Heat recovery ventilation

A recent BRANZ project on energy-efficient ventilation looked at the performance of a heat recovery ventilation system installed in a test house.

BY PETER MCDOWALL, BRANZ BUILDING PHYSICIST

WE OFTEN hear of a reluctance by occupants to ventilate their house due to the perception that too much heat is lost via outgoing air. This has given rise to the increased popularity of ventilation systems that recover heat from the outgoing ventilated air and use it to heat up the colder outside air brought in to replace it. These systems are often referred to as balanced heat recovery ventilation.

Extremely efficient if well designed

Heat recovery works by passing the warm outgoing air from inside the house through a heat recovery core at the same time as the cold outside air brought in to replace it (Figures 1 and 2). While the two air streams never physically mix, they are in close enough proximity for heat to pass from one to the other.

In this way, heat that is otherwise lost through ventilation is recovered by using it to heat the incoming replacement air, reducing the need for additional heating and the energy loss associated with ventilation.

Heat recovery systems can be extremely efficient. In the BRANZ test house, we found around 90% of heat was recovered from ventilated air within the core. However, the actual delivered efficiency dropped to around 55% when ducting losses were considered despite using insulated ducting.

Most of these losses are avoidable through careful installation and planning of ductwork.

Best suited to more airtight homes

Heat recovery systems are best suited for use in:

- colder climates
- houses with lower levels of natural infiltration or with higher airtightness.

Overseas research provides a good rule of thumb, stating the 'infiltration rate should not exceed 10-20% of the flow rate through the heat recovery unit'.

Figure 3 shows the simulated cost to maintain a temperature of 20°C in a 90 m^2 house for a typical month in Wellington at different airtightness levels.

We used the same ventilation rate (0.4 ach) measured in our test house. Infiltration rates were based on simulations and average July wind data for Wellington. A simple electric heat source was assumed at a cost of $0.25/kWh, but this cost could be reduced with the use of a heat pump.

Finally, we modelled a heat recovery efficiency of 55%, similar to what we measured in the test house, as well as an ideal system running at 90% efficiency. Effects of solar gains were not included.

As the house becomes less airtight, the cost to maintain 20°C increases. This occurs because a significant fraction of air is lost due to infiltration and therefore no heat can be recovered from it. For this reason, heat recovery ventilation systems are better suited to more airtight homes.

Pointers to improve efficiency

In New Zealand, ducting is generally installed in a roof space outside the thermal envelope. Because of this, the surrounding air temperature is often colder than the air being carried inside the ducting.

This leads to heat being lost through the ducting as heat travels from warm spaces to cold spaces. Any heat that escapes through the ducting cannot be recovered and counts as heating loss from within the warm building envelope, leading to a drop in efficiency.

There are several simple ways of reducing these losses and maintaining a high level of heat recovery efficiency:

- Install all the ducting within the building's thermal envelope. This optimum solution virtually eliminates ducting heat losses as the air inside and outside the ducting are at the same temperature.
- Use insulated ducting. A higher R-value will lead to less heat loss so it pays to use the highest rated insulated ducting available if installed outside the thermal envelope. If necessary, an insulation blanket can be used to cover the ductwork provided it does not deform the ducting.
- Keep run lengths of ducting as short as necessary. Longer duct runs allow more opportunity for heat to escape and are harder for the fans to drive air through.

Improving heat recovery ventilation efficiency means less additional space heating is required to heat the incoming air.

Unheated rooms can reduce efficiency

Efficient heat recovery is not solely about good ducting. Most systems work on the assumption that all rooms covered by the system are heated equally. BRANZ research suggests this is rarely the case in New Zealand houses. We often encounter spot heating where only one room - typically the lounge or family room - is heated and only at certain times of day.

We modelled a heat recovery ventilation system based on a house where some rooms were heated and some were not, incorporating heating habits and temperatures measured in homes around Wellington.

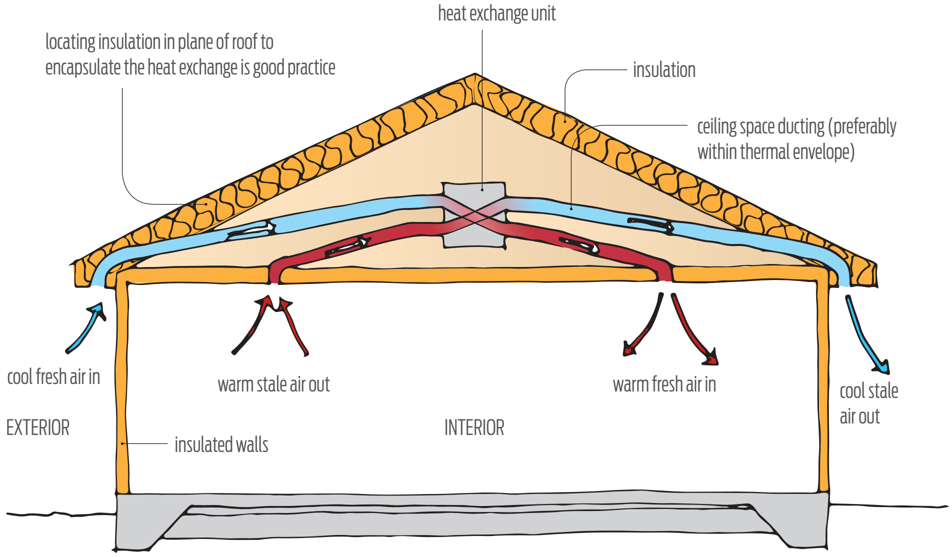

Figure 1: Schematic of air movement using heat recovery ventilation system.

