Heating for low energy housing

The BRE has tested different methods for heating low energy houses. Did a warm air system with mechanical ventilation and heat recovery beat the more conventional wet radiators and electric panels?

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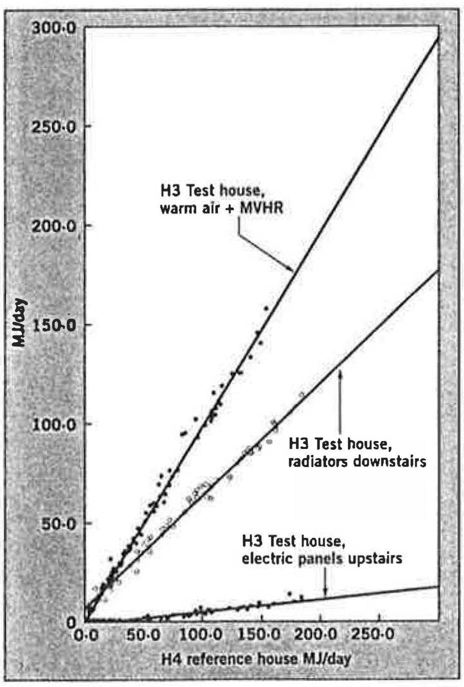
Further reading
Rayment R, 'The perfect match', *Building Services Journal*, 12/92.
Rayment R, 'The use of matched houses to investigate energy savings', *Proceedings of the 1995 CIBSE National Conference, October 1995.*

Some test houses set up at the Building Research Establishment (BRE) have been used to examine different ways of heating low energy dwellings. In this context, low energy means a design heat loss of about 2 kW, a 1 kW fabric loss and about the same for ventilation loss.

Three types of heating system have been evaluated: gas-fired warm air with mechanical ventilation and heat recovery (mvhr) operating through a thermal store (which also supplied dhw), electric panels and a mixed system comprising a gas-fired boiler, downstairs radiators and some electric panels upstairs.

The mvhr system boasts a fan-powered fresh air inlet which is pre-warmed by heat exchange with exhaust air from the kitchen and bathroom. This incoming air is fully warmed by mixing with recirculation air from the landing, before finally bypassing over a water-to-air heat exchanger which is fed from the thermal store.

FIGURE 1: Comparing space heating consumption for warm air plus mvhr, and radiator plus electric panel heating.



A plenum then feeds the air into ducts, most of which descend down the inside of the external walls to outlet terminals in each room.

An important factor to note is that all the ductwork (apart from the descenders) is in the loft above the roof insulation, and therefore outside the heated part of the house. The ducts are insulated by an inch of foil-covered fibreglass.

Operational issues

Temperature control of the mvhr system is by a single thermostat in the ground floor dining room. With this set-up it was found to be impossible to balance the upstairs terminals to prevent overheating, and consequently they had to be shut off.

This then gives rise to two problems: namely how the bedrooms are to be ventilated, and how they are to be heated in very cold weather.

The latter was the subject of a separate investigation, which found that the test house could be adequately warmed by downstairs heating, provided that the bedroom doors were left open.

In very cold weather the houses had unacceptably low temperatures in the bedrooms when the doors were closed. An examination of loft and ductwork temperatures showed that losses from the ducts (even though they are insulated), could be as high as 500 W.

In its defence, the system was originally recommended in 1991. Other systems are now available that extract heat from the kitchen, and whose ductwork lies entirely within the heated envelope.

Many suggestions for an alternative heating system were put forward, but it was decided to test one consisting of ground floor radiators controlled by a single room thermostat and individual, thermostatically-controlled electric panels upstairs. The ground floor radiators were served from a thermal store, but could be fed from a boiler.

As the test houses are very airtight, trickle ventilators were installed above the windows, and just the extract part of the mvhr system was used to draw air from the bathroom and kitchen. This partial system was fully checked against the complete mvhr system for adequate ventilation and moisture clearance. Both of these systems gave mean daily air change rates of approximately 0·5 ac/h.

By introducing moisture from standard simulations of bath, basin and kitchen sink hot water run-offs – and also from people simulators and cooking – it was found that both systems could avoid condensation from water vapour inputs of at least 20 litres/day.

Performance results

The systems were compared in a pair of similar, adjacent test houses. Figure 1 shows the comparison between the two houses, where H3 represents the test house and H4 the reference house with the full mvhr system left unchanged throughout the tests.

It can be seen that, by using the full mvhr system in both houses, the daily gas consumption figures are very similar and the correlation between them is excellent.

The effect of changing to the alternative heating system in the test house – wet radiators plus electric panel heaters – is also shown in figure 1.

Clearly, there is a dramatic reduction in gas consumption. There is also an electricity consumption for the upstairs panels, but this is almost completely offset by the fact that only the exhaust fan is needed. For the full mvhr system there is an additional supply fan consuming around 7 MJ/day. The overall saving is about 30%.

An examination of the mean daily temperatures shows that they do not differ between the houses by more than about 0·1°C, so there is no deterioration in comfort.

The conclusion, then, is that the simpler and cheaper heating system is satisfactory and better value for money. It must be emphasised, however, that systems which avoid high duct heat losses could be expected to show a marked improvement.