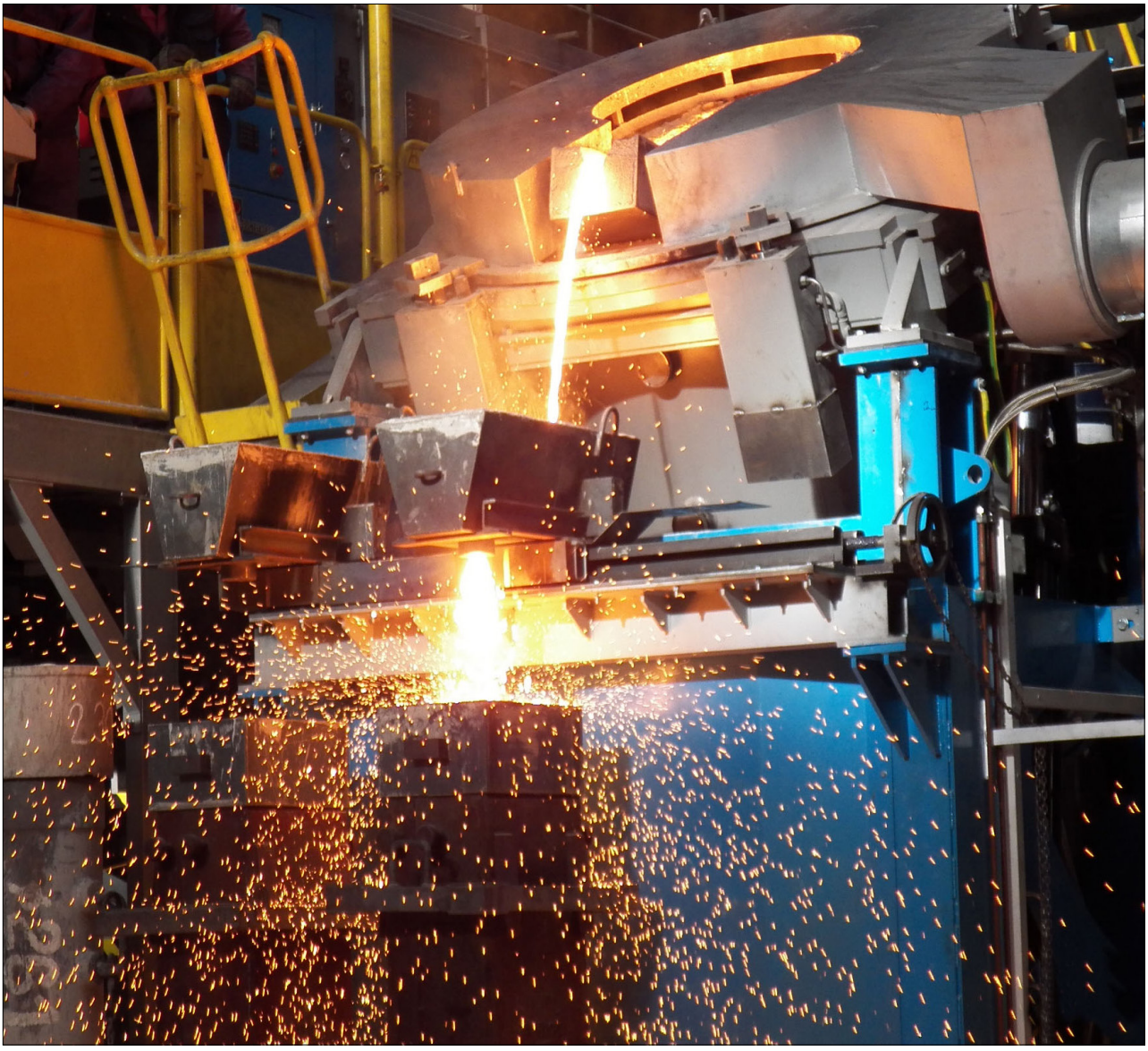
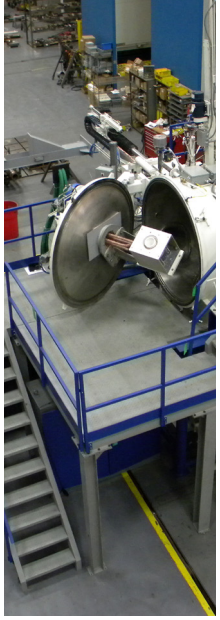
INDUCTOTHERM GROUP



