INDUCTOTHERM GROUP

Vacuum Precision Investment Casting Furnaces

CONSARC

VPIC Process

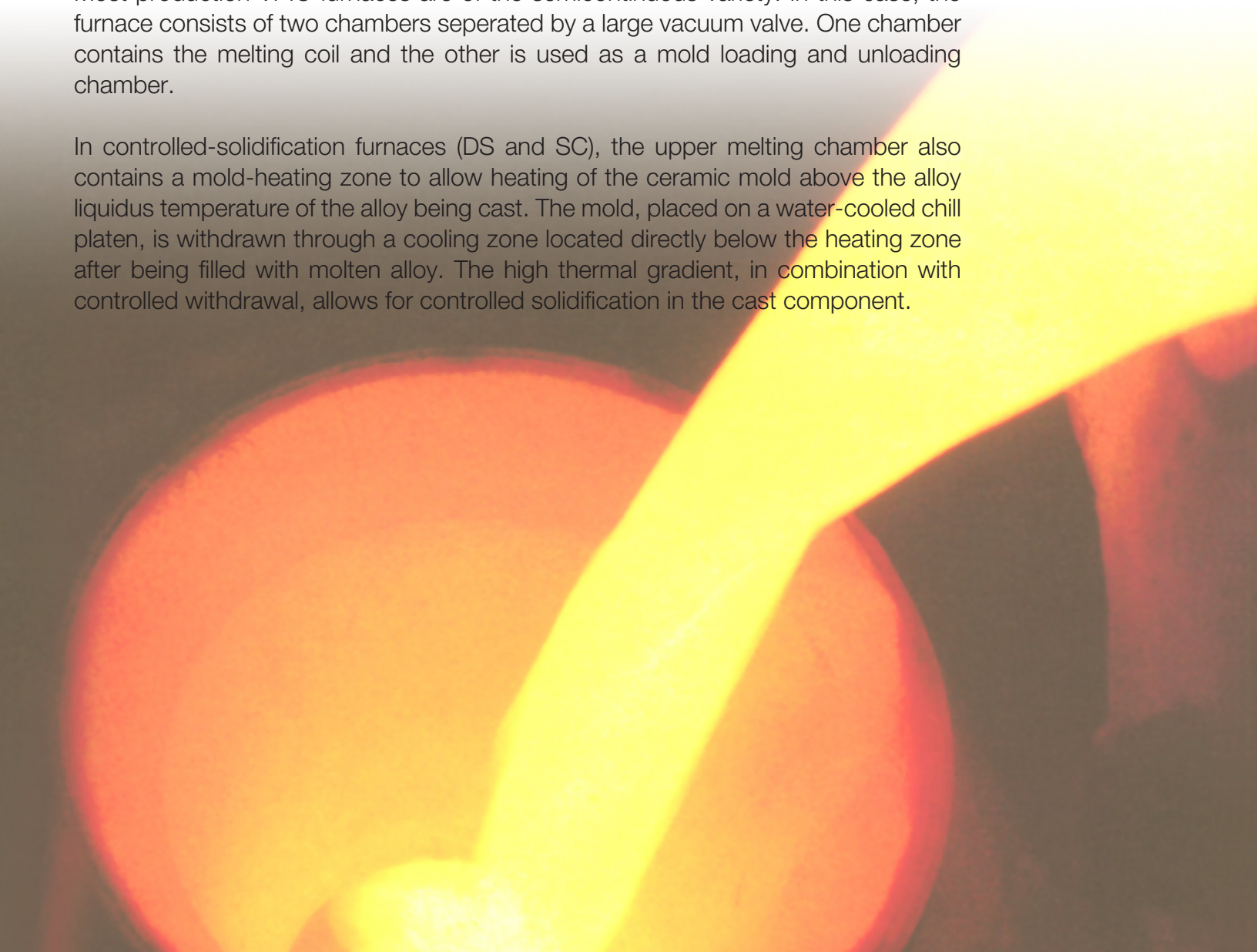
The production of advanced superalloy components for applications in aerospace, power generation, automotive, biomedical, chemical or recreational industries is accomplished in a Vacuum Precision Investment Casting (VPIC) Furnace.

