Communications

Physical Properties of Organic Acids

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Studies of rates of dissolution of organic acids are frequently used as a technique in mass transfer investigations. These substances can be readily molded and machined into various shapes of well-defined geometry. Their solubilities lie in a convenient range, and analytical procedures are simple. Further, existing evidence indicates their rate of dissolution to be mass transfer controlled with no appreciable interfacial resistance(*1, 2*).

TABLE 1.—PHYSICAL PROPERTIES OF BENZOIC ACID–SATURATED AQUEOUS SOLUTIONS

T, °C.	Solubility, g. moles/liter	Density, g./cc.	Viscosity, cps
22	.025.40	0.99836	
23	.026.05	0.99817	0.934
25	.027.46	0.99776	0.894
26	.028.33	0.99754	0.077
27	.029.36	0.99726	0.861

TABLE 2.—PHYSICAL PROPERTIES OF CINNAMIC ACID–SATURATED AQUEOUS SOLUTIONS

T, °C.	Solubility, g. moles/liter	Density, g./cc.	Viscosity, cps
22	.003.17	0.9986	
23	.003.26	0.9983	0.935
24	.003.36	0.9980	0.915
25	.003.45	0.9978	0.895
26	.003.54	0.9975	0.876
27	.003.63	0.9973	0.857

TABLE 3.—PHYSICAL PROPERTIES OF A 4.44-*M*. GLYCEROL-WATER SOLUTION SATURATED WITH BENZOIC ACID

T, °C.	Solubility, g. moles/liter	Density, g./cc.	Viscosity, cps
22	.038.0	1.1035	3.526
23	.039.6	1.1029	3.433
24	.041.1	1.1023	3.340
25	.042.7	1.1017	3.339
26	.044.3	1.1012	3.247
27	.045.8	1.1007	3.154
28	.047.3	1.1001	3,061
29	.048.9	1.0996	2.968
30	.050.5	1.0990	2.875

Paucity of data on densities, viscosities, and diffusion coefficients in aqueous solutions necessitated the measurement of these properties adjunct to mass transfer studies undertaken by the authors(*1, 2, 3*). The following standard procedures were employed.

1. *Solubilities* were obtained by equilibrating the given solute with water in a 1,000-cc. flask shaken in a carefully controlled (±0.05°C.) thermostat. Twelve- to fifteen-hour periods were allowed for an equilibration at a given temperature. In special experiments, in which samples were withdrawn at various time intervals, it was found that no detectable concentration change occurred after about 3 to 4 hr. After equilibration the solution was filtered under pressure through a sintered-glass plate into another flask clamped in the same thermostat. In this manner temperature changes during filtration were avoided. Samples of 25 cc. were titrated with a standardized sodium hydroxide solution. Reproducibility was within ±2%.

TABLE 4.—PHYSICAL PROPERTIES OF A 3.65-*M*. GLYCEROL-WATER SOLUTION SATURATED WITH BENZOIC ACID

T, °C.	Solubility, g. moles/liter	Density, g./cc.	Viscosity, cps
20	.030.2		
21	.031.2		
22	.032.4	1.0761	2,540
23	.033.53	1.0755	2.442
24	.034.65	1.0749	2.343
25	.035.79	1.0743	2.244
26	.036.95	1.0738	2.043
27	.038.16	1.0734	2.045
28	.039.45	1.0729	1.946
29	.040.78	1.0724	1.848
30		1.0720	1.749

TABLE 5.—PHYSICAL PROPERTIES OF SALICYLIC ACID–SATURATED AQUEOUS SOLUTIONS

T, °C.	Solubility, g. moles/liter	Density, g./cc.	Viscosity. cps
22	.013.9		
23	.014.7		
24	.015.5	0.99764	0.911
25	.016.3	0.99740	0.896
26	.017.0	0.99716	0.873
27	.017.8		

TABLE 6.—DIFFUSION COEFFICIENTS

Substance	Temperature, °C.	Coefficient $D \times 10^{-5}$ sq. cm./sec.
Benzoic acid	30	1.06
Benzoic acid in 4.44-molal glycerol solution	30	0.33
Salicylic acid	30	1.24
Cinnamic acid (*5*)	25	0.91

2. *Viscosities* of the saturated solutions were measured with an Ubbelohde type of effusion vicosimeter. Prior to and during the determinations the solution was thermostated (±0.05°C.). Distilled water was used for calibration. The effusion times were reproducible within less than 1%.

3. *Densities* were determined by means of a 50-cc.-capacity carefully thermostated pyknometer. Distilled water was used for calibration. The density values could easily be reproduced within unity in the fourth place.

4. *Diffusion coefficients* were obtained by a McBain-Northrup type (*3*) of diaphragm cell, consisting of an approx.-3-mm.-thick, 5-cm.-diam. glass diaphragm separating two compartments of about 80 to 100 cc. volume. The cell was calibrated by use of a 0.075 *N* potassium chloride solution at 25°C. Saturated or near-saturated solutions were brought into contact through the diaphragm with pure solvent, diffusion taking place for periods of 4 to 5 days. At the conclusion both compartments were analyzed for acid content. The values presented are averages of several independent measurements, with a maximum deviation of approximately ±1.5% (*4*).

Literature Cited

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