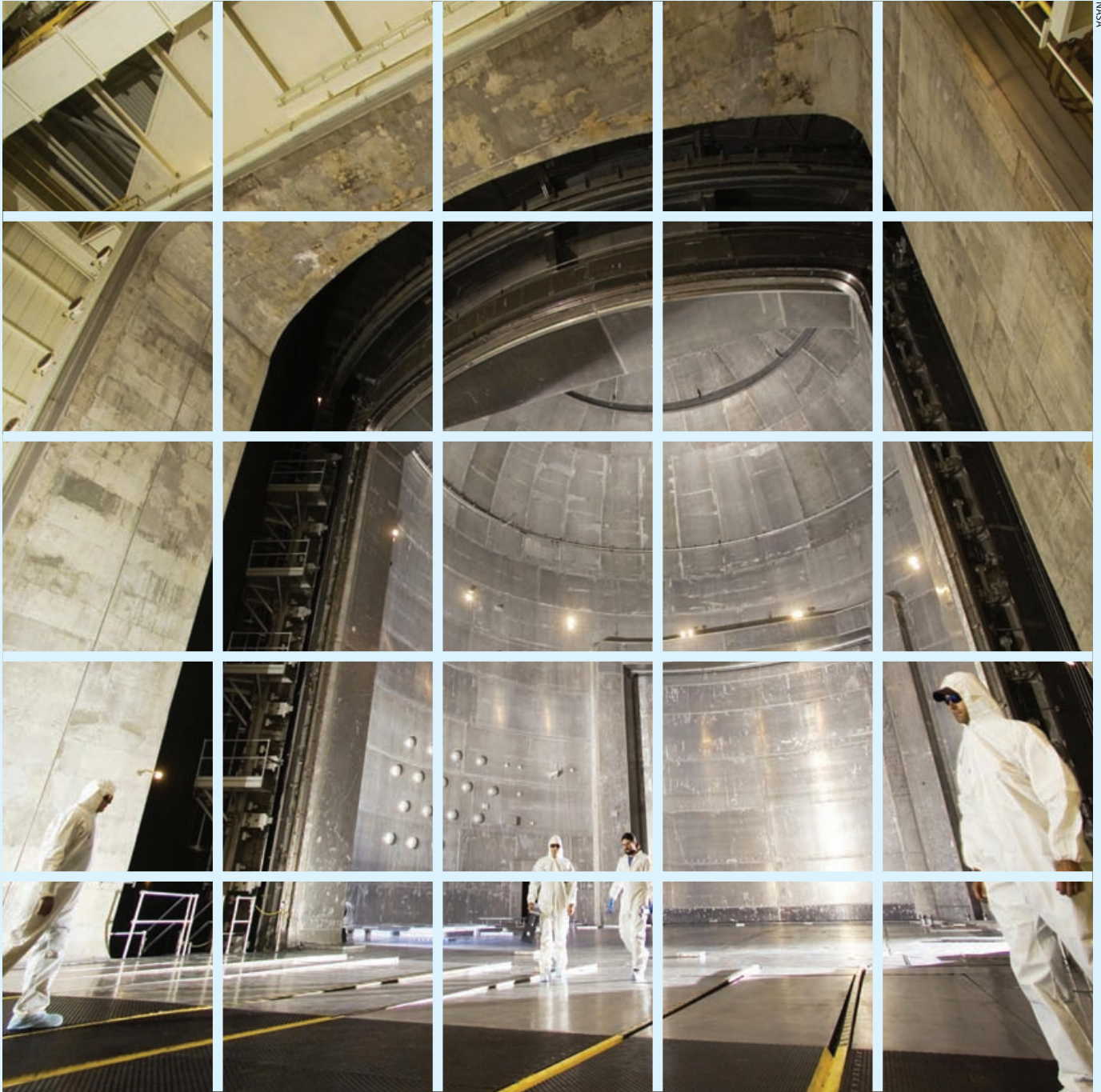


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VACUUM CHALLENGES AND SOLUTIONS



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Dry vacuum aids steel degassing

Simon Bruce and Vic Cheetham of Edwards Ltd examine how steel-degassing plants are replacing steam ejectors with modular dry vacuum pump systems.