Vacuum Cap Furnaces

CONSARC

Consarc Corporation | Rancocas, New Jersey



About Consarc

Consarc Corporation, located in New Jersey, USA, and Consarc Engineering Ltd, located in Scotland, UK, are part of the Inductotherm Group of companies, the leading world suppliers of induction heating and melting equipment. Whether you're melting, remelting, casting, brazing, or atomizing, Consarc has a solution for you.

EXPERIENCE

For over 60 years, Consarc has been designing custom vacuum furnaces and engineering solutions for the aerospace, energy, technology, and defense sectors. From our first Vacuum Arc Remelting Furnace in 1963 to the world's largest single-electrode Electroslag Remelting Furnace produced in 2010, Consarc has been providing the most advanced solutions to vacuum metallurgy at every step of the way. Our industry-leading measurement and control systems and automated process technology demonstrate our continual comitment to innovation and improvement.

Hundreds of Consarc furnace installations around the world attest to our proven ability to design and deliver high-performance vacuum furnaces for the world's most advanced materials. Consarc offers a wide range of furnace sizes, configurations, and options to ensure that every installation not only meets the purchaser's requirements, but is also suitable to use for decades to come.

SUPPORT

We believe that if our customers are successful, then we will be successful too. This partnership approach is present throughout the furnace design, testing, and delivery process, and continues with after-sales support to develop, carry out, and troubleshoot customers' processes.

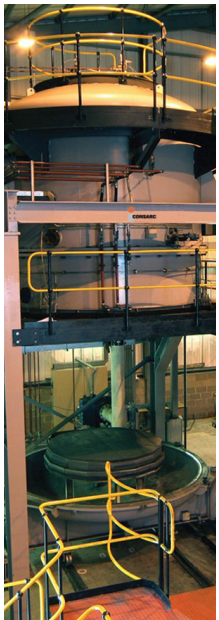
Consarc has a global technology team dedicated to advancing our furnace technology and supporting our customers with their processes. Technical staff have far-reaching backgrounds in research and production of various materials, processes, and processing equipment. Many services are offered including melt profile development and optimization, 2D/3D modeling, operator training, and on-site troubleshooting assistance.

FLEXIBILITY

If more than 60 years of experience across hundreds of furnace designs has taught us anything, it's that one size does not fit all. That's why we specialize in custom furnace solutions that are tailored to meet customers' unique needs and requirements. Whether you're looking for an upgrade or a furnace customized for a specialized application, we've got you covered.

Our experienced team of engineers and designers will work closely with your engineers, metallurgists, and maintenance personnel to understand your specific requirements and develop a furnace that meets those exact specifications. With our custom solutions and careful guidance, you can be confident that you're getting the best possible fit for your needs, without any unnecessary compromises.