Conventional processing produces castings having equiaxed, or randomly orientated, grain structures. Using the principles of the ‘lost wax’ process, a ceramic mold is prepared and heated prior to casting. A measured quantity of pre-alloyed metal is then rapidly melted and poured into the mold under vacuum.

Directionally solidified (DS) and single-crystal (SC) castings are required for use in aerospace and industrial gas turbine applications due to their superior mechanical properties at very high operating temperatures. VPIC furnaces used to cast these components also control the solidification process within the casting.

Most production VPIC furnaces are of the semicontinuous variety. In this case, the furnace consists of two chambers seperated by a large vacuum valve. One chamber contains the melting coil and the other is used as a mold loading and unloading chamber.

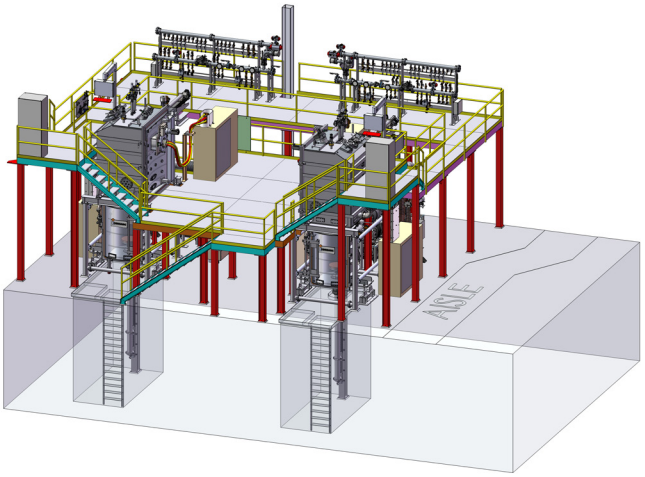
In controlled-solidification furnaces (DS and SC), the upper melting chamber also contains a mold-heating zone to allow heating of the ceramic mold above the alloy liquidus temperature of the alloy being cast. The mold, placed on a water-cooled chill platen, is withdrawn through a cooling zone located directly below the heating zone after being filled with molten alloy. The high thermal gradient, in combination with controlled withdrawal, allows for controlled solidification in the cast component.



VPIC Furnaces

VPIC is extensively used for the manufacture of high performance castings in the Aerospace, Industrial Gas Turbine, Automotive and Biomedical markets.

The two chamber design features a melt chamber, containing the induction melting coil, with a vacuum isolation valve separating the melt chamber from the mold chamber. The mold chamber incorporates the mold transfer mechanism allowing for the melt down of the charge in the melt chamber independent of the ceramic mold handling and transfer operations.

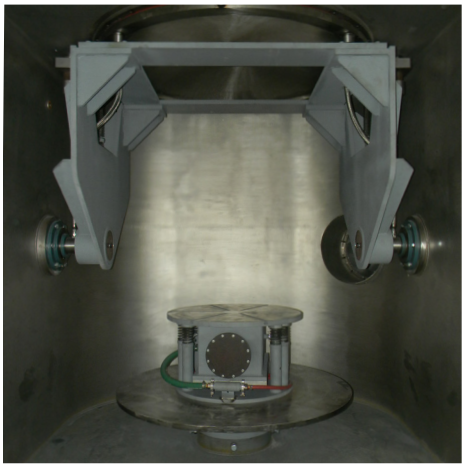


FEATURES AND ADVANTAGES

- Vertical, horizontal, or pitless vertical furnace configurations.
- Door mounted, rapid exchange melt coils, without any power connections internal to the vacuum chamber (no insulating of connections required)
- Melt coil horizontal translation system for accurate pouring with Teach Pour
- Fully electromechanical drive systems
- Horizontal or vertical billet charging with liner insertion and removal capabilites
- High speed mold transfer with multi position control (Equiax)
- Precision mold withdrawal system with electromechanical servo control (DS/SC)
- Large capacity vacuum systems for fast mold chamber evacuation
- Automatic temperature control of molten metal with optical pyrometer and immersion thermocouple
- PLC based automated controls with full SCADA
- Multi Zone Induction mold heating (Inductotherm Dual Switch)
- Automatic Baffle Exchange – Exchange baffles under vacuum without cooling mold heater

