Solubility of Aromatic Hydrocarbons in Water and Aqueous Solutions of Sugars

By MAMORU NANGO,* HARUO YAMAMOTO, KOUHEI JOUKOU, MITSUO UEDA, AKIRA KATAYAMA, and NOBUHIKO KUROKI
(*Department of Applied Chemistry, College of Engineering, University of Osaka Prefecture, Sakai, Osaka, Japan*)

Summary 'Sugaring out' and sugaring in' phenomena are observed on the solubility of aromatic hydrocarbons in water and aqueous solutions of sugars.

BENZENE and other aromatic hydrocarbons are of interest in the study of the solubility of nonelectrolytes in water,[1,2] and show interesting solubility characteristics.[1] We here report measurement of the solubility of aromatic hydrocarbons in water and sugars solutions using the method of Bohon and Claussen.[1] Figures 1—3 illustrate the solubilities of benzene, biphenyl, and phenanthrene, respectively in water, and in aqueous solutions of glucose, fructose, and sucrose between 0 and 35 °C. Figure 1 shows that the addition of sugars to water decreases the solubility of benzene; the decrease in solubility follows the order: glucose < fructose < sucrose < water. This observation of decreased solubility in sugar solution is analogous to the

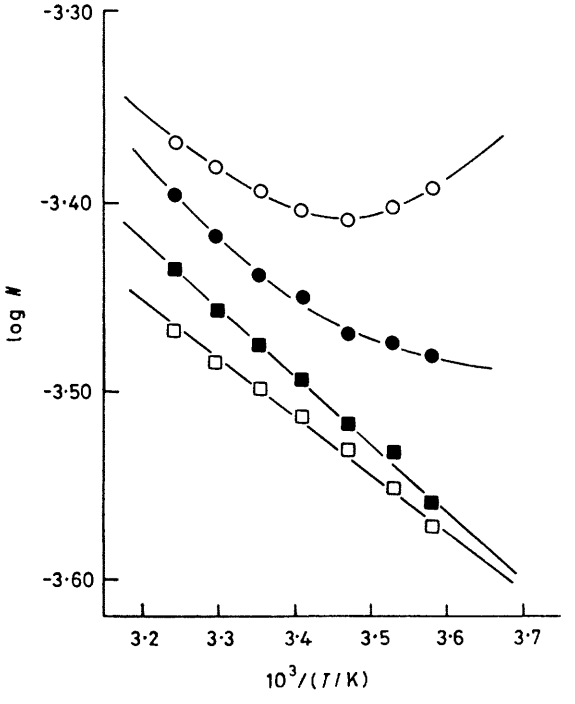

FIGURE 1. Solubility of benzene [log mole fraction (N)] in water and aqueous sugars *vs.* reciprocal absolute temperature. ○: water; ●: 1 mol l^{-1} sucrose; ■: 2 mol l^{-1} fructose; □: 2 mol l^{-1} glucose.

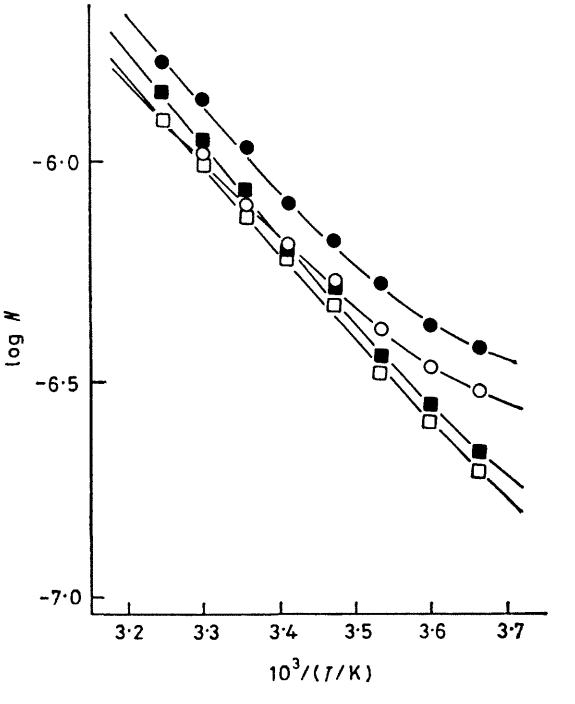

FIGURE 2. Solubility of biphenyl [log mole fraction (N)] in water and aqueous sugars *vs.* reciprocal absolute temperature. ○: water; □: 2 mol l^{-1} glucose; ■: 2 mol l^{-1} fructose; ●: 1 mol l^{-1} sucrose.

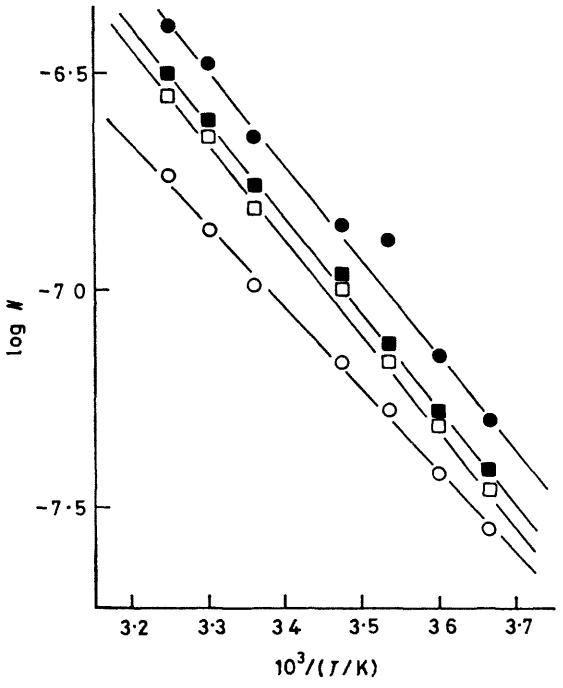

FIGURE 3 Solubility of phenanthrene [log mole fraction (N)] in water and aqueous sugars *vs* reciprocal absolute temperature ○ water, □ 2 mol l^{-1} glucose, ■ 2 mol l^{-1} fructose, ● 1 mol l^{-1} sucrose

'sugaring out' phenomenon described by Lakshmi and Nandi [3] Figure 2 shows that the addition of glucose to water also decreases the solubility of biphenyl However, the addition of fructose increases the solubility of biphenyl at higher temperatures (between 25 and 35 °C), and the addition of sucrose leads to a greater increase in solubility at all temperatures studied The increase in solubility at 25 °C follows the order sucrose > water ~ fructose > glucose Figure 3 shows that the addition of sugars increases the solubility of phenanthrene at all temperature measured and this increase follows the order sucrose > fructose > glucose > water Thus, benzene showed decreased solubility ('sugaring out') in all the sugar solutions studied, while phenanthrene showed increased solubility ('sugaring in'), biphenyl showed intermediate behaviour, its solubility being increased in some cases and decreased in others These results show that the solubility of aromatic hydrocarbons in sugar solutions depends not only on the sugar used but also on the size of the aromatic hydrocarbon Thus, we cannot interpret the solution behaviour of aromatic hydrocarbons in sugar solutions only in terms of a 'sugaring out' effect.[3]

(*Received, 12th September* 1979, *Com* 973.)

[1] R L Bohon and W L Claussen, *J Amer Chem Soc*, 1951, **73**, 1571
[2] C Tsonopoulos and J M Prausnitz, *Ind Eng Chem Fundamentals*, 1971, **10**, 593 H P Benneto and J W Letcher, *Chem and Ind*, 1972, 847, R D Wauchope and F W Getzen, *J Chem Eng Data*, 1972 **17**, 38 H A Massaldi and C J King, *ibid*, 1973, **18**, 393, C S Sutton and J A Calder, *ibid*, 1975, **20** 320, T Suda S Kito, and Y Ito *ibid*, 1975, **20**, 373 F P Schwarz and S P. Wasik, *ibid*, 1977, **22**, 270, F P Schwarz, *ibid*, 1977, **22**, 273, D Mackay and W Y Shiu, *ibid*, 1977, **22**, 399, W E May, S P Wasik, and D H Freeman, *Analyt Chem*, 1978, **50**, 997
[3] T S Lakshmi and P K Nandi, *J Phys Chem*, 1976, **80**, 249