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



Consarc Engineering Ltd. | Holytown, Scotland

VCAP
The Process

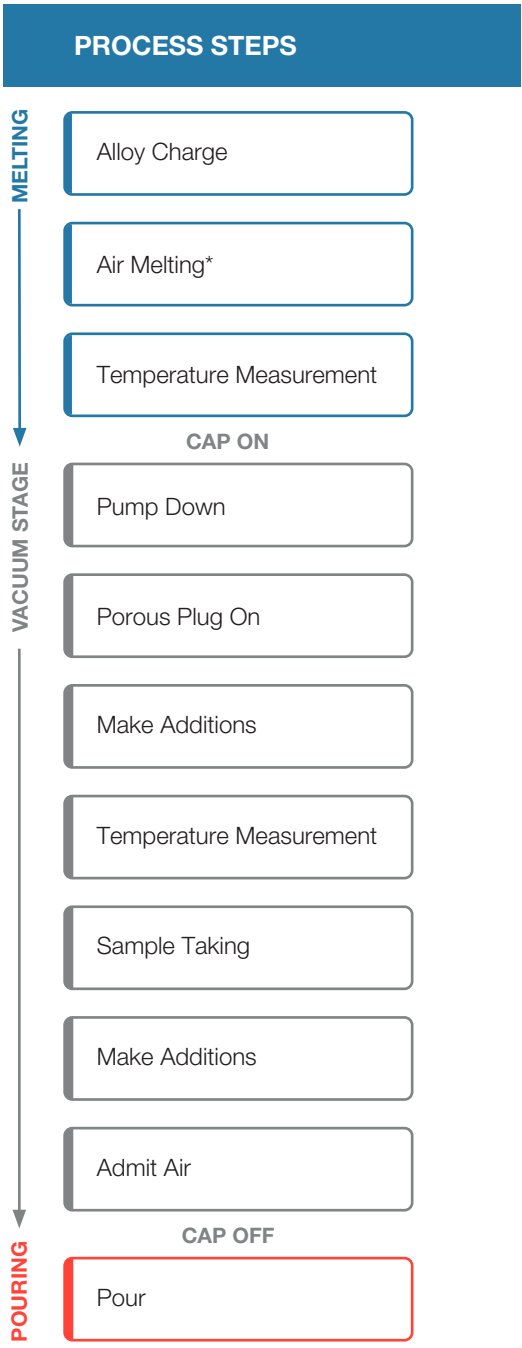
The VCAP furnace is designed for induction melting a solid charge in an air atmostphere or vacuum, with final degassing stage under vacuum. The final pouring of the metal is performed in air or under protective atmosphere of inert gas. Configuration is based on the Inductotherm range of steel shell induction furnaces which are fully adapted by Consarc for vacuum treatment of liquid metal.

The furnace shell is fully sealed for vacuum operation and a sealing flange/apron is provided on top of the unit. Following the air melt operation (or vacuum/inert gas if required), a water cooled vacuum lid can be placed on top of the furnace, either by factory crane or optional lift/swing pivot arm. The vacuum chamber is connected to a multi-stage mechanical vacuum pumping system which can evacuate the atmosphere above the molten bath.

The induction melting coil is powered from an Inductotherm VIP Power supply with the power and frequency matched for fast melt rates (high productivity) and optimum stirring (metallurgical quality) in the liquid state. The stirring frequency ensures that the alloy is fully homogenized and that fresh liquid metal is cycled to the surface of the bath to aid the degassing procedure.

Once the atmosphere is evacuated, the degassing procedure and intensified CO reaction allows removal of undesirable gases, Hydrogen, Nitrogen, and Oxygen to much lower levels than would be possible in air.

At the end of the degassing sequence, the vacuum lid can be removed and a protection ring is placed around the sealing flange. The furnace is then ready for tilt pouring into the customer's transfer ladle or molds. The pouring process is usually carried out in air, but options for pouring under protective atmosphere are also available.



** Melting might also be performed under vacuum.*

Note: This flowchart does not include any manual slag removal operations that may happen during "cap off" stages before starting the vacuum stage.

