. The setpoint is displayed and adjusted by pressing either the raise or lower button.

Eurotherm 2416 CC

The Eurotherm 2416 CC is an advanced setpoint programming temperature controller with eight segments, any of which can be a ramp, step or dwell. It is housed in a compact 1/16 din size measuring 48 x 48mm.
It provides precise control with the advanced PID control algorithm giving stable 'straight-line' control of the process. Power feedback is used to stabilise the output power and hence the controlled temperature against supply voltage fluctuations. The controller continually corrects for drift and this gives high stability and rapid response to process changes.

Eurotherm 2408 CP

The Eurotherm 2408 CP contains the same features as the 2416 CC, but with 16 segments and is housed in a 1/8 din size measuring 48 x 96mm high. The larger case allows for more options including storage of up to 20 separate programmes.

Overtemperature Protection

An independent overtemperature protection system may be justifiable to protect expensive heating elements or valuable furnace contents. Where the Carbolite 201 controller is the main controller, an overtemperature protection option can be integrated into the same display panel and incorporates an independent power supply and control circuit. When required with other main controllers, a separate Eurotherm 2132 digital controller is fitted. This unit is housed in a compact 1/32 din size measuring 24 x 48mm wide. The additional control unit uses a separate thermocouple and operates a contactor to shut down the furnace in the event of the set temperature being exceeded.

Communications Software

IPS communicates with the programmer and allows data logging. It also shows a graph of furnace temperature and set point on the computer screen and allows storage of programs on disc, and easy editing and error free downloading to the furnace programmer.

Other Options

Additional control systems can be supplied and they include cascade control, multi-segment programmers and process timers. The Carbolite 201 controller is also available with an integral process timer. When the working setpoint is reached, a timed period starts and can either end with an audible alarm or to switch off the power at the end of the time period.

Standard Electrical Supply

When ordering, always quote the model, controller and the preferred type of electrical supply from the list. Please indicate the frequency (50 or 60 Hertz) and number of phases. For 3-phase supplies (where applicable), please state whether a neutral is available (if so, please quote both the phase-to-phase and the phase-to-neutral voltages, eg 380.220V). Typical single phase voltages are 100, 110, 200, 208, 220, 240 and 254V. 3-phase voltages **without** neutral are typically 220, 380, 415 and 440V. 3-phase voltages **with** neutral are typically 220/127, 380/220, 415/240 and 440/254.

Note

As a result of continuous product development, we reserve the right to change specifications and illustrations. In the unlikely event of one of our standard products not meeting your requirements, we have the capability to design and manufacture a unit specifically tailored to meet your needs.
Carbolite manufactures in compliance with the relevant safety standards to BS EN 61010-1: 1993 & 61010-2-010: 1995. All products carry the CE mark which indicates compliance with all relevant European safety directives; ie Low Voltage Directive and ElectroMagnetic Compatibility directive.

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