THERMAL TECHNOLOGY INC
HIGH TEMPERATURE EXPERTS

LABORATORY HOT PRESSES GROUP 1400

Features

Thermal Technology's Group 1400 laboratory hot presses are designed for high temperature, high pressure consolidation of powder materials. Operating at temperatures to 2500° C and uniaxial loads to 10 or 25 tons, this equipment is capable of densifying virtually all known ceramic materials. The furnaces are available with graphite, tungsten mesh, molybdenum mesh, or silicon carbide hot zones to meet specific process requirements. Atmospheres ranging from high vacuum to inert to reducing to oxidizing can be accommodated.

The basic models of hot pressing systems include the furnace, press load frame with rams, manual power supply with water-cooled flexible power leads, and manually controlled hydraulic force system.

With the versatility built into Thermal Technology's Group 1400 hot presses, high purity, high strength technical ceramics can be fabricated. A variety of accessories can be installed at time of purchase or in the field at a later date.

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Hot Zone Construction

Resistance heating elements are positioned to allow adequate clearance between the die body and the element for ease in loading and unloading to insure temperature uniformity. The work zone may be used for pressureless sintering or heat treating applications with load train removed and insulation plugs and hearth plate installed.

The standard graphite hot zone is constructed with thermally stable high-temperature graphite insulation and machined graphite heating elements. Sufficient insulation and power is provided to attain 2250° C in inert gas or vacuum (2500° C with rams withdrawn). Sustained operation in high vacuum over 2000° C is not recommended due to sublimation of graphite heating elements. Graphite hot zones are ideally suited for processing of carbides and other ceramics where carbon contamination is not a critical issue.

Refractory metal hot zones are recommended when high purity or low thermal mass is required. Tungsten or molybdenum mesh heating elements provide greater radiating surface area than rod heating elements, lowering element watt density and hence lowering element operating temperature. The lower element operating temperature for a given hot zone temperature assures less distortion, longer life, better uniformity, and greater reliability. When combined with tungsten or molybdenum radiation shielding, these all-metal hot zones provide an ultra clean environment. The fully dense metal contains no porosity that could outgas contaminants, and the low thermal mass of the complete hot zone permits rapid heat up and cool down. Refractory metal hot zones are used for processing of silicon nitride and other technical

ceramics when all contamination must be avoided. Refractory metal is also called for when a rapid process cycle is required to minimize time between production runs or experimental procedures. When equipped with a suitable power supply, tungsten hot zones can be used to 2500° C and molybdenum hot zones to 1700° C in either high vacuum, inert, or hydrogen atmospheres.

For operation in air, oxidizing or high purity inert gases to 1500° C, a furnace utilizing silicon carbide heating elements and alumina/silica insulation is available. Typical applications include production of PZT and ferrite materials requiring accurate partial oxygen pressures to control stoichiometric composition. Full or partial pressure air atmospheres can be used for processing oxide ceramics and other compositions requiring a reactive oxidizing environment. The silicon carbide furnace can also be used to 1350° C in commercial grade reducing atmospheres and to 1200° C in dry hydrogen or vacuum.

All Group 1400 laboratory hot presses use a bell jar configuration in which the furnace is elevated from its closed position by means of hydraulic lift cylinders. This provides nearly 360 degree access to the work zone for alignment, pre-loading and instrumentation. After loading, the furnace is lowered in the operating position and secured with a toggle clamping mechanism.

Construction Chamber

The smaller Group 1400 systems (4.5" diameter or less) have a furnace with a water-cooled vessel fabricated from heavy-wall, seamless extruded 6061-T6 aluminum tube. The exterior of the vessel is anodized. The bulkheads are hard anodized with integral water-cooling passages.

The larger Group 1400 systems utilize a furnace vessel that is fabricated of stainless steel and jacketed with an integral water-cooling shroud.

The cold wall design acts as a sink for heat leaving the hot zone, insuring rapid cool down and short cycle times. The water-cooled wall construction efficiently removes heat escaping from the hot zone, maintaining inner wall temperature at a level which insures structural integrity of the chamber while keeping the outer wall cool enough to touch, reducing heat load to the room. An all stainless steel chamber provides a maintenance free inner wall which is suitable for high vacuum operation and compatible with corrosive substances often liberated during load processing. The large cooling passages and corrosion resistant stainless steel also reduce the possibility of clogged cooling circuits, which could generate hot spots.

All furnaces are Viton O-ring sealed and designed for full vacuum or 15 psig (103 KPa) pressure operation. Radial ports are provided at the hot zone centerline for viewing and instrumentation. Top and bottom ports are provided for the pressing rams.

Refer to the specification sheets of the various furnace groups for detailed construction description, location of ports, and discussion of operation in specific working atmospheres.

Hydraulic Press System

A rigid post and platen-type load frame has been designed to insure proper alignment and parallelism of ram and load train assembles. The standard construction is conservatively rated for repeated application of maximum design load without distortion or misalignment. A hydraulic cylinder is securely mounted below the furnace chamber on the press frame support beam. An electric motor-driven hydraulic pump assembly provides working fluid to the hydraulic cylinder. A water-cooled, stainless steel ram transmits the force from the cylinder into the furnace chamber. Another water-cooled, stainless steel ram is fixed to the upper press frame support beam and extends into the top of the furnace chamber, providing a fixed surface for the load to react against. A secure vacuum seal is achieved with an O-ring seal between the chamber and the pressing rams.