Applications

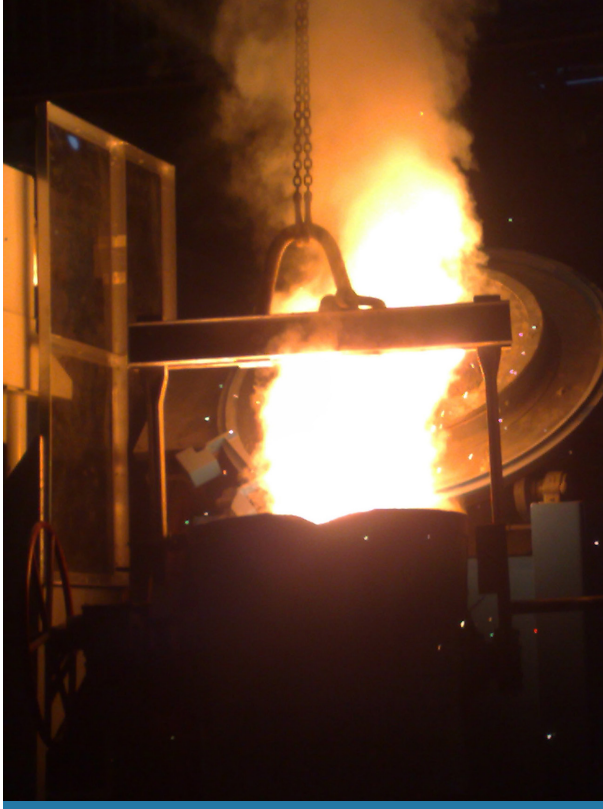
VCAP furnaces offer a compelling option for high-quality foundry applications that require an improvement on air melting and do not require full vacuum melting. VCAP furances are available to suit a wide variety of applications in sizes ranging from 50 kg (110 lbs) to 20 tons. Typical applications feature the following materials:

- Low and high carbon steels
- Stainless steels
- Cobalt-based alloys
- Tool and die steels
- Nickel-based alloys
- Non-ferrous alloys

METALLURGICAL CONSIDERATIONS

Some typical processes that can be performed in VCAP include:

- Melting conventionally in air from a solid or liquid charge. Options to melt under vacuum or controlled-atmosphere are also available.
- Controlled-atmosphere melting from solid charge
- Alloy homogenization and chemistry adjustment
- Vacuum degassing (hydrogen and nitrogen removal)
- Reduction of low vapor pressure tramp elements (e.g. Pb, Cd, Bi, Zn)
- Deoxidation using combination of vacuum and CO reaction
- Decarburization - intensified CO reaction at low pressure enabling Carbon to oxidize and be removed as CO into the surrounding environment, leaving the metal with a reduced carbon content.
- Desulphurization - use of reducing slags and/or powder injection in air or controlled atmosphere
- Argon purging of metal with porous plug
- Melt and mix of selected raw materials in batch sizes from 50 kg (110 lbs) to 20 tons