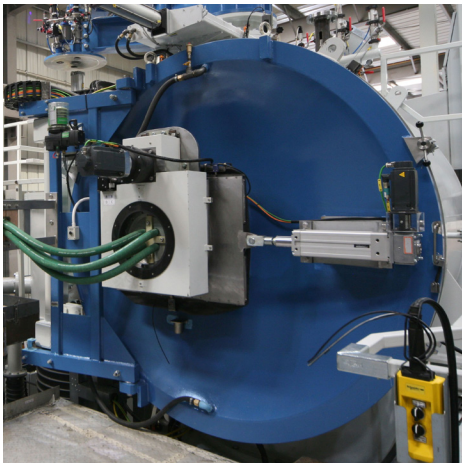
All furnace systems can be configured to meet individual customer specifications and casting requirements.

Latest Technologies



Mold Vibrator

Liner Dump



Coil Tilt & Translate

MELTING TECHNOLOGY

The productivity of an equiax furnace is limited by the rate at which the base charge material can be melted. With the assistance of electromagnetic modeling, induction power supplies can be designed with the melting power and frequency optimized for a given range of melt capacities and charge sizes.

GRAIN REFINEMENT

Finer grain equiax structures can be achieved with a mold vibration device installed on top of the mold platen. The system provides adjustable frequency as well as adjustable weights in the rotary motor to account for different mold and pour weights, while maintaining the proper amplitude and frequency.

AUTOMATIC CHARGING & LINER REMOVAL

Accurate and consistent ingot charging and spent liner removal is critical to the productivity of the casting operation. Consarc's chargers allow ingots and liners to be inserted into the crucible at the push of a button or automatically in step sequence operation. Spent liners can be automatically removed with a gripper device or overturned out of the crucible into a separate liner dump chamber.

POURING CONSISTENCY AND ACCURACY

The nature of the molten metal stream entering a mold has a significant effect on the quality of the casting. Consarc has developed translational tilt pour systems which allow the induction coil and crucible to be traversed during the pour, thus ensuring the complete molten stream enters the mold as consistently as possible from pour to pour. The translational pouring system also provides an added element of flexibility to the furnace and allows the user to pour molds with pour cups located off center in large mold configurations, e.g. large vane sections.

AUTOMATIC BAFFLE CLAMPING

The thermal baffle in a DS / SC system is sometimes positioned in place during the heater set up, with the furnace open and heater cold. Consarc has developed reliable automatic baffle clamping systems that allow the baffle to be exchanged without cooling down the heater or opening the melt chamber to atmospheric conditions. The baffle clamping system utilizes an externally-mounted actuator and internal clamps to secure and release the baffle underneath the heater. The baffle can be introduced and removed through the mold chamber in a matter of minutes thereby saving considerable production time.