The market for high-performance steels has experienced significant growth, driven by the needs of infrastructure projects in many regions, especially China, India, Russia, Eastern Europe and South America. Much of this demand is met by melting down scrap steel and using secondary steel-making processes, such as vacuum degassing (VD) and vacuum oxygen decarburization (VOD), to control impurity levels.

VD is usually associated with making “long products”, such as rails and beams. Liquid steel is held for a period of time under a good vacuum (typically <1 mbar) and purged with inert gas to remove lighter impurities and dissolved gases, especially hydrogen. The final hydrogen content of steel has a significant impact on its properties and durability. Less hydrogen means greater strength and resistance to cracking over the product’s lifetime.

VOD is mainly used to reduce the carbon content of special stainless steels. A medium vacuum of around 100–200 mbar is used to facilitate controlled carbon removal from the steel (decarburization) by injecting oxygen gas onto the liquid-steel surface, before continuing to a VD phase.

Both VD and VOD are often used in electric arc furnace (EAF) facilities, which process recycled scrap steel. EAFs are a flexible way of making a variety of different steels in relatively short timescales. Adding VD/VOD capability allows high-value products to be made when required.

The traditional method of providing a vacuum for VD/VOD processes is large multistage steam ejector pump systems, fed by steam boilers. These systems consume a considerable amount of energy, generate significant greenhouse gases and can be a source of hazardous air pollutants. Many melt-shop owners are turning to dry mechanical vacuum pumping systems, which offer both significant cost savings and environmental benefits.

Dry vacuum pump technology has undergone continuous development to keep pace with the demands of industry. In the steel industry, vacuum processes must operate under harsh conditions, such as abrasive dusts. Dry screw primary vacuum pumps have proved successful in these conditions, and the latest generation of double-ended dry screw pumps combine high pumping capacity with high tolerance to abrasive dusts. These pumps form the basis of Edwards’ modular pumping systems for steel-degassing plants.

Each dry pumping module comprises two stages of mechanical vacuum boosters in front of the third (final) stage dry screw pump. A module can degas around 23 tonnes of liquid steel in about 20–25 min, so a number of parallel modules are installed in each plant according to the “heat” size – the mass of liquid steel in each batch.

Additional modules can be added if production increases. Modularization results in more compact equipment that uses less electrical power, cooling water and purge gas. It also



Degassing pumping modules made by Edwards and installed in a production facility.

offers the ability to refine system operating characteristics to meet the exact needs of the process and makes the transport, installation and commissioning of equipment easier.

The modular three-stage steel-degassing system offers significant operational cost savings compared with conventional steam ejectors. The cost of energy for steam generation, routine maintenance for ejector cleaning and the strong demand for utility water, plus disposal costs of contaminated waste water, result in a significantly lower operating efficiency and higher net operating cost compared with dry systems.

The dry pumping systems, in contrast, require only modest amounts of electrical power, purge gas and cooling water. On a typical VD plant processing 300 000 tonnes of steel per year, and depending on plant configuration and utility costs, the operating costs of a dry modular system can be less than 10% of the equivalent steam ejector system. This can represent potential savings of more than €1 per tonne of steel processed, offering a short payback time.

The demand for dry vacuum pumping systems for VD and VOD processes has grown substantially. Edwards recently signed a contract to supply China’s Chong Qing Steel Group Co with the world’s largest mechanical vacuum pumping system, to be used for degassing 230 tonne quantities of liquid steel in each batch. The pumping capacity of this system will be a world-beating 1000 000 m³/h pumping speed at a vacuum level of 0.67 mbar.

The trend away from traditional steam ejectors towards dry modular vacuum pumping systems for steel degassing is expected to continue for the foreseeable future.

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