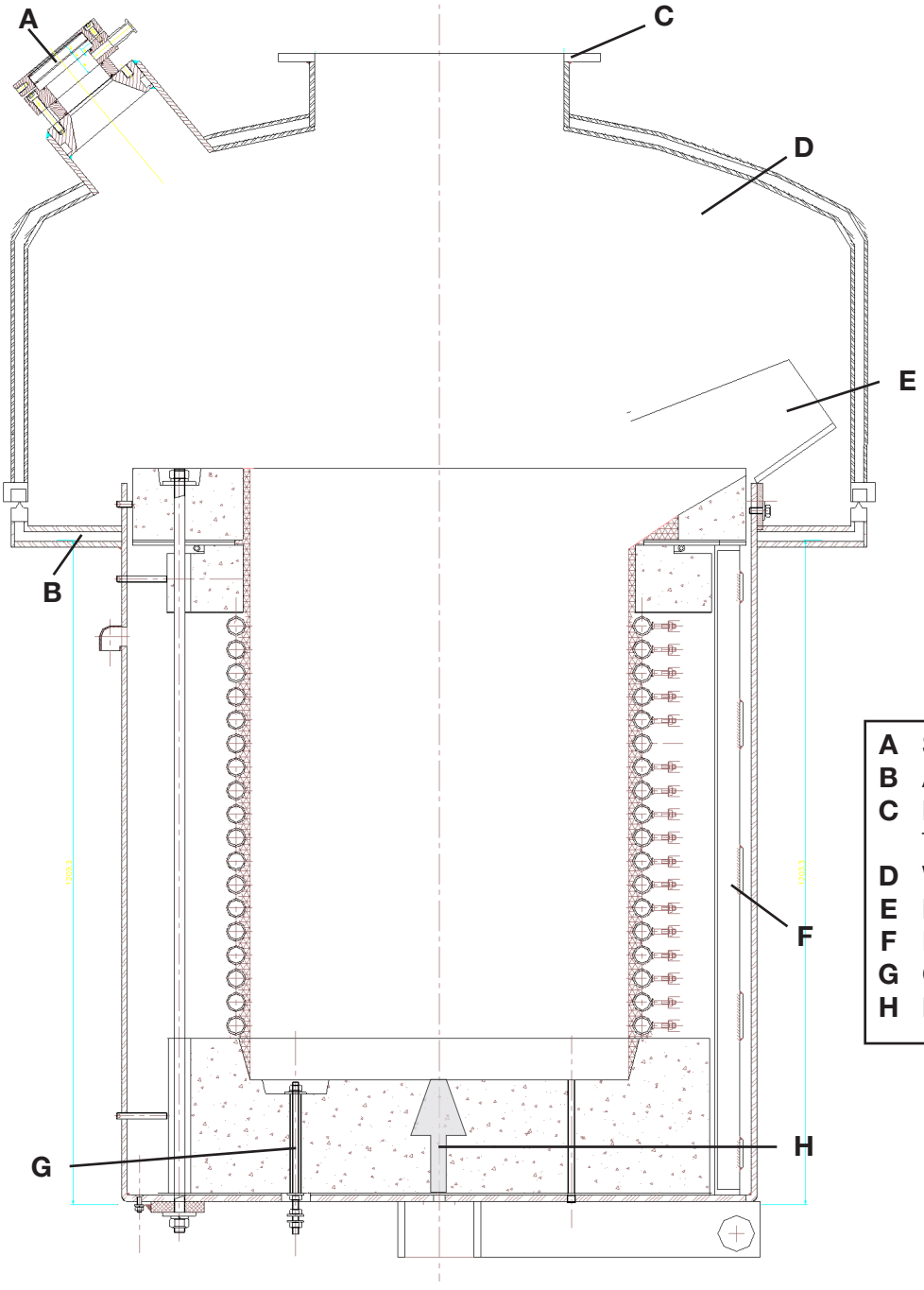
AIR MELTING CHALLENGES

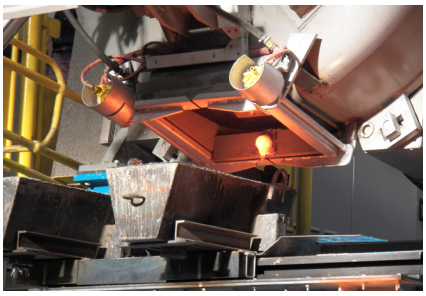
"Air melting" is the process of induction melting metals in an open atmosphere, without any special controls or conditions. The main challenge of air melting is exactly that: metal is exposed to air, which is composed of Nitrogen, Oxygen, and water vapor containing Hydrogen. These elements react with the molten metal in undesirable ways, causing impurities to form.

- *Oxygen and Nitrogen react with liquid metallic elements and give rise to inclusions in castings*
- *Hydrogen can react with metals that are notmally ductile, weakening them to the point where they can fail catastrophically. This is known as "embrittlement"*
- *Trapped gasses cause "porosity," or the formation of small voids or holes in the metal, which reduces strength, toughness, and ductility, and may decrease resistance to corrosion and other forms of degradation.*

Exposing liquid metal to a vacuum can remove dissolved gasses in the molten state to lessen the effects mentioned above. VCAP furnaces provide the flexibility to melt, refine, and pour either in air or under vacuum at any stage, offering options for a wide range of applications and materials.

