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Waste-heat recovery system saves energy at drying facility

Waste-heat recovery using a heat wheel

Summary

A waste-heat recovery system for flue- and exhaust-gas applications up to 200°C has been developed and installed by Ecopower Pty Ltd for a labelling-paper manufacturer, Jac Australia Pty Ltd in Tottenham, Victoria. A novel rotary heat exchanger with up to 95% heat-recovery efficiency, showing minimal pressure drop, is used to preheat fresh air for an industrial labelling-paper machine using waste heat from the contaminated dryer exhaust. The fuel consumption of the dryer has been reduced by 30% and the installation achieved a payback period of approx. two years.

Highlights

- **Savings up to AUD 30,000 per year**
- **Payback period of approx. 2 years**
- **Suitable for most industrial applications with exhaust temperatures up to 200°C**

The interior of the rotary heat exchanger as used in the adhesive labelling dryer at Jac Pty Ltd.

Aim of the Project

Labelling-paper machines continuously require large amounts of heat to dry the adhesive that is spread as a thin layer on one side of the processed paper. The dryer is indirectly heated by heat-transfer oil, which, in turn, is heated by a natural-gas-fired oil heater. Fresh air is blown into the dryer, where it is brought up to temperatures ranging from 80°C to 200°C, depending on the actual drying process being used. During the drying process the fresh air is contaminated by evaporation of solvents and drying products from the labelling paper. The disposal of these contaminants is effected by a hot air vent in the roof. The contaminated exhaust air cannot be recycled back into the dryer. However, heat recovered from a large portion of the exhaust heat can be used to preheat fresh air, thereby enabling significant reductions in fuel consumption. A newly developed air-to-air rotary heat exchanger (heat wheel) has been installed for this purpose at the labelling-paper manufacturer Jac Australia Pty Ltd in Tottenham, Victoria.

The Principle

A waste-heat recovery system using a rotary air-to-air heat exchanger, or heat wheel (the Ecopower Recovery System) has been installed at Jac Australia Pty Ltd to recover waste heat from an adhesive labelling dryer. Ecopower designed and developed a highly efficient heat wheel with optimum heat-transfer qualities and low pressure drop. Figure 1 shows a schematic of the heat wheel.

The heat wheel is constructed using a high-temperature-resistant plastic film, which forms the matrix for heat transfer and is capable of operating in exhaust or flue-gas waste-heat recovery applications at temperatures up to 200°C. The plastic film is capable of handling temperatures up to 300°C. However, further development is required to increase the temperature range of the heat wheel over 200°C. The hot exhaust gas passes through the rotary heat wheel, where it is cooled by the heat-transfer matrix and vented to the atmosphere as flue gas. Fresh air is drawn in past the heat wheel, where it is heated by the rotating matrix and enters the dryer to replace the vented exhaust gas.

Flue-exit temperatures need to be maintained above vapour dew-point temperatures to avoid harmful corrosive effects from condensation of the flue gas in the heat-recovery system and flue stack. The dew-point temperature limits depend on the particular vapours in the stream. This may vary depending on whether the lower temperature water-based operation or the higher temperature silica-based operation is in effect. The flue-exit temperature can be controlled by changing the heat wheel's rotation speed. A slowly rotating heat wheel transfers less heat than a fast one. Consequently, decreasing the wheel speed results in a higher flue-exit temperature, while an increase in wheel speed leads to a lower flue-exit temperature.

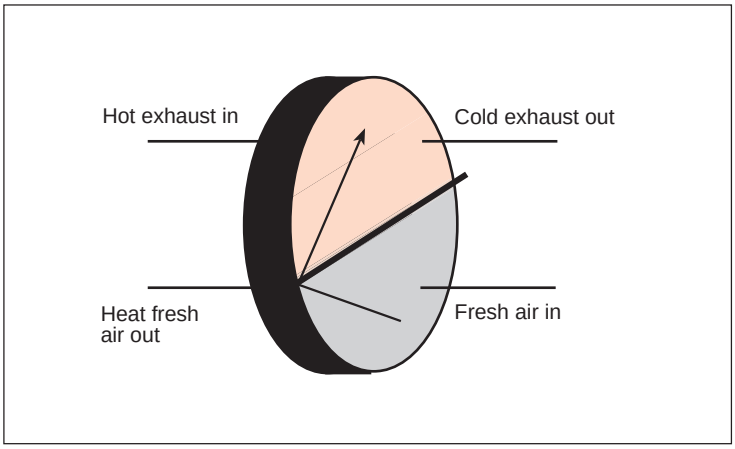

Figure 1: Schematic of the high-efficiency rotary heat exchanger.

