APPLICATION NOTE

VACUUM ARC REFINING (VAR)

edwardsvacuum.com

WHERE IS VACUUM USED?

Vacuum arc refining (VAR) is a secondary melting process that allows the improvement of ingot structure, homogeneity and cleanliness. A cylinder-type consumable electrode produced with vacuum induction melting (VIM) is placed into a cylindrically enclosed copper crucible cooled by a water jacket. The DC power supply activated between the electrode and crucible base creates an electrical arc that melts the extremity of the electrode. Metal droplets falling through the arc gap are exposed to vacuum and extreme temperature conditions, causing the removal of dissolved gases, vaporisation of elements with high vapour pressure such as carbon, sulphur and magnesium and improvement in oxide cleanliness. A new ingot is formed in the cooled crucible by directional solidification from bottom to top, avoiding macrosegregation and microsegregation.

Typical vacuum levels are in the range of 10^{-1}-10^{-3} mbar. No carrier gas is used in the process; gas load is from the outgassing of absorbed gases and vaporisation of impurities.

Magnesium Chloride is the main impurity in Titanium VAR process. Even if it is collected in cold traps and chambers attached to the reactor, it can reach the vacuum system during pump down. Magnesium Chloride has corrosive effects if it comes into contact with water vapour or if it is trapped in oil.

TYPICAL VACUUM ARC REFINING SYSTEMS

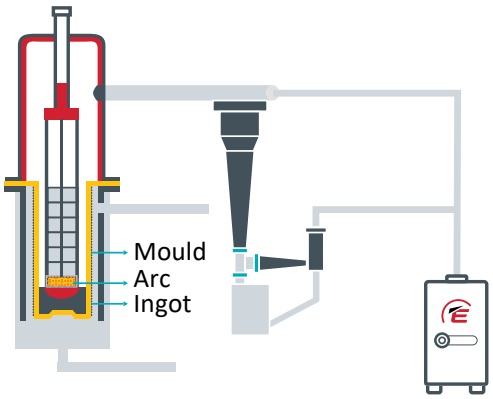
The required vacuum levels can be achieved with a vapour booster backed by a booster-primary pump combination or with a three-stage booster combination.

SOLUTIONS

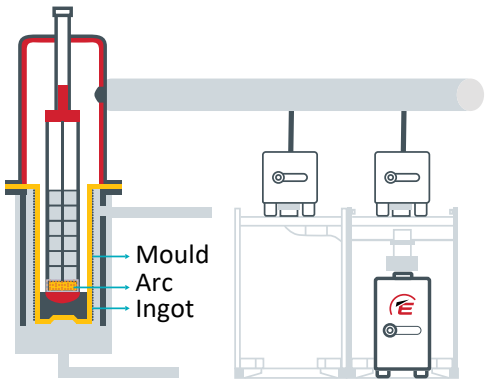
Dry pumping systems - Recommended technology	
GXS dry screw pumps and combinations	MAXX vacuum systems (GXS pump range systemised with pXH mechanical boosters)

Oil Sealed pumping systems - Conventional technology	
Stokes Microvac rotary piston pumps with the EH and 6” Stokes booster combination	Vapour booster

One - Stage Booster / Backing pump and vapour booster combination



Two - Stages Boosters and backing pump combination



Typical layout for vacuum arc refining

EDWARDS' BENEFITS

GXS DRY SCREW PUMPS

160–750 m³/h primary pumps offer pumping speeds up to 3,450 m³/h with vacuum boosters. Equipped with an intelligent on-board controller with extensive communication and automated control capabilities. These dry pump systems substantially reduce maintenance and operating costs.

Benefits:

- Increased tolerance to particles created by the melt
- Clean residual vacuum
- Capability to effectively handle corrosive dusts
- Elimination of oil back streaming, which is a source of contamination and degassing in the furnace
- Large water vapour pumping capacity aids the drying of the new chamber lining
- Elimination of oil mist at the exhaust and external oil leaks

Highly reliable
Ability to handle harsh processes

Low maintenance cost
No unplanned down time

Increased productivity
Longer intervals between services

Safe operation, consistent output
Automated control of your process

MAXX VACUUM SYSTEMS

The GXS pump range is complemented by the new generation of pXH large mechanical boosters for an integrated flexible modular skid design.

Variety of pump combinations ensure optimised configurations
Delivers the performance required by your processes

Easy to upgrade
Allows a smooth upgrade whenever you need more capacity

STOKES MICROVAC ROTARY PISTON PUMPS

Packaged with the EH range or 6" series of mechanical boosters.

Value for investment
Low rotational speed that enables the longest pump life cycle

Easy maintenance on site
Robust, simple mechanism for high reliability and ease of rebuild

Proven and tested
Time-tested, proven performance of over 80 years

VAPOUR BOOSTERS

Unique product for providing maximum pumping speed at VAR pressures in between mechanical boosters and diffusion pumps – 4,000 and 12,500 l/sec

Highly reliable
Tolerant to pumping in contaminated systems and processes

Flexibility and ease of use
Tolerant to various inlet and exhaust pressures

Proven and tested
Time-tested, proven performance of over 40 years

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