Technical session topic: New fluids and energy efficient transfer processes in advanced refrigeration technologies.

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Energy efficiency of a household air conditioner, using new HFC refrigerants

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An advanced simulation model of a household air conditioner with finned coil condenser and evaporator has been developed. While the compressor is characterised by its performance data, detailed models of the condenser and the evaporator were built: their heat transfer area is subdivided into several elements, three-dimensionally arranged, so that the real arrangement of the two streams is perfectly represented. The most advanced and reliable correlation are used for evaluating the local values of the heat transfer coefficients of the refrigerant, whereas for the air side heat transfer coefficient an uniform value is assumed as from manufacturers data. The heat flow is calculated node by node taking into account the variation in the saturation temperature of the refrigerant. When occurring dehumidification, the Threlkeld approach is used.

This simulation model has been used for comparing the performance of R22 with that of its main HFC substitutes (R407C, R410A, R404A, R32); the performances are evaluated in terms of COP and swept volume, being the same the refrigerating capacity.

For each fluid the optimal configuration of condenser and evaporator is determined, with reference to the optimal number of circuits (i.e. the one that leads to the best trade-off between heat transfer coefficient and pressure drop). In general, high pressure fluids perform better than low pressure fluids, if their inherent characteristics of lower pressure drop are exploited for increasing the mass velocity and hence the heat transfer coefficient: this conclusion is in good agreement with the theoretical analyses of the influence of the fluid properties on heat transfer and pressure drop.

Another kind of optimisation is analysed, which is related to the optimal subcooling of the liquid condensed: refrigerants with the highest exergy losses during throttling take profit from large subcooling.

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