Controls & Automation

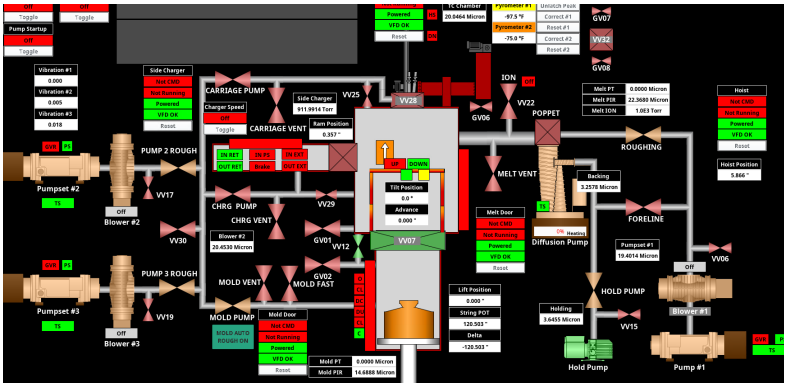
All Consarc furnace installations are supplied with a fully integrated and interlocked control system for safe and efficient operation of the furnace and its systems. The control system allows the furnace to operate in a series of automatic sequences (step sequences) created in a melt recipe. The operator is then prompted for action as required during a melt cycle. The operator has the ability to select previously defined parameters for a particular casting or alternatively create a new set of recipe parameters if required.

Teach and edit facilities have been developed to allow successful operations, such as speed of crucible tilting, position of crucible and mold location, to be saved by the computer, then edited for optimization for future reproduction in automatic mode.

The System Control and Data Acquisition (SCADA) system provides comprehensive data logging facilities along with trending and melt report generation. Consarc control systems can also be connected to a customer's factory network for data transfer and management.

As part of the Consarc DS/SC control package, a system for tracking key withdrawal process parameters is provided. These parameters are constantly compared to a dynamic alarm window with a set of historical recipe values for the same mold type.

In the event that a process variable is moving out of the anticipated levels the system will automatically alert the operator. In the event of total control thermocouple failure the operator can select to complete the cast with the furnace using the recipe kW values. This changeover would give the opportunity to save the castings which would have otherwise been scrapped without this feature.



TEACH POUR

With Consarc's teach pour system, gone are the days of different yields and inconsistency between operators on different shifts. Each part or mold can have a dedicated teach pour profile to ensure a high quality and high yield casting every time.

When set to "Teach" the SCADA system will record angular position and horizontal position of the induction furnace during the pouring operation. This data is organized in a database that can be edited to improve the smoothness of the pour or to improve the consistency of the metal pour for an individual part.

After recording and editing if necessary, the saved profile can be replicated with precision. The user selects the appropriate part and profile, and the pour profile will automatically be executed upon presentation of the mold into the melt chamber.

Equiax Casting Furnaces

In Equiax casting furnaces, no special consideration is given to controlling solidification conditions in the mold. Solidification is controlled by the users mold design and any thermal insulation placed around the mold. The resulting casting has a crystalline structure with randomly-oriented grains.

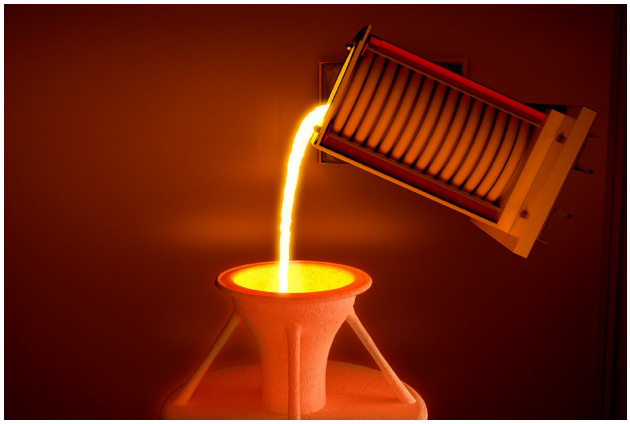
With the melting chamber under vacuum, the two-chamber design allows a pre-heated ceramic mold to be loaded into the mold chamber and the chamber rapidly evacuated. The interconnecting valve between the two chambers is then opened and the mold transported by either a vertical ram located in a pit below the furnace (vertical furnace) or trolley mechanism (horizontal furnace) into the melt chamber. Pouring is then carried out immediately. The filled mold is then retracted into the loading chamber and the interconnecting valve closed. Melting can continue uninterrupted in the melting chamber under vacuum - independent of mold handling. This maximizes the production rate of the furnace with the rate-limiting factor being the melting rate of the induction power supply.

