

Chemical Equilibrium and Critical Phenomena: The Solubilities of Iron (III) Oxide and Cobalt (II, III) Oxide in Isobutyric Acid + Water Near the Consolute Point

James Baird^{C, S}

Department of Chemistry, University of Alabama in Huntsville, Huntsville, AL, U.S.A.

Baichuan Hu

Materials Science Graduate Program, University of Alabama in Huntsville, Huntsville, AL, U.S.A.

The upper consolute point of a mixture of isobutyric acid and water occurs at 26.2 °C and 38.8 weight percent isobutyric acid. We have measured the solubilities of iron (III) oxide, Fe_2O_3 , and cobalt (II, III) oxide, Co_3O_4 , along the critical isopleth at temperatures just above the critical solution temperature. In both cases the measured solubility values are in the parts per million range. The two oxides share other features in common: (1) The dissolution proceeds by reaction of the oxide with isobutyric acid to form a salt plus water. (2) The solubility data plotted in van't Hoff form make a straight line when the temperature, T , is sufficiently in excess of the critical solution temperature, T_c . (3) The dissolution reaction is endothermic. By combining these three features with the principle of critical point universality, one may predict that the slope of the van't Hoff plot should depart from its constant value and become strongly negative as T approaches T_c . This is exactly what is observed experimentally in the case of both Fe_2O_3 and Co_3O_4 when T is within 1 K of T_c .