Interfacial Tension and Wetting Behavior of Refrigeration Lubricants in the Presence of a Refrigerant Atmosphere

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Lubricants used in mechanical compressors for refrigeration systems fulfill several tasks such as the minimization of friction and wear, the reduction of refrigerant leakage through dynamic sealing systems, or the prevention of overheating by heat removal. They are in constant contact with the refrigerant where entrainment of lubricant out of the compressor unit cannot be completely prevented. Thus, miscibility with the refrigerant is required to ensure the transport of entrained lubricant back to the compressor and to avoid its undesirable accumulation in other parts of the refrigeration cycle. The interaction with the refrigerant affects the thermophysical properties of the lubricant and thus also its efficiency regarding its original tasks. It is of particular interest to know the impact of the presence of refrigerant on the interfacial tension between the refrigerant-containing lubricant and the surrounding refrigerant atmosphere as this property is directly related to the wetting behavior of such mixtures on the solid surfaces present in refrigeration systems. Nevertheless, also the properties of these surfaces in terms of their surface free energy and roughness affect the wetting characteristics. In this context, only few experimental studies are available in the literature.

In the present contribution, measurements performed with the pendant drop method demonstrate the effect of varying temperature and pressure of an R134a (1,1,1,2-tetrafluoroethane) atmosphere on the interfacial tension of lubricants based on polyalkylene glycol or mineral oil, where an interplay of the impacts of varying temperature and solubility has been observed. Furthermore, a setup allowing for the characterization of the wetting behavior of lubricants on solid surfaces in air and refrigerant atmospheres will be introduced. Here, the spreading velocity of continuously added lubricant is analyzed, where a high-speed camera is used to record the wetting process in an optically accessible measurement cell.