Inside VCAP





Pouring spout

A	Sight Glasses
B	Apron with vacuum seal
C	Port for small charger, sampling, TC, access hatch
D	Water-cooled vacuum lid
E	Pouring Spout
F	Inductotherm Steel-Shell Furnace
G	Connection for GLD
H	Bottom Porous Plug

The “port” or “hatch” on a VCAP furnace has a variety of uses, including very quick sampling, charging, and temperature measurements using the existing air melting dipTC systems.

Flexible Design

The VCAP furnace range provides a fully-flexible, cost-effective approach to custom furnace design, with a wide range of options to best suit your technical requirements and budget.

STANDARD UNITS

All VCAP furnaces come equipped with the following features:

- Induction furnace and vacuum shell
- Water-cooled vacuum lid
- High-capacity vacuum pumping system
- Hydraulic tilt system
- Viewing ports
- Water-cooling manifolds
- Inductotherm VIP Power Supply suitable for vacuum application
- Immersion thermocouple/sampling
- Control systems

ADDITIONAL ENHANCEMENTS

Consarc offers many optional accessories that can be fitted as required, including:

- Automated vacuum cap handling
- Back tilt
- Closed-loop water cooling
- Double trunnion pour for high pouring accuracy
- Dry pumps *(highly recommended)*
- Fume ring (used during air melting)
- High-voltage supply transformer
- Hydraulic lining pushout system
- Liquid metal charge
- Manual charging hatch
- Melt manager control upgrade (see sidebar)
- Optical pyrometer
- Vacuum-sealed overmelt charger
- Porous plug inert gas (argon) purging
- Pour-through hatch - inert gas pouring
- SCADA supervisory control systems
- Scrap and raw material charging
- Spare caps

