Solubility Correlation of Carbon Dioxide + Lubricant Oil Mixtures

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Since Lorentzen and Petterson initiated a renewed interest in CO_2 as an environmentally-friendly refrigerant [1], extensive studies on this CO_2 "trans-critical" vapor compression cycle have been undertaken both experimentally and theoretically. A major interest is the application for automobile air-conditioning systems at the present, and the development of commercial units is still in progress. In the vapor compression cycle, lubricant oils are always required, and thermophysical properties of lubricant and refrigerant mixtures must be well studied. It is known that CO_2 does not dissolve completely in any familiar lubricants such as mineral, alkyl benzene, polyol ester (POE), and polyalkylene glycol (PAG) oils. Currently, the choice of lubricants seems PAG or POE, although there are few published data concerning solubility of CO_2 in these lubricant oils [2] and, to our best knowledge, these experimental data have not been analyzed theoretically (or with thermodynamic equations). The trans-critical cycle is involved in obtaining knowledge of thermophysical properties in the supercritical regions of CO_2, in which the properties of refrigerant + lubricant oil mixtures are not well studied. In this report, we have investigated the phase behavior (or solubility) of CO_2 + PAG and POE mixtures, correlating observed solubility data [2] with our equation of state (EoS), which was developed earlier for refrigerant + oil mixtures [3]. Observed data have been well correlated with the present EoS, which is used for predicting the general phase behavior for CO_2 + these lubricant oils, and indicates type III (for PAG) or V (for some POE) mixture behavior according to the van Konynenburg-Scott classification [4].

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