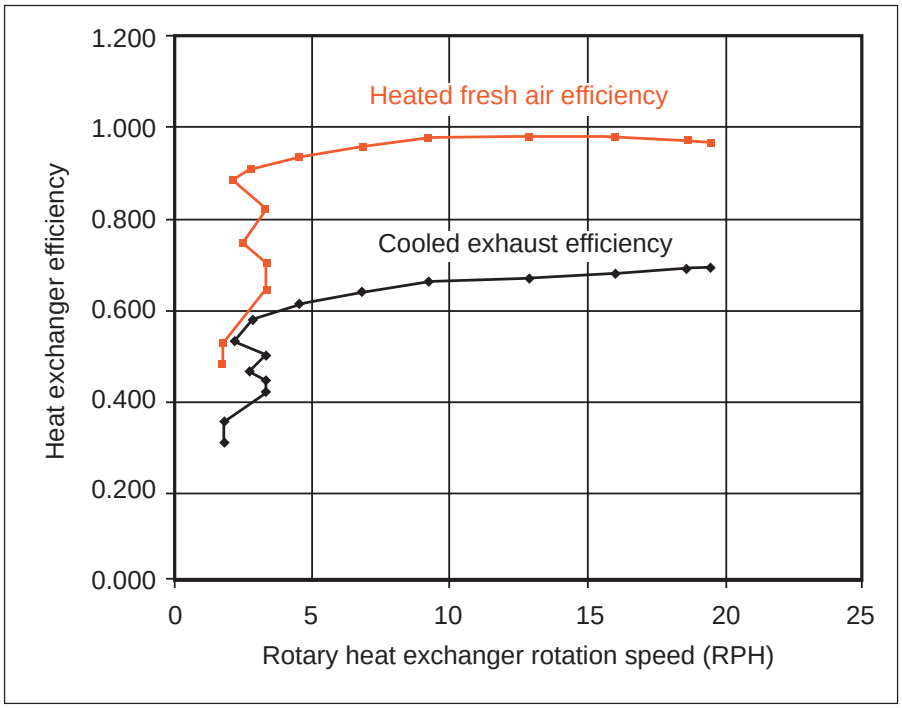

Figure 2: Performance results of the heat wheel at a dryer exhaust temperature of 142°C.

The Situation

The performance of the installation has been monitored and the results for an exhaust temperature of 142°C are given in Figure 2. The system was designed to automatically maintain a preset flue exhaust or exit temperature by controlling the rotation speed of the heat wheel. The heat wheel rotates between 2-20 RPM. The drying facility's natural gas consumption before and after the installation of the heat wheel totalled 3.7 GJ/h and 2.6 GJ/h, respectively. This represents a 30% reduction in the dryer's fuel requirements. Typical operating conditions include a dryer exhaust air temperature of 180°C and a fresh air temperature of 20°C. The temperature of the fresh air after passing through the rotary heat exchanger is 156°C. These results, together with flow metering of natural gas to the dryer, showed that a heat wheel efficiency of over 90% is being achieved.

The Company

Ecopower Pty Ltd is an Australian company that specialises in energy technology, waste heat recovery, biogas and landfill gas utilisation, and cogeneration. It received the 1995 Australian Energy Award (Environmental Category) for the most innovative energy-saving project.

Economics

Savings at Jac Australia Pty Ltd have been considerable due to the 24-hour operation of the plant six days a week. Based on this, plus the energy pricing prevailing when the installation was installed in 1995, and 6,500 annual operating hours of the dryer, annual fuel cost savings add up to AUD 28,600. Installation costs for the heat wheel amounted to AUD 63,000. This results in a payback period of approx. 2.2 years. Following the success of this heat recovery system, a second unit has now been installed at the plant and implementation of a third is being considered.

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* IEA: International Energy Agency
OECD: Organisation for Economic Co-operation and Development

IEA

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This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the frame-work of 40 Implementing Agreements, containing a total of over 70 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination of Demonstrated Energy Technologies. Currently, the Energy Efficiency programme is active in 15 member countries.

This project can now be repeated in CADDET Energy Efficiency member countries. Parties interested in adopting this process can contact their National Team or CADDET Energy Efficiency.

Demonstrations are a vital link between R&D or pilot studies and the end-use market. Projects are published as a CADDET Energy Efficiency 'Demo' or 'Result' respectively, for ongoing and finalised projects.

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