Other operations in the melting chamber such as crucible liner removal, recharging the melt coil with pre-alloyed bars and crucible liners, taking immersion thermocouple readings, etc., are also carried out using vacuum locks so there is no requirement to break the vacuum in the melting chamber.

The semi-continuous VPIC furnace can be designed with either a vertical or horizontally arranged mold chamber, the capacity of such furnaces being only practically limited by the customer's maximum mold size.

Vertical furnaces are the most widely used and offer an excellent technical solution for the vacuum casting process with compact floor space and fast mold transfer times. A key benefit of a vertical furnace is the ability to easily manipulate the vertical position of the mold relative to the crucible lip, prior to and during the pour, to ensure the shortest metal drop height into the mold. Vertical furnaces can exceed the height limitations of some facilities, and typically require a pit to be dug in the foundation below the furnace. Horizontal furnaces do not normally require a pit, and still can accommodate very large mold sizes.

Mold Vibrator in Equiax VPIC


Equiax Pouring Metal


External Coil Tilt and T

Traverse


CONSARC
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DS / SC Casting Furnaces

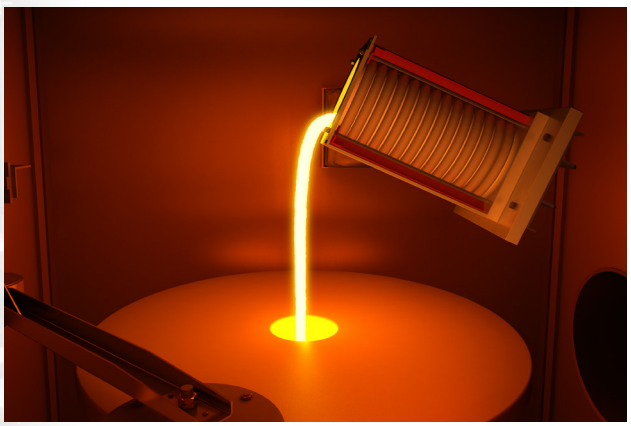
Directionally solidified and single crystal castings are required in advanced turbine technology due to their mechanical properties at very high temperature service. Furnaces designed to cast these components have additional features in order to exert a high level of control over the solidification process in the casting.

Controlled solidification furnaces are similar in general appearance to vertically orientated equiax furnaces. However, in addition to the induction melting coil, the upper melting chamber also contains a mold heating zone to allow the ceramic mold to be heated above the alloy's liquidus temperature prior to pouring. The mold heater can be single zone induction or be comprised of multiple control zones using patented Inductotherm Dual Switch technology. The molds are placed on a water-cooled chill plate on top of the mold ram. A thermal baffle is located at the base of the heater. This baffle, together with the chill plate and a water cooled chill ring directly below the heating zone, creates a high thermal gradient for directionally-controlled solidification in the cast component.

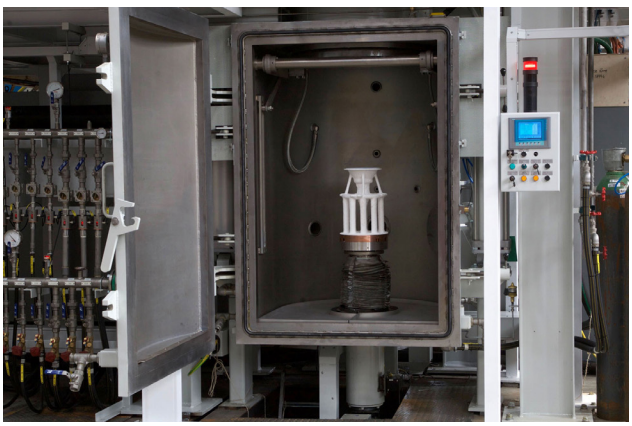
Movement of the mold into and from the mold heating zone is accomplished by an electric servo motor-driven ram assembly which is PC/PLC controlled to an exact withdrawal profile. This level of control is essential during withdrawal of the mold from the heating zone into the cooling zone in order to create the optimum thermal gradient and solidification control in the cast product.

