Measurement of Surface Tension for Refrigerants R245fa, R1243zf, R1234ze(Z), and R1233zd(E)

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Low global warming potential (GWP) refrigerant R1243zf is a possible candidate to replace R134a for kitchen refrigerators and air conditioning applications. R1234ze(Z) and R1233zd(E) are very recently under consideration as the candidates to replace R245fa that is widely used in organic Rankine cycles and high-temperature industrial heat pumps. The capillary constant and surface tension of saturated R1243zf, R1234ze(Z), and R1233zd(E) were measured at temperatures from 274 K up to 350 K or the critical temperature, using a measuring apparatus based on the differential capillary rise method. The propagated uncertainty in the surface tension was typically 0.2 mN m^{-1}. The surface tension of R1243zf is approximately 0.5 mN m^{-1} less than that of R134a at a temperature of 300 K, despite the R1243zf has a higher critical temperature than that of R134a. The surface tension of R1233zd(E) is more than 10% higher than that of R1234ze(E) at a given temperature. The experimentally quantified surface tensions were represented within 0.13 mNm^{-1} by a van der Waals type equation expressing the temperature dependence as,

$$s = 53.30 (1 - T_r)^{1.247} \text{ for R1243zf}$$

$$s = 56.57 (1 - T_r)^{1.22} \text{ for R1234ze(Z)}$$

$$s = 61.95 (1 - T_r)^{1.277} \text{ for R1233zd(E)}$$

where, s and T_r are the surface tension and the reduced temperature, $T=T/T_{crit}$. The critical temperatures T_{crit} are given as 376.93 K and 423.27 K for R1243zf and R1234ze(Z), respectively, by Higashi et al. (2014, 2013), and 438.75 K for R1233zd(E) by Hulse et al. (2012).