HEAT PUMPS FOR ENERGY EFFICIENT SANITARY WATER HEATING

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ESKOM *eta* award winner 2002 for energy efficiency in the commercial building sector

Enerflow EH-MT Heat pumps for energy efficient water heating

The Enerflow EH-MT series external-air to water heat pumps recovers heat contained in the ambient air and transfers it to the water via a vapour compression cycle. Only a fraction of the total thermal energy output of the heat pump is consumed as electrical energy. Heat pumps therefore provide an energy efficient alternative to conventional heating plants that utilise pure electrical resistance heaters.

Heat pump performance is dependant on ambient air temperature, with a higher ambient air temperature leading to a better thermal performance of the heat pump. Heat pumps are therefore best suited to warmer climates, but can still operate efficiently at lower ambient temperatures above 5ºC.

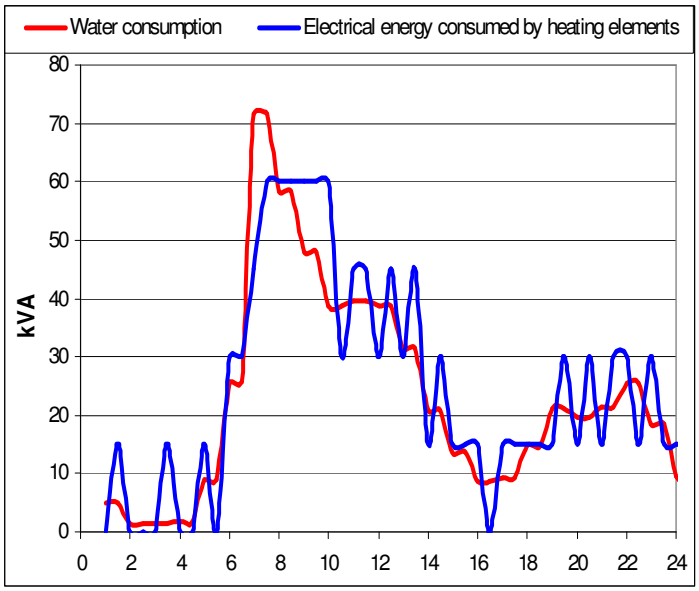
In climatic regions where a large difference between summer and winter ambient temperatures exists, heat pumps can be combined with an electrical heater utilised as a backup heater. This combination optimises energy efficient operation and hot water availability for a wide range of ambient air temperatures.

Heat pumps vs. conventional sanitary water heating plants

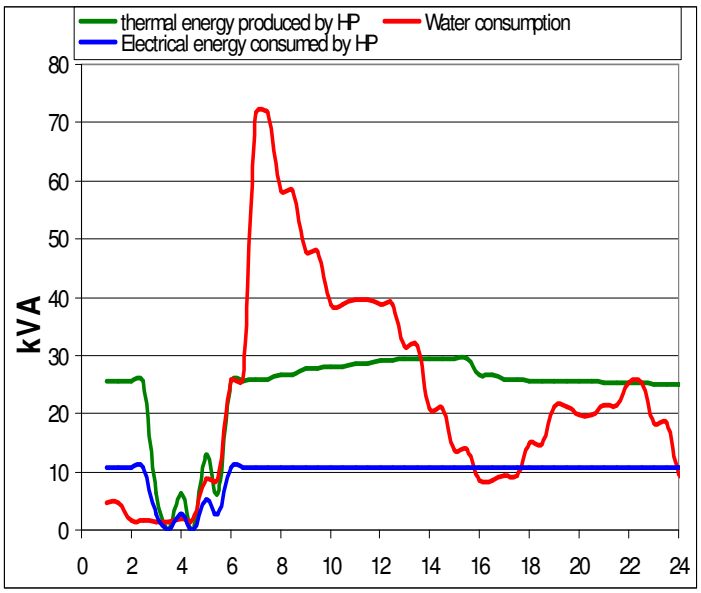
Most conventional sanitary water heating systems utilize direct electrical resistance heating elements to heat water. These heating elements are usually installed inside the hot water storage tanks, according to ASHRAE guidelines.

Large amounts of sanitary hot water are typically required in hotels, hospitals, correctional services facilities and high density residences in the industrial sector. If this hot water requirement is provided by means of direct electrical heating, large amounts of electrical energy is consumed, and usually a significant demand contribution is also made by the water heating system towards overall building electric peak demand.

The figure shows a 24-hour profile for a typical case study where a water heating system is designed for 100 hotel occupants according to ASHRAE criteria. The inlet water temperature from the water mains is assumed to be 18ºC, and hot water consumption is 100 litres per person at 60ºC. The ASHRAE design criteria results in 60kW installed heating capacity. The simulation result shows that the electrical heating elements consumes ±600kWh per day to heat the required amount of hot water and recover storage tank losses. Furthermore, the maximum demand of the water heating plant is 60kVA. This demand contribution occurs at a time where it can contribute to overall building peak demand.



