

Normal-Paraffins, Aromatics, Alcohols and Organic Acids in the Liquid Phase Along the Saturation Line: a Prediction Method for the Thermal Conductivity in the Reduced Temperature Range 0.30 to 0.99

Giovanni Latini^{C, S}

Dipartimento di Energetica, Università Politecnica delle Marche, Ancona, Marche, Italy

Several equations exist in the technical and scientific literature for the calculation of the thermal conductivity of the organic compounds in the liquid phase, but they generally cover a small number of substances and narrow temperature ranges. Theoretical methods are usually unfit for providing correct values, the exception being for very simple molecular structures (spherical symmetry). Semi-theoretical equations based on simple physical assumptions are generally useful only for some members of a given family. Empirical or semi-empirical methods are based on the available experimental data, can be used in limited temperature ranges (usually near the temperature of 20°C) and generally are too simple to cover the different molecular structures, or too complicated and requiring parameters difficult to be assessed.

Some remarkable prediction methods exist in the literature relating the liquid thermal conductivity with temperature and density, but such methods are reliable only for a few compounds, while our goal is to give to engineers an equation containing only the temperature (a property easy to be measured) and some parameters characteristic of the liquid phase, of each organic family and of each compound in large temperature ranges. The equation proposed in this work is valid for a large number of organic substances in the liquid phase along the saturation line. The normal Paraffins, the Aromatics, the Alcohols and the Organic Acids are taken into account (on the whole about 70 substances) in reduced temperature ranges usually from 0.30 to 0.99, when the critical enhancement appears. The equation provides the calculation of the thermal conductivity by the knowledge of the reduced temperature T_r and three specific parameters. The first parameter is the “golden ratio” (“Phi” $=1.6180339887...$ is linked with the simplest “series of Fibonacci” : 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144,...) which can be considered characteristic of the liquid phase, while the second and the third parameter are characteristic of the single investigated organic family. The starting point of the research was an accurate investigation on the best available experimental thermal conductivity data (an approach already used by the author for the refrigerant fluids) followed by a strange and fascinating mathematical interpretation including the “golden ratio”; this route finally leads to a second investigation on the experimental thermal conductivity data in order to arrive to an equation containing the reduced temperature, the three parameters cited above and the physical and chemical properties of each compound. In the investigated reduced temperature range (from 0.30 to 0.99, that is from the normal melting point to very near the critical temperature) the mean absolute deviations between calculated and experimental thermal conductivity data are generally less than 3% and the maximum ones usually less than 8%. The new equation is proposed for all the organic compounds in the liquid phase along the saturation line with a strong predictive value for engineering purposes.