A DAIRY UNIT IN PUNJAB, PD01, ADOPTS LOW CARBON TECHNOLOGY

Electric Heat Pump technology for improving energy efficiency

Tags

Sub-sector:	Dairy
Location:	Punjab
Partners:	JICA, JST, IGES, TERI
Year:	2013

Background

The dairy industry is of crucial importance to the Indian economy. India is the largest producer of milk in the world (about 128 million tonnes annually) and also the world's largest producer of dairy products by volume. The Indian dairy industry boasts of an annual growth rate of 7%, and exports of dairy products have been growing consistently at about 25% annually. The dairy industry plays a key role in providing employment and income generating opportunities for millions of rural families, particularly for marginal farmers and women. Cooperatives account for about 60% of the installed milk processing capacity. At the village level, cooperative societies of milk producers undertake the collection, chilling and transportation of milk to the processing plants. The milk is processed and marketed by 170 milk producers' cooperative unions at the district level, which federate into 15 State Cooperative Milk Marketing Federations at the state level.The National Dairy Development Board (NDDB) is the apex institution responsible for the development of the dairy sector.

Despite its impressive and growing production levels, the Indian dairy industry is finding it hard to meet the escalating demands for milk and dairy products arising from changing consumption habits and rapid urbanization. Most of the small and mediumsized (SME) dairy units use conventional-design steam generators (boilers) and refrigeration plants that are low in energy efficiency, and typically account for more than 75% of the total energy costs. Hence, the dairy industry is looking for modern, energy efficient technologies that would help units improve their productivity and profitability by reducing energy costs.

Dairy technology

The basic manufacturing process in dairy units requires both chilling and heating applications. At the village-level collection centres, the milk is chilled to 4° C or below to ensure that it remains fresh during transport to the processing plants. Here, the milk is pasteurized by heating it very rapidly to a high temperature for a precise duration of time, and then quickly cooling it to 4° C or below. This destroys the bacteria naturally present in

the raw milk, and helps preserve the milk for a longer period. The pasteurized milk is then packaged for distribution to consumers.

Intervention

In this backdrop, TERI in partnership with Institute for Global Environmental Strategies (IGES), Japan undertook a project to identify, demonstrate and promote the application of an energy effi cient, low carbon technology (LCT) in the Indian dairy industry. The project is part of a larger research collaboration titled 'Research Partnership for Application of Low Carbon Technology for Sustainable Development' (ALCTS), funded by Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA), which aims to promote Japanese LCTs in energy intensive MSME sectors in India.

The project conducted feasibility studies on a range of LCT options available with Japanese manufacturers, and EHP Unit finally selected the electric heat pump (EHP) technology for demonstration in the Indian dairy industry. In parallel, the project conducted a number of surveys and site visits to different dairy clusters/units in India, based on which the project selected two dairy units for demonstration of EHP technology: one each in the states of Punjab and Gujarat. These states are among the leading producers of milk and dairy products in India (Punjab produces 9.5 million tonnes of milk annually, while Gujarat produces 9.8 million tonnes/year). They host a large number of dairy-based SMEs, and hence offer enormous potential for energy savings and reduction of carbon emissions through the adoption of LCTs by dairy units. This case study focuses on demonstration of EHP technology in a dairy unit of the Punjab State Cooperative Milk Producers' Federation Limited (MILKFED).

Energy and emissions profile of Punjab dairy cluster	
Total energy consumption	4.7 Pj
Specific energy consumption (average)	0.51 GJ/tonne
Total CO_2 gemeratopm	0.54 million tonnes
Emission intensity	0.06 tCO_2/t product

The project conducted detailed studies at the dairy plant to gather baseline performance data and identify possible energy saving options. The existing equipment in the plant included a chilling facility, two boilers operating on furnace oil (of 4 tonnes and 3 tonnes capacity), and production equipment such as pasteurizer, milk separator, dryer, butter churner, etc.

Based on its analyses, the project recommended the installation of an EHP system which would simultaneously provide pre-heated supply water to the boiler facility and pre-cooled return chilled water for the chiller facility.

EHP technology

An EHP system works on the principle of the 'heat pump'. This is the cyclic process in which heat is taken up from an area of cold temperature and discarded into an area of high temperature.A heat pump cannot operate by itself; it requires an external energy source. In an electric heat pump (EHP) system, electrical energy is used to drive the heat pump.

In simple terms, an EHP system utilizes the heat emitted by a refrigeration process to heat water. Thus, EHP technology provides heating as well as cooling output simultaneously. EHP systems are very suitable for the dairy industry, as they can be used to meet the process cooling and heating requirements of a dairy unit, while reducing the load on its existing boiler and chilling plant.

Investments, energy savings, and other benefits

The EHP system was designed and customized by the Japanese firm Mayekawa. It was installed, integrated with the existing systems at the dairy plant, and successfully commissioned in June 2013, under the guidance and supervision of the project team from India and Japan. The EHP system uses CO2 as a refrigerant, and is designed to preheat boiler feed water to around 80° C, and cool the return water for the chiller by about 4° C. The project has been monitoring the performance of the EHP system following its commissioning. The results so far indicate that with a potential annual operating time of 3672 hours per year (i.e.12 hours daily for 51 weeks of the year), the EHP system is achieving an annual primary energy saving of about 35%, or 19 tonnes of oil equivalent (toe). In terms of curtailing greenhouse gas emissions, the EHP system is achieving an annual reduction in CO_2 emissions of 62.6 tonnes (about 38%).The dairy plant personnel have been trained in the operation and maintenance of the EHP system.

About 50 other dairy units in Punjab and Gujarat could potentially adopt the EHP system similar to the demonstration plant. These replications would result in a saving in equivalent primary energy of 952 toe/year, and a reduction in CO2 emissions of 3128 tonnes/year.

EHP Unit