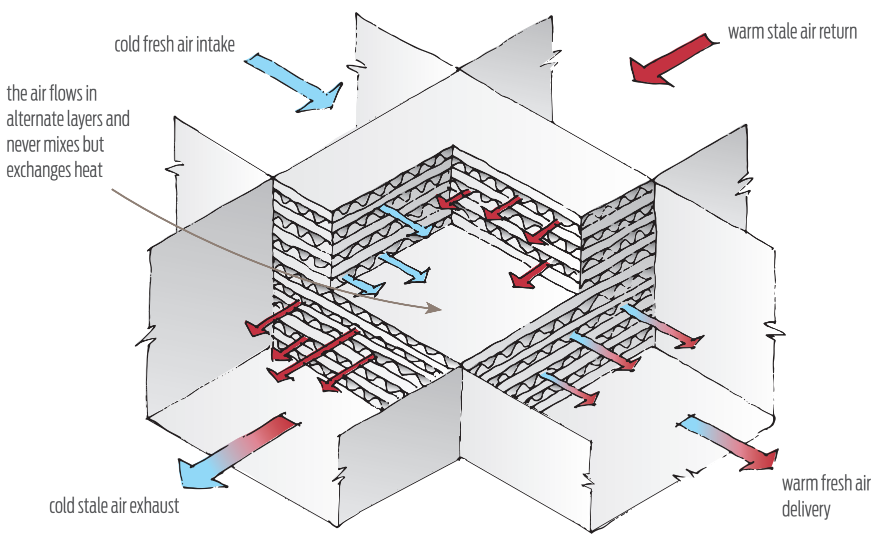

Figure 2: Schematic of a cross-flow mechanical ventilation heat recovery system.

Significant reductions in heat recovery efficiency were observed when unheated rooms were included in the ventilation system. Cold air ventilated from an unheated room lowers the overall tempeature of ventilated air from all rooms, meaning less heat can be recovered.

Ideally, only attempt to recover heat from rooms significantly above outside air temperatures. Similarly, recovered heat can be lost when returned to unheated rooms where it can easily escape to the outside, such as a room with no insulation.

It's not for all homes

Heat recovery ventilation has great potential as an energy-efficient ventilation system. It is best suited to more airtight homes that require mechanical ventilation to maintain a healthy indoor environment and where all spaces served by the unit are heated. Many older homes are unsuitable due to their high levels of natural infiltration.

Ductwork has a huge impact on heat recovery efficiency. Where possible, install inside the thermal envelope. Outside the thermal envelope, the highest-rated insulated ducting should be used to minimise heat loss.

It is important to carefully plan the layout of return and supply ports with respect to the likely heating habits of each zone to maximise its heat recovery efficiency and therefore benefit to the user.

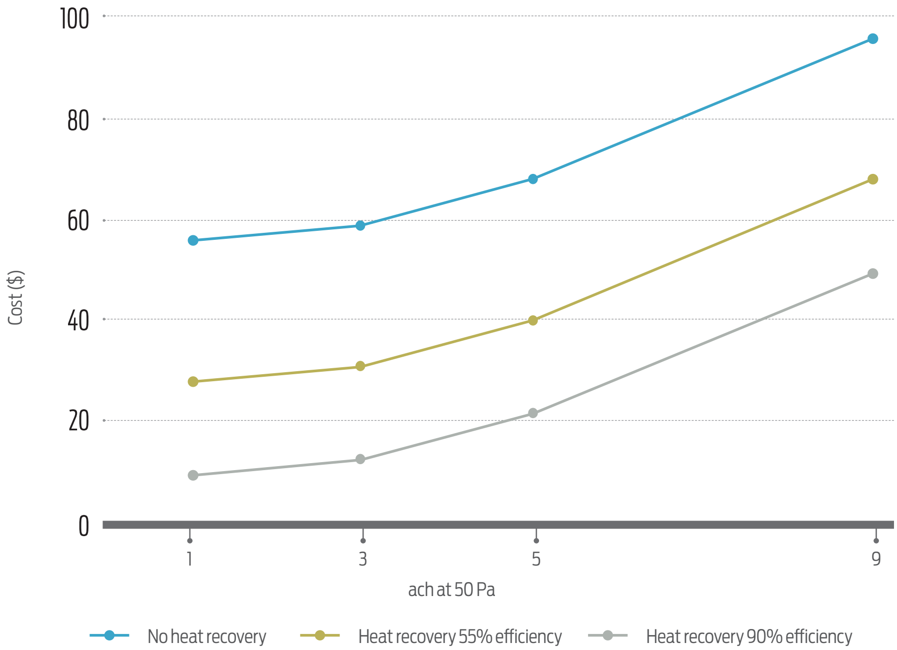

Figure 3: Cost to maintain 20ºC in 90 m² Wellington house for July at different airtightness levels.