DIN - DEPARTMENT OF INDUSTRIAL ENGINEERING

PhD Course in Mechanics and Advanced Engineering Sciences (DIMSAI)

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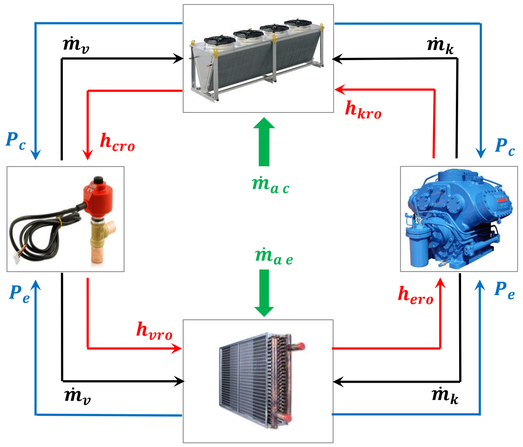
DYNAMIC MODELS FOR THE ANALYSIS OF INDUSTRIAL REFRIGERATION PLANTS

Introduction and aim

Industrial and commercial refrigeration systems represent one of the most relevant fields in terms of energy consumption, which can be reduced, with a strong influence on environmental impact, using many advanced technologies such as advanced control strategies [1]-[2]. Dynamic modelling of refrigerators represents a useful analysis tool since it allows to determine the most suitable regulation system in terms of energy consumption and control quality for a given plant configuration. TRNSYS is a widespread software used to carry out transient analysis on systems and it is characterized by large libraries of functions, called “Types”; currently, however, no functions able to capture the dynamics of the constitutive components of a refrigerating machine are available. In this first year, the standard TRNSYS library has been integrated with functions, written as FORTRAN subroutines, which simulate the main components of a vapour compression refrigerating machine, such as evaporator, condenser, compressor and expansion valve, in order to be able to implement dynamic models of more complex industrial refrigerating plant.

Mathematical model



Electronic Expansion Valve (EEV)

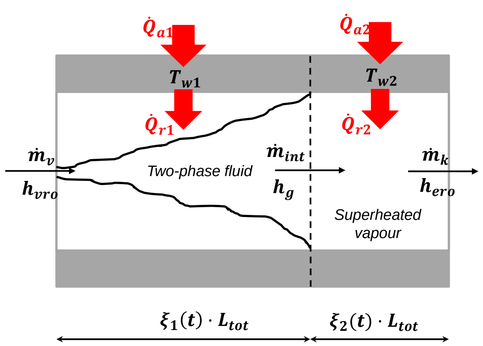
$$\dot{m}_v = A_v \cdot C_d \cdot \sqrt{\rho_{cro}(P_c - P_e)}$$
$$h_{cro} = h_{vro}$$

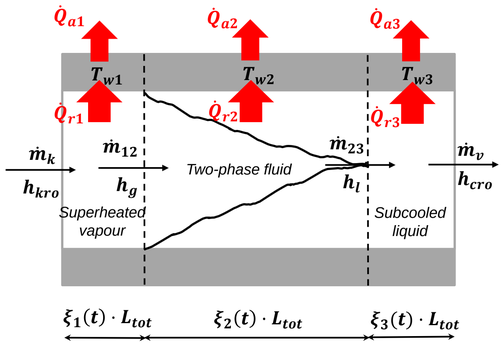
Volumetric Compressor

$$\dot{m}_k = \rho_{ero} \cdot \omega_k \cdot V_k \cdot \eta_{vol}$$
$$h_{kro} = h_{ero} + \frac{h_{kro\,is} - h_{ero}}{\eta_{is}}$$

Heat Exchangers

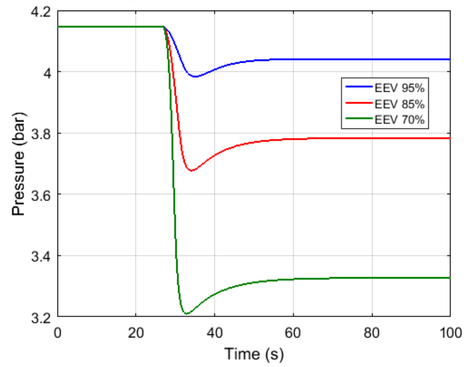
$$\bar{\bar{Z}}(\bar{x}) \cdot \frac{d\bar{x}}{dt} = \bar{\bar{F}}(\bar{x}, \tau)$$
$$\bar{x}_{evap} = [\xi_1, P, \gamma, h_2, T_{w1}, T_{w2}]$$
$$\bar{x}_{cond} = [\xi_1, \xi_2, h_1, P, \gamma, h_3, T_{w1}, T_{w2}, T_{w3}]$$

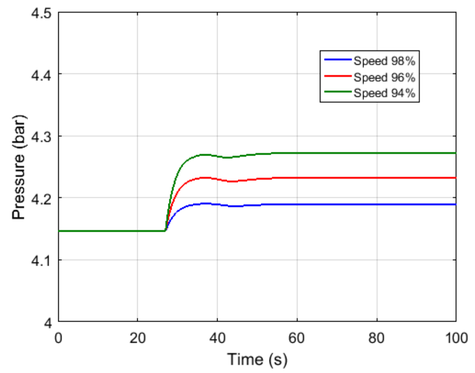


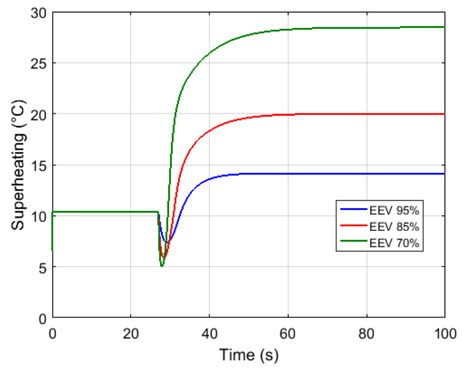


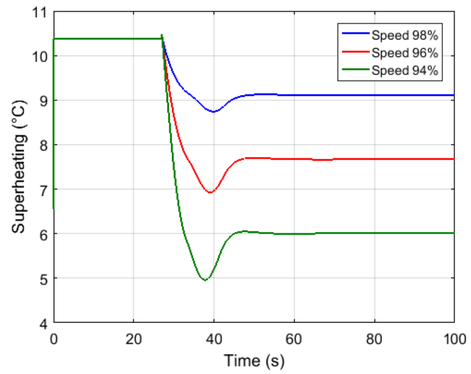
Results

The following results regard the evaporator response to a sudden change in valve opening and compressor velocity.









Conclusions

The standard TRNSYS library has been integrated with functions able to simulate the dynamic behaviour of the main components of a vapour compression refrigerating machine: evaporator, condenser, expansion valve and compressor.
Other components like the receivers need to be modeled in order to carry out energy analysis on more realistic plant configurations.

References

[1] A. Mota-Babiloni, J. Navarro-Esbrì, A. Barragan-Cervera, F. Molés, B. Peris, G. Verdù, *Commercial refrigeration – An overview of current status*, International Journal of Refrigeration, 57, 186-196 (2015)
[2] C. Park, H. Lee, Y. Hwang, *Recent advances in vapor compression cycle technologies*, International Journal of Refrigeration, 60, 118-134 (2015)

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IL PRESENTE MATERIALE È RISERVATO AL PERSONALE DELL'UNIVERSITÀ DI BOLOGNA E NON PUÒ ESSERE UTILIZZATO AI TERMINI DI LEGGE DA ALTRE PERSONE O PER FINI NON ISTITUZIONALI