AN INVESTMENT CASTING UNIT IN RAJKOT, RIC01, ADOPTS LOW CARBON TECHNOLOGY

Gas Heat Pump technology for improving energy efficiency

Tags

Sub-sector:	Foundry
Location:	Rajkot
Partners:	JICA, JST, IGES, TERI
Year:	2013

Background

Rajkot, located in the state of Gujarat, is an important engineering cluster in the country. The cluster is renowned for its entrepreneurship and product specialization. There are an estimated 2200 engineering units in the cluster, the majority of which are in the small-scale sector. These engineering units manufacture a range of products such as castings, pump-sets, automobile components, diesel engine generating sets, bearings, machine tools and so on. Rajkot is a prominent foundry cluster in India, with over 500 foundry units. Rajkot hosts the highest concentration of investment (precision) castings units in India—about 70 out of a total of 120 units in the country. Most of these units are members of Rajkot Engineering Association (REA). Many of the investment casting units sell their products to multinational firms, and some are also exporting to countries in Europe, the Middle East and the Southeast Asia. The investment casting units use electricity, natural gas (NG) and other fuels in their processes.

Investment casting—technology

Investment casting is one of the oldest known techniques of metal-forming. The term 'investment' comes from the traditional solid mould process, in which a plaster-like material (stucco) is poured or 'invested' into a container holding an assembly of wax patterns that are identical to the final metal products desired. After the plaster has set, the disposable wax patterns are melted and/or burned off, leaving hollow cavities into which molten metal is poured to yield the desired products. Beeswax was used 5000 years ago to make the wax patterns; today, the patterns are made using high technology waxes, refractory materials and specialist alloys. In the typical 'lost wax' process used today, wax is injected into an aluminium die to produce a wax pattern that is an exact replica of the desired component. A number of such wax patterns are assembled around a sprue (i.e. a central wax rod which acts as a channel through which molten material is introduced into a mould), repeatedly dipped into a vat of agitated ceramic material, and allowed to dry. The ceramic coated moulds are then de-waxed by heating in a wax bath or autoclaving. The hollow ceramic shells that remain are pre-heated, and molten metal is poured into them to produce the required castings. The shells are cooled; the ceramic material is removed from the metal castings by water blasting or vibrations; and the castings are separated from the sprue and cleaned.

The investment casting process allows the production of castings with utmost accuracy, repeatability and versatility in a variety of metals and high performance alloys, making it the most preferred method to produce dimensionally accurate high-precision casting components for major industry sectors such as automobiles; general engineering; valves, compressors and pumps; pharmaceuticals; textile and sewing machinery; defense equipment; food processing machinery; power and hand tools; and so on.

Intervention

With an objective to promote application of ‘low carbon’ Japanese technologies among SMEs in India, the Ministry of Environment and Forests, Government of India (MoEF) and the Government of Japan initiated a research project titled ‘Research Partnership for Application of Low Carbon Technology for Sustainable Development’. The project is funded by Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA), with TERI and Institute for Global Environmental Strategies (IGES), Japan as the research partners. Under the project, feasibility studies were conducted before undertaking demonstration of cleaner technologies from Japan among Indian SMEs. Gas heat pump (GHP) has been successfully demonstrated in selected investment casting SMEs in Rajkot and demonstration of electric heat pump (EHP) technology is planned in a chocolate factory in Gujarat and a dairy unit in Chandigarh. The project also aims to implement best operating practices for air compressor and induction furnace systems in various SME sub-sectors. A Joint Coordination Committee has been set up to guide the research activities under the chairmanship of MoEF.

A small-scale investment casting unit in Rajkot, RIC01, was selected for demonstration of an energy efficient GHP air conditioning system developed by Japanese manufacturers. The unit uses the lost-wax process to manufacture precision investment castings of ferrous and non-ferrous metals, alloys and super alloys.

The project conducted detailed studies at the unit to gather baseline performance data and identify possible energy saving options. Based on the studies, the project recommended the installation of an energy efficient GHP air conditioning system to replace the existing electrical air conditioning system for drying castings. In the electrical drying system, electricity was drawn to run the compressor and the refrigerant used was R-22, an ozone depleting substance. The GHP air conditioning system uses a NG-based engine to drive the compressor, and the refrigerant used is R410A, which has zero ozone depleting potential.

GHP system – outdoor unit (L) indoor unit (R)

In a gas heat pump (GHP) air conditioning system, a gas engine is used to drive the compressor. Only the fan and peripheral equipment consume electricity. Hence, the electricity consumed by a GHP system is much less than that consumed by an electrical system of similar capacity.

Investments, energy savings, and other benefits

The GHP system was designed and customized by a Japanese manufacturer, YANMAR Energy System Co. Ltd, and commissioned at the unit in February 2013. The project has been monitoring the performance of the GHP system following its commissioning. The preliminary results establish the reliability and viability of the system. Installation of the GHP system required an investment of around 2.8 million rupees, compared to around one million rupees for the electrical system. However, the primary energy consumption of the pilot GHP system (179 million kcal/year) is just about half that of the electrical system (342 million kcal/year). This represents a 48% reduction in primary energy consumption. In terms of curtailing greenhouse gas emissions, this translates to a reduction of 54 tonnes of CO_2 emissions each year. Also, the shift to using the ozone-friendly R410A refrigerant represents a small but significant step towards preserving the ozone layer.