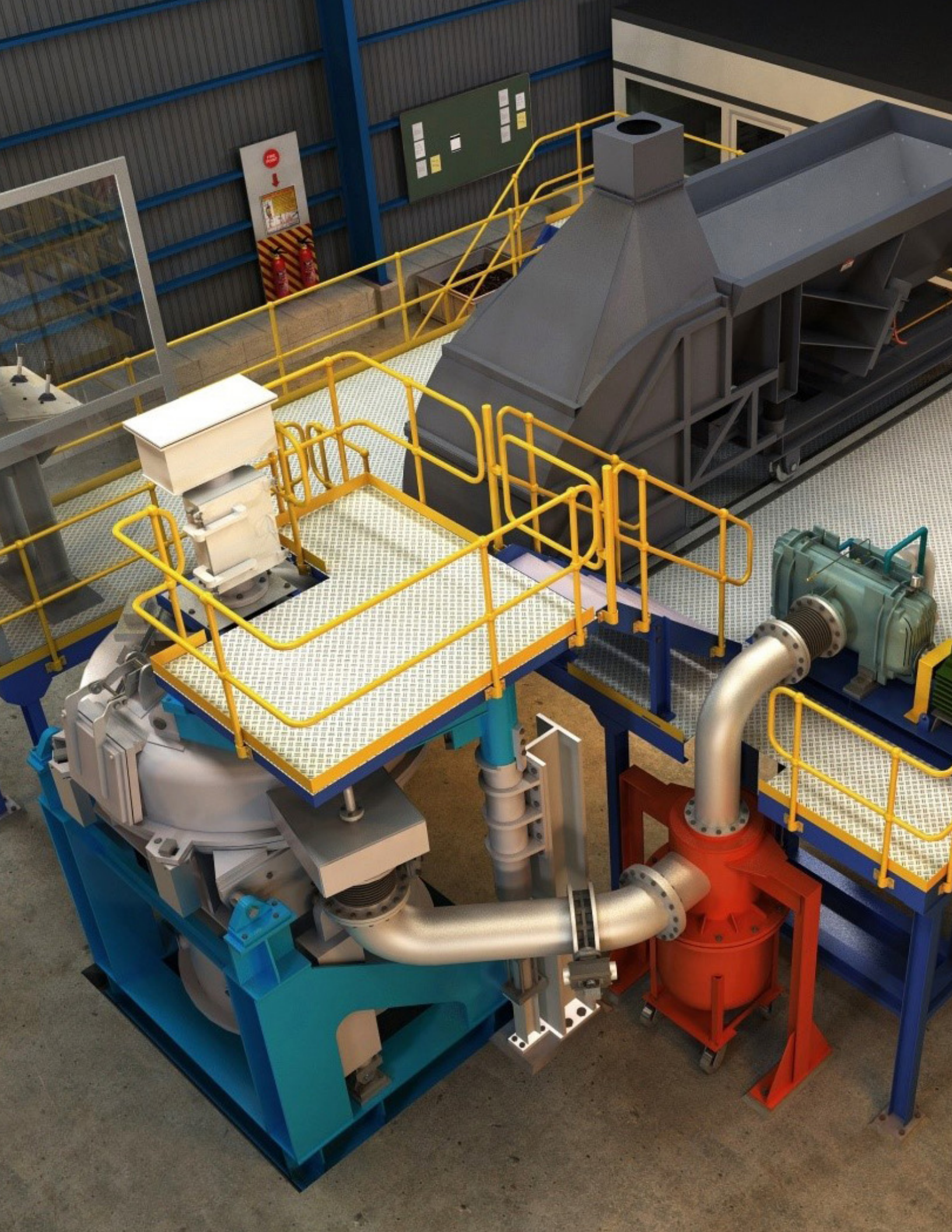
Inductotherm Melt-Manager®

Melt-Manager® Control Systems utilize embedded microprocessor controls and provide the operator with melt control modes and diagnostics for analysis and support. They integrate a color touch-screen LCD display that provides direct access to inverter information and controls.

Melt Control Modes *The kilowatt hour melting feature allows the operator to input a kilowatt hours per ton and furnace weight to calculate the kilowatt hours needed to reach pouring temperature. This also provides a safety hold power feature which maintains a furnace bath temperature when the kilowatt hour count is complete.*

Preheat Controls *The automatic cold start feature allows the operator to input a heating schedule to preheat the furnace lining to reduce manpower requirements and production efficiency. The sintering feature also improves long lining life by allowing the operator to input a heating profile to automate the sinter control process.*

Easy-to-access Diagnostics *Provides main display of equipment meters, alarms and event information with a color-coded status. The furnace inductance calculation feature can aid the operator in determining the furnace lining condition.*



VCAP Benefits

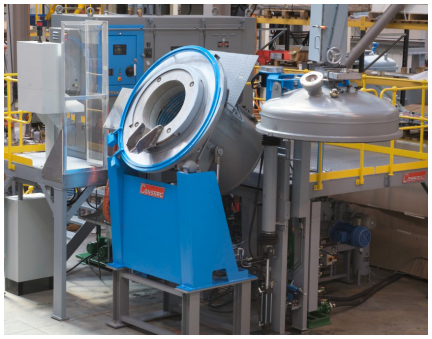
VCAP furnaces offer several key benefits for the production of high-performance alloys and other advanced materials. Some of the biggest benefits of VCAP furnaces include:

- Better micro-cleanliness and smaller residual inclusions due to strong carbon deoxidation
- Increases fluidity of metal, improving mould filling
- Significant improvement of mechanical properties
- Improvement of technological characteristics like hot workability, weldability, and machinability
- Significantly reduced scatter in product properties and characteristics resulting in less rejections
- Increased precision in chemistry control compared to air melting
- VCAP can also be used in air melting mode as needed

VCAP is a hybrid process, combining air and vacuum induction melting (VIM) technologies.

