INFLUENCE OF OIL ON THE OPERATION OF VAPOUR-COMPRESSION REFRIGERATION SYSTEMS

Olivier LOTTIN*
Laboratoire d'Energétique et de Mécanique Théorique et Appliquée
UMR 7563 CNRS-INPL-Université Henri Poincaré
BP 160 – 2, avenue de la Forêt de Haye, 54504 Vandoeuvre lès Nancy, France
Olivier.Lottin@ensem.inpl-nancy.fr - +33/0 3 83 59 55 48
Philippe GUILLEMET
Ecole Polytechnique de l'Université de Nantes,
Laboratoire de Génie des Matériaux et Procédés Associés,
BP 50609, La Chantrerie, 44306, Nantes, France
Philippe.Guillemet@polytech.univ-nantes.fr - +33/0 2 40 68 31 20
Jean-Marc LEBRETON
Electricité de France, Research and Development Division, 77818 Moret sur Loing, France
Jean-Marc.Lebreton@edf.fr - +33/0 60 73 78 56
Michel FEIDT
Laboratoire d'Energétique et de Mécanique Théorique et Appliquée
UMR 7563 CNRS-INPL-Université Henri Poincaré
BP 160 – 2, avenue de la Forêt de Haye, 54504 Vandoeuvre lès Nancy, France
Michel.Feidt@ensem.inpl-nancy.fr - +33/0 3 83 59 55 48

Even when separators are used, a small quantity of oil always escapes from the compressor of vapor-compression refrigeration systems and pollutes the refrigerant. This pollution is accompanied by adverse effects dependent with the modification of the physical and thermodynamic properties of the refrigerant, which can have a significant impact on the quality of heat transfer inside the exchangers and on the flow characteristics of the mixture. However, it is difficult to predict precisely the importance of these effects in most of the future installations, since there are numbers of HFC and synthetic oil which can replace the well-known HCFC/mineral oils couples condemned by current regulations. Considering this, a reliable numerical model would provide interesting results for design.
The work presented in this paper ended in the conception of refrigeration system simulation software that takes account of the circulation of oil mixed with the liquid refrigerant. We consider as a whole, on one hand the effects of oil on the thermodynamic properties of the mixture (changes in the saturation pressures in the condenser and evaporator) and on the other hand the variations of the physical properties of the oil/refrigerant mixture, which modify the quality of heat transfers within the exchangers and the pressure losses. The simulated system operates with the R410A HFC blend and the compressor is lubricated by ISO 32 POE synthetic oil.
The relations used for the determination of the thermodynamic properties of the oil/refrigerant mixture are presented but we mainly focus on the modeling of the whole system and its response to an increase in the amount of circulating oil is analyzed. Some conclusions are drawn about the optimum overheat control in the evaporator when the refrigerant is polluted by oil. In particular, it is shown that there are optima values for which either the exchanged power or the refrigeration COP is maximized. On the other hand, a sensitivity study is carried out about the hypotheses used for the modeling of the compressor in the presence of oil in the refrigerant.

* Corresponding author