Waste heat with huge potential

The dairy industry can achieve profitable reductions of energy through systematic approach and waste heat recovery.

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A systematic approach for analyzing the energy use in dairy factories is the key to obtain the maximum of possible energy and economic savings, while taking advantage of the latest technological developments.

An analysis made within the research project THERMCYC for the utilization of industrial excess heat in Denmark showed that there are large opportunities to reduce energy use by smart integration. It was found that in Denmark the excess heat from the food industry alone is equal to the heating demand of around 150,000 households.

Focus on the dairy industry

The dairy industry was early in the research project identified as a promising sector, where the new developments could be integrated and lead to a considerable reduction in energy use. It was found, that in Denmark the dairy factories are responsible for one quarter of the waste heat from the food industry. In particular drying, evaporation and refrigeration processes cause these large amounts of waste heat.

Systematic approach for successful integration

The work with opportunities to minimize the amount of excess heat and thereby saving money has to be approached with a strict bottom-up analysis. It is important to obtain a complete overview of all the energy using processes as well as the energy supply of the dairy factory, before decisions for optimizations are taken. This will avoid wrong prioritization of projects and bad investments.

The first step is an energy mapping, where the energy need for all processes with heating and cooling demands and utility systems are systematically analyzed. With the energy mapping in place it is then possible to assess the state of energy efficiency, from which suggestions for improvements can be made.

The optimization should be done by the following steps:

- Optimizing the energy need by challenging process parameters and equipment design
- Internal process integration
- Optimizing energy distribution systems
- External production process integration
- Optimizing utility systems
- External heat recovery

The consultant company Viegand Maagøe who is participating in the THERMCYC project has with success assisted a broad variety of Danish and international companies in working with this systematic optimization method.

Heat pump technology with cost-effective integration

The temperature of the waste heat will often be below the required process temperature. In these cases, heat pumps can be used to lift the temperature of the waste heat to higher temperatures. New developments made within the THERMCYC project show, that the performance of the heat pump can be increased with up to 40 %. Higher temperatures will make the utilization of heat pumps an interesting option for drying, pasteurization and sterilization processes in the dairy industry.

CO_2 neutral utility system and export of heat

After the processes have been improved, the utility system should be optimized, and cost-efficient and environmental alternatives should be assessed. Increased efficiencies of heat pumps, meaning less electric energy required to increase the temperature, make it interesting to replace existing utilities, e.g. natural gas fired boilers. If the electricity is generated from renewable sources, the CO2 emissions can be considerably reduced. There is also the opportunity to produce process heat and cold water in the same heat pump, to further increase the degree of utilization (external process integration).

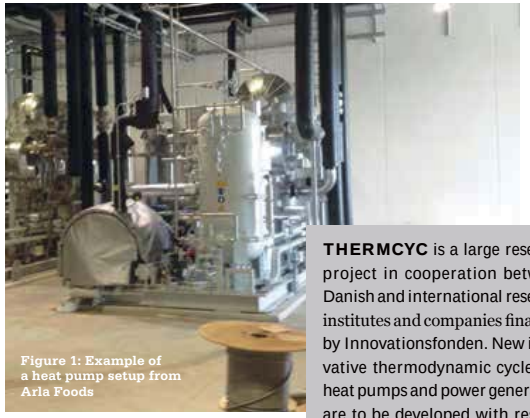

Figure 1: Example of a heat pump setup from Arla Foods

At the end the remaining excess heat, e.g. drying air or condensate, should be utilized outside of the factory (external heat recovery). This can, for instance, be other industrial sites with heating demands or district heating networks. Studies, made within the THERMCYC project showed that there is a large potential of exporting waste heat. Excess heat from a milk powder factory could supply up to 4.000 households with district heat. ■

THERMCYC is a large research project in cooperation between Danish and international research institutes and companies financed by Innovationsfonden. New innovative thermodynamic cycles for heat pumps and power generation are to be developed with respect to excess heat in Denmark. The projects partners are the Department of Mechanical Engineering and Chemical Engineering at the Technical University of Denmark, Aalborg University, Danish Technological Institute, Viegand Maagøe, AP Møller Mærsk, Danfoss, Arla Foods, Alfa Laval, Technische Universität München, Delft University of Technology and MAN Diesel & Turbo.

Heatpump reduced Arlas gasconsumption with 30 pct.
Several examples from Denmark confirm that it is both technically and economically feasible to utilize waste heat. As an example, Arla Foods has been working systematically with energy optimisation, based on the principles described in this article. This means that Arla Foods has made a complete mapping of energy on all sites. From the energy maps it became clear that there was potential for utilizing waste heat both internally and externally. The internal waste heat could be utilised both directly and by the use of a heat pump.

The heat pump can act as a cooling and heating device covering the cooling demand at 2 °C and at the same time covering the heating demand at 85 °C. Cases from Arla Foods show that by making this integration the consumption of natural gas could be reduced by more than 30 %. These potentials would not have been fully exploited if Arla Food had not worked systematically with the energy optimisation.