AIR MELTING

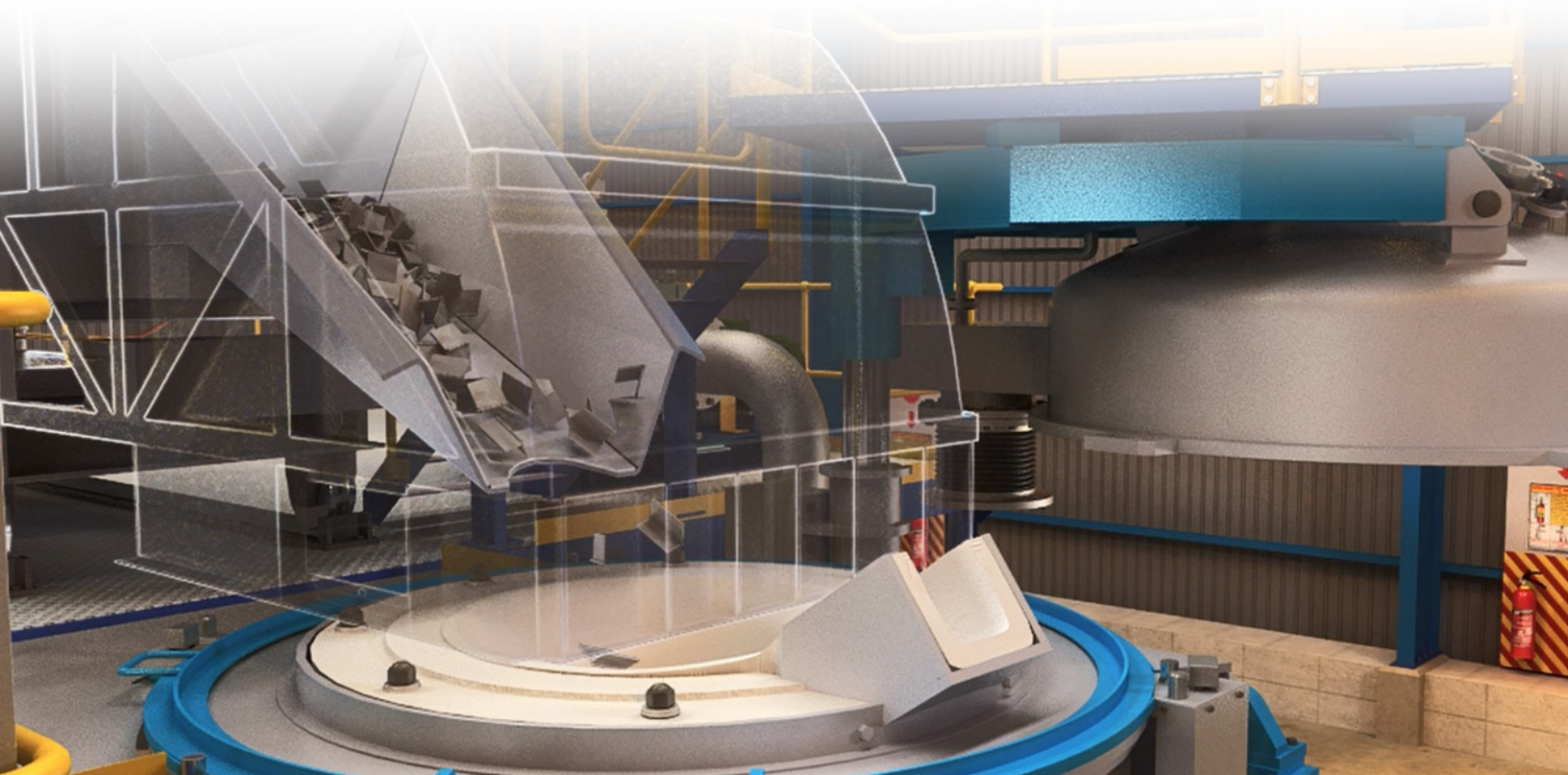
VCAP MELTING



VACUUM MELTING AND POURING

LOW ← **CAPITAL INVESTMENT / COMPLEXITY / QUALITY** → **HIGH**

Overall, VCAP furnaces offer a powerful combination of precision, purity, and flexibility, making them an ideal choice for producing high-performance alloys and other advanced materials.



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!

CONSARC
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202401

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