Why can’t we be friends?
Mech services plumbers vs RAC mechanics
Heat pumps have been used in industry for the past decade or more. Although the use of high-temperature heat pumps in Japan is commonplace, it is almost unheard of in Australia. However, with rapidly escalating gas prices, the highly efficient production of heat – particularly from waste streams – has brought heat pumps to the attention of the local food-manufacturing sector, as Sean McGowan reports.

But more recently, developments in industrial high-temperature heat pumps that can heat air or water to 90°C plus with high COP – combined with historically high gas prices – have made their use in the food-processing industry an attractive proposition. Anywhere where heating is done by high-priced gas, LPG or electric resistance heaters, heat pumps could be an option worth considering.

The most economical applications of these high-temperature heat pumps occur where they are used to recover heat from warm streams, from moist air (such as the recovery of the latent heat from the exhaust of washers or dryers), or where they can be used to simultaneously cool one stream and heat another. In these cases the effective COP can be well over 5.

ENERGY PRODUCTIVITY

Like so many others, the Australian food-processing industry has been impacted significantly by rising energy prices. Businesses on the east coast of Australia have seen a rapid escalation of gas prices in the past two years, with many companies seeing contract prices rise to $12/GJ or more.

For these reasons, increasing numbers of food-processing businesses are turning to “behind-the-meter” renewables and technologies to improve process efficiency and energy productivity (EP), thereby reducing energy consumption and costs.

As reported by IT Power for the Australian Renewable Energy Agency (ARENA), high-temperature (HT) heat pumps are being highlighted as one technology that could meet some of the 35PJ (petajoule) of energy used to produce high-temperature heat for the Australian food industry.
A2EP released a report, The Next Wave, early in 2017 documenting opportunities to improve energy productivity in the food value chain using innovative technologies and business models," says Jonathan Jutsen, Chair of the A2EP.

One of the key transformative changes identified in the report was the electrification of food processing, which is displacing fossil-fuel fired boilers and steam systems with non-thermal processes and point-of-end-use heating technologies like HT heat pumps.

“We call this change transitioning from Industry 1.0 (the steam age) to Industry 4.0,” says Jutsen. “Heat pumps have a special role through their potential to capture waste heat and upgrade it for reuse in processes.”
HIGH-TEMPERATURE HEAT PUMPS

Following the identification of HT heat pump potential in The Next Wave report, A2EP has assessed the opportunities for HT heat pump measures in the food value chain. High-temperature heat pumps for the Australian Food Industry was released last month. According to the A2EP report, HT heat pump technology has developed rapidly in the past decade, particularly for heat pumps delivering temperatures more than 80°C — and up to 140–150°C for cascaded or multi-stage heat pumps.

Because heat pumps are more efficient when operating across a smaller temperature difference (about 2–4 per cent per degree reduction), systems that use multiple heat pumps in a series can achieve large efficiency improvements — so they can operate across larger overall temperature differences at high efficiencies,” it says.

Developments in Japan have included the commercialisation of packaged heat pumps using CO₂ to produce hot water up to 90°C with a heating capacity of up to 72kW, and hot air up to 100°C with a heating capacity of 110kW. These can deliver a CoP of 4.2 and 3.7, respectively.

Other technologies have achieved heating and cooling of circulating water and steam generation using a reverse Rankine cycle (CoP of up to 5), while industrial heat pumps have reportedly been developed to provide steam at 120°C to 165°C using cascading and multi-stage approaches (CoP of 2.5).

“Improving technologies and economies of scale of production of packaged units are making heat pumps more competitive, supported by declining costs of renewable electricity (and energy storage) and increasing costs of natural gas.”

The applications for Australian food processing are many, and vary according to the industry sector. They can include dryers, food washing, water heating for process and cleaning, pasteurisation and combined process heating and cooling, such as the case in the production of bread. Waste heat can be captured from waste-water streams, hot humid air, or condenser heat from refrigeration systems, for reuse in these processes.

The report says a number of factors need to be considered in assessing the overall economics of heat pump use. These include the relative price of electricity and available fuels, the lift temperature (between the waste-stream temperature and the process need), the capital cost of the heat pump, the ability to simultaneously deliver multiple functions (heating and cooling) and the operating hours of the heat pump.

Importantly, the report says, heat pumps can be the solution to replacing antiquated steam systems that have very poor overall efficiencies. This is often not appreciated by users because the losses are many and varied through the system.

“By replacing whole-steam systems with non-thermal processing, and point-of-use heating, much greater savings can be achieved,” the A2EP report says.

“Heat pumps can often also deliver other business benefits, including improved plant reliability, reduced system maintenance, enhanced controllability leading to improved product quality, increased throughput, reduced water consumption and environmental management costs, space savings and improved working conditions (less noise and heat).”

BARRIERS TO APPLICATION

A number of barriers to the application of HT heat pumps in the Australian food-processing industry exist, including capital cost, a lack of energy-efficiency incentives and government promotion (which drove their adoption in Japan), and a lack of awareness and knowledge of how to achieve the most economically attractive application of the technology.

“Based on interviews with stakeholders, most manufacturing businesses have very limited knowledge of high temperature heat pumps and potential applications,” says the A2EP report.

A lack of local technical expertise, experience and infrastructure was also identified by the report as a potential barrier.

Heat pumps can be the solution to replacing antiquated steam systems that have very poor overall efficiencies.

“While there are at least four companies that have come forward in stakeholder meetings with the interest and capacity to supply high-temperature heat pumps in Australia, there are only a relatively small number — probably less than five — high-temperature installations in the Australian food industry.”

Despite the lack of local experience, the Australian Alliance of Energy Productivity believes there is enough potential identified through its report to justify further actions to promote the use of HT heat pumps in the Australian food industry.

This could include the piloting of heat pumps in the most promising applications, with strong replication potential exists, including conducting some demonstration projects of the replacement of whole-steam systems.

THE AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY (A2EP)

The A2EP is an independent, not-for-profit coalition of business, government and environmental leaders promoting a more energy-productive and less carbon-intensive economy.

Among its work is the 2xEP project, which aims to double Australia’s energy productivity. It has identified two value chains — food (farm to plate/export) and shelter (focusing on construction materials) — where emerging technologies and new business models can substantially improve energy efficiency beyond the impact of current leading practice in Australia.

The High Temperature Heat Pumps for the Australian Food Industry: opportunities assessment report is the first to emerge from the food value chain.

It was produced with the funding support of the NSW Office of Environment and Heritage and Sustainability Victoria, and the support of RMIT University and AIRAH among a host of industry stakeholders.

Go to www.2xep.org.au/innovation-next-wave.html