A SC casting is produced in a similar fashion to a DS casting with the exception of a grain selector being added to the bottom of the mold.

Mold Heater



DS/SC Pouring Metal



Mold Chamber and Chill Plate

Solutions at every step

Primary Melting

Vacuum Induction Melting (VIM) is the first step in creating metals used in the most demanding applications. A VIM furnace incorporates an induction furnace within a vacuum chamber in order to prevent oxidation of volatile elements during the melting and refining stages. The end result of the process is a high purity metal with a homogenous chemical composition for use in secondary processing. Once molten and fully refined, the molten metal is passed through a preheated tundish for a final refinement before entering into ingots for further processing.

Masteralloy Vacuum Induction Melting Furnace (VIM)

Electrode Vacuum Induction Melting Furnace (VIM)

Secondary Processing

Remelting and casting are secondary melting processes used to further refine and improve the quality of materials produced from primary melting. During the remelting processes, a metal alloy ingot is melted in a controlled atmosphere environment to remove impurities and/or improve the macro and microstructure of the ingot or cast part, depending on the final application. The hallmark of secondary melting is not the melting but rather the controlled solidification which is what gives the final product its refined structure for use in high-temperature and high-stress applications.

Electroslag Remelting Furnace (ESR)

Vacuum Arc Remelting Furnace (VAR)

Vacuum Precision Investment Casting Furnace (VPIC)

Thermal Processing

Vacuum Aluminum Brazing (VAB) is a specialized process used to join aluminum components using a brazing alloy in a vacuum environment. Brazing is commonly used to join metal parts that are difficult or impossible to weld using traditional welding techniques. Other thermal processing options are also available from Consarc, designed to fit customers' specific process needs.

Vacuum Aluminum Brazing Furnace (VAB)

Vacuum Heat Treat Furnace (VHT)

Specialized Melting

Consarc offers a wide range of additional melting options. Inert Gas Atomization furnaces are used to produce metal powders with high purity and controlled particle size distribution. Vacuum Cap furnaces are versatile units capable of vacuum degassing and controlled-atmosphere melting operations.

Vacuum Inert Gas Atomization Furnace (VIGA)

Vacuum Cap Furnace (VCAP)

ONE SIZE DOES NOT FIT ALL

Considering a stock furnace option that doesn't meet your exact needs? Why not consider a custom designed Consarc furnace?

Our team of experts works with you to create tailored solutions that fit your unique requirements. We don't believe in a one-size-fits-all approach - every project is different, and we take the time to understand your specific needs before designing a furnace that meets them perfectly.

Our commitment to collaboration and flexibility set us apart from other furnace manufacturers. You'll have input every step of the way, ensuring that the final product is exactly what you need. Plus, our flexible approach means that we can adapt to changes and make adjustments as needed.

Experience the difference a custom Consarc furnace can make. Get in touch with us today!

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ABOUT CONSARC

For more than 60 years, Consarc Corporation (USA) and Consarc Engineering Ltd (UK) have been designing vacuum induction furnaces and engineering solutions for the world's most advanced materials. We believe in a partnership approach that is present through furnace design, testing, delivery, and comissioning, but it doesn't stop there. Consarc offers after-sales support for troubleshooting, process optimization, and spare parts.

In addition to a field engineering team, Consarc has a global technology team dedicated to advancing furnace technologies and optimizing machine performance. Our 'tech team' staff have far-reaching backgrounds in research and production of various materials, processes, and processing equipment. Many services are offered including full Technology Packages, melt profile development, process optimization, operator training, and metallurgical consulting.

In a world where everyone seems to be looking for a quick fix or an off-the-shelf solution, we believe that there's tremendous value in taking the time to do things right. Contact us today to learn more about our solutions and how they can benefit your business.

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