University of South Australia

SUMMARY REPORT:

Investigation of the Impact of Ducting on the Energy Use of Air Conditioners

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SUMMARY

Air conditioning represents more than 10% of Australia's greenhouse gas emissions. The thermal performance of ducting is an important factor in affecting the energy usage of air conditioners. To address this factor, the Australian Building Codes Board is increasing the energy efficiency requirements of ducting in the Building Code of Australia (BCA). Furthermore, the National House Energy Rating Scheme (NATHERS) is being upgraded, through the software package AccuRate, to ultimately include the impact of ducting in the energy rating of homes.

Heat loss in ducting is predominantly affected by the thermal resistance of the duct. Currently, the thermal resistance or R value of ducting products, according to the BCA, is specified through calculation. The final R value is primarily based on the material R value of the bulk insulation used in the duct. Experimentation conducted at the University of SA of a sample of products has shown that the specified R value can be significantly lower than the actual thermal resistance of the duct. Generally all ducting tested produced results which were lower than the rated values. However, it was found that the R value of Rt1.0 polyester duct, with a total R value rating of 1.0 m^2K/W, was significantly lower than its rated value. This duct is the most commonly used ducting in air conditioning installations. The ducting with the highest performance, out of the sample tested, was the Energy Smart™ ducting with a total rated R value of 1.65 m^2K/W. It is recommended that the rating of ducting should be based on measured R values of the ducting product.

The impact of the measured thermal resistance on the energy usage of air conditioners was investigated for a typical new house in Adelaide. This was achieved through mathematical modelling the performance of a typical inverter and fixed speed air conditioner, based on manufacturers data together with ducting. This work was combined with building thermal load data from AccuRate, a leading building modelling software developed by the CSIRO.

The study identified that, with Rt1.0 polyester duct operating with an inverter, duct losses represented 17% of the energy consumption of the air conditioner. Applying the Energy Smart™ duct, resulted in an energy saving and reduction of greenhouse gas emissions of 9%, or $45/yr in running costs, based on $500/yr total running costs. With electricity prices anticipated to increase in the future the value of these savings will increase.

It was determined that since inverter air conditioners operate longer, the duct losses in these systems are higher than for fixed speed units. As a result the energy savings achieved through using an inverter were substantially reduced. It was shown that the electrical energy usage of the Rt 1.0 duct with an inverter air conditioner was almost identical to the Energy Smart™ duct and a fixed speed air conditioner with only 2% difference.

Due to the lower thermal load achieved with ducting with higher thermal resistance, it was identified that the cooling design load could be reduced from 120[1] to 110 W/m^2, when using the Energy Smart™ duct. With a lower cooling capacity the COP of an inverter is lower. However, with the Energy Smart™ duct, energy savings relative to the higher capacity unit with the Rt 1.0 duct of 7% or $37/yr were still achieved.

The application of ducting with a higher thermal resistance achieved a significant reduction in peak power demand. Relative to the Rt 1.0 polyester duct with a fully sized inverter unit, the Energy Smart™ duct applied to either a fully sized or reduced sized inverter unit achieved a reduction in the number of peak hours by 30%.

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[1] AIRAH (2007). *AIRAH Handbook*, Australian Institute of Refrigeration, Air-conditioning and Heating Inc., Melbourne, Australia.