Alternatively, the water heating system can be designed or retrofitted to include a heat pump water heater. Enerflow EH-MT heat pump water heaters are connected in an in-line heating configuration that maximises the benefit provided by the reservoir storage capacity. This configuration allows the heating recovery work required from the heat pump to be spread over a longer period during the day, without compromising hot water supply to end users.



The resultant heat pump installed heating capacity required for the same case study is now only 30kW, as opposed to the 60kW installed heating capacity in the conventional heating plant. The resultant 24-hour profile is shown in the adjacent figure. Electrical energy required to heat the daily hot water requirement and recover storage losses is only 230kW, which is 370kWh less than the electrical elements used in the conventional plant. This represents a 62% reduction in energy consumption. The maximum demand contribution of the heat pump system is only 11kVA. This is 49kVA less than the conventional system, representing an 80% reduction in maximum demand contribution.

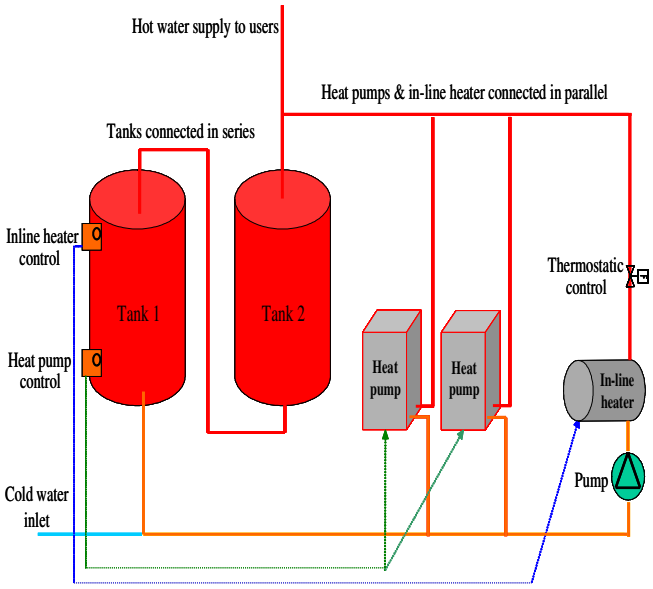
Life cycle cost analysis

From the above comparison it is clear that significant energy and peak demand savings can be realised by utilising heat pumps, with subsequent cost savings. Naturally the initial cost of the heat pump is higher than a conventional installation with simple heating elements. However, the higher capital cost requirement is easily offset by the operational cost savings and payback periods of two to three years are typically realised. Furthermore, the total life cycle cost of the heat pump water heating system is typically 40% less than that of electrical elements, over a 10 year life cycle.

Integration of heat pump units into existing sanitary water heating plants

Heat pumps are easily integrated into existing sanitary water heating plants at hotels, hospitals, correctional services facilities and large scale sanitary water heating facilities at industrial sites. Minor changes are made to the piping lay-out of the plant for connecting and integrating the heat pump unit(s), and the same hot water storage tanks are still utilized to store hot water. The heat pump is typically installed outside the plant room to allow free air ventilation for the unit. The heat pump can be installed indoors, but would then require ducting to obtain free air delivery to the units.

The figure to the right shows the typical heat pump installation. The figure also shows that the heat pump can be combined with an in-line electrical backup heater as described earlier.



M-Tech Industrial company profile

M-Tech Industrial (Pty.) Ltd. is an ISO9001 accredited engineering company based in Potchefstroom with a full-time technical staff of forty graduate engineers. A number of lecturers from North-West University (Previously Potchefstroom University) also work on a part time basis in the company.

M-Tech was founded in 2000 by Dr. Gideon Greyvenstein and Dr. Pieter Rousseau, at the time both professors in mechanical engineering at Potchefstroom University. M-Tech Industrial grew out of an engineering consultancy known as M-Tech Mechanical that has existed since 1987.

M-Tech initially focussed on consulting work in the fields of fluid mechanics and thermodynamics as well as the design of thermal-fluid systems. M-Tech also developed commercial thermal-fluid systems simulation software that is licensed internationally.

In 2005 M-Tech Industrial acquired Enerflow Technologies cc, a heat pump systems design and manufacturing company that was established in 1992. M-Tech therefore attained the technology and manufacturing expertise associated with a wide range of refrigeration and heat pump products.

M-Tech has close ties with the Engineering Faculty of North-West University, which acts as its research partner. The special relationship with North-West University contributes to the high-tech entrepreneurial culture of the company.

M-Tech is a Level 3 BBBEE contributor.

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