Oil pressure from the motor-driven hydraulic pump is manually controlled from a bypass valve to provide constant force acting upon the pressing cylinder. Valving is provided to allow use of the pump to actuate cylinders for raising the furnace for loading. The hydraulic oil reservoir is water cooled for pressure

stability.

Load train spacers, with thermal insulation barriers and end insulation packs, are required to transfer the applied force into the hot zone and onto the work punches (pistons). These spacer sets, with attachment pins/bolts, are optionally available in high-density graphite, aluminum oxide, silicon carbide, refractory metals and other materials. Load train spacers are designed with required support to allow the die case (cylinder) to "float" during pressing; this assures that force on both end punches will be equalized.

High-density graphite, ultra high-strength graphite and aluminum oxide punch and die sets are available in a variety of sizes. Other materials and types can be provided upon request, including graphite fiber-wound structures and silicon carbide.

Power Supply

The Group 1400 power supply consists of a step-down power transformer controlled through a SCR power regulator. The interface to these devices is a panel-mounted operator station at the front of the electronics rack enclosure. The station provides the following features for the furnace operator:

- Illuminated push buttons for all functions.
- Digital display of secondary voltage current.
- Ten turn digital dial potentiometer for manual power control or power limit when used with an optional automatic controller.
- Front panel selection of either of two optional controller sensors.
- Interlock alarm and reset switch.
- Enable controls for optional vacuum and/or hydraulic equipment.

In addition, DIP switch selection on a printed circuit board within the enclosure allows for easy adaptation to a variety of optional or special programmers, controllers and temperature/power sensors.

The six-foot high electronics rack enclosure provides more than adequate space for optional equipment or field additions. The enclosure utilizes the universal 19 inch rack mounting arrangement. A main power circuit breaker located on the side of the enclosure provides a readily accessible means for connecting the electrical utility to the system and a disconnect for safe maintenance of components within the enclosure.

Facility Requirements

Electric: As specified for the model selected.

Water: Cooling water amounts also vary with model. General requirements are an inlet/drain differential pressure of 50 psi (345 KPa) with an inlet temperature of 65-85° F (18-30° C). This water flow will limit cooling water temperature rise to 20° C when furnace is at maximum power.

Process Gas: As required for the application.

Vacuum: A vacuum pump for purging prior to process gas backfill is definitely recommended.

Installation: Systems are complete and require only connections to use supplied sources of power, cooling water, and operating gas/vacuum.

Hot Zone Dimensions

Model No.	Hot Zone Size	Max. Die Case Dia.	Power Supply	Max. Temp.
HP20-1100-3580-W2 (Tungsten)	3.5"dia. x 8" high (89 mm x 203 mm)	2.5" (64 mm)	40 kVA	2500° C
HP20-1100-4080-M1 (Molybdenum)	4.5" dia. x 8" high (114 mm x 203 mm)	3.5" (89 mm)	20 kVA	1800° C
HP20-1100-4080-W2 (Tungsten)	4.5" dia. x 8" high (114 mm x 203 mm)	3.5" (89 mm)	40 kVA	2200° C
HP20-1000-3060 (Graphite)	3.0" dia. x 6" high (76 mm x 152 mm)	2.5" (64 mm)	20 kVA	2500° C
HP20-1000-3560 (Graphite)	3.5" dia. x 6" high (89 mm x 152 mm)	3.0" (76 mm)	20 kVA	2300° C
HP20-1000-4560 (Graphite)	4.5" dia. x 6" high (114 mm x 152 mm)	4.0" (102 mm)	20 kVA	2000° C
HP20-0614-SC (Silicon Carbide)	6.0" dia. x 14" high (152 mm x 356 mm)	4.2" (107 mm)	15 kVA	1500° C
HP50-0914-SC (Silicon Carbide)	9.0" dia. x 14" high (229 mm x 356 mm)	7.0" (178 mm)	20 kVA	1500° C
HP50-7010-WM (Tungsten)	7.0" dia. x 10" high (178 mm x 254 mm)	6.0" (152 mm)	100 kVA	2300° C
HP50-HTG-7010 (Graphite)	7.0" dia. x 10" high (178 mm x 254 mm)	6.0" (152 mm)	60 kVA	2500° C

Notes:

- HP20 designates 22,000 pound (10,000 kg) press frame.
- HP50 designates 50,000 pound (25,000 kg) press frame.
- High force press frames to 100,000 pounds (45,000 kg) can be supplied with furnaces to 10 inch (250 mm) diameter.

Optional Accessories

- Temperature sensors
- Automatic temperature control
- Automatic power control
- Automatic applied force systems
- Recorders
- Gas controls
- Vacuum systems
- Hot eject
- Muffle tubes for graphite furnaces
- Special modifications
- Special systems

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