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STUDIES ON SOLUBILITIES OF ETHYLENE IN BENZENE AT HIGH PRESSURES

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Introduction

The solubility of ethylene in benzene was determined as a series of the investigations on the solubilities of gas at high pressures. No data for the solubility of ethylene in benzene at high pressures are available, but at atmospheric pressure Horiuti's data¹⁾ are the most reliable. From the diagram recently published by Jolley and Hildebrand²⁾ it is observed that there is some acid-base interaction between benzene and ethylene which is weaker than that between benzene and acetylene.

Experimentals

Materials Ethylene was prepared by the dehydration of ethyl alcohol and purified by distillation. Its infra-red spectrum shows that it is almost perfectly pure from ether.

Apparatus and procedures In the measurements of the solubilities of gases in liquids at high pressures, the most critical operation is sampling and at this point some improvement was made for the apparatus for the solubility of acetylene. The high pressure part of the apparatus

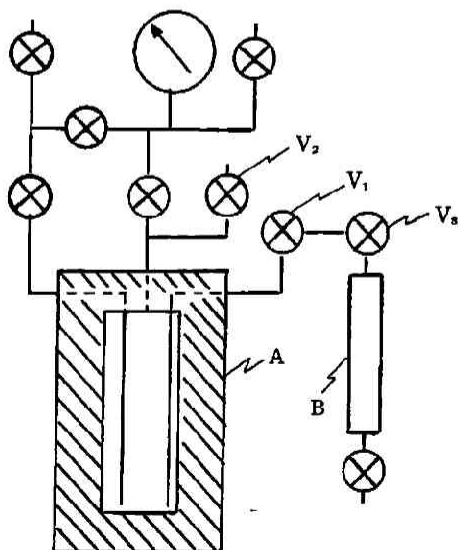


Fig. 1 Apparatus for solubility of ethylene

- 1) J. Horiuti, *Sci. Papers Inst. Phys. Chem. Research, Tokyo*, **17**, 125 (1931)
- 2) J. H. Jolley and J. H. Hildebrand, *J. Am. Chem. Soc.*, **80**, 1050 (1958)

is shown in Fig. 1. After the equilibrium was obtained by bubbling a large quantity of the gas at the experimental temperature and pressure, the stainless steel sampling vessel B, which is filled with mercury, is connected with the valve V_1 . The pipe line connected with the valve V_1 and the sampling vessel are also filled with mercury and then the liquid sample is introduced into the sampling vessel by letting it displace the mercury, while the pressure in the equilibrium vessel A is maintained constant by admitting the compressed ethylene gas from the gas storage vessel. In this way the sampling is made at constant pressure. The analysis of the liquid phase sample is in principle the same as in the case of acetylene, except in the present case the weight of the residual liquid being measured. The gas phase sample was taken out from the valve V_2 and it was condensed by liquid air and then warmed to room temperature. The residual weight of benzene in the sampling glass tube was measured by means of a balance. However in this case the accurate measurements enough to discuss about the treatment by the statistical thermodynamics could not be obtained.

Results

The results for the solubility of ethylene in benzene are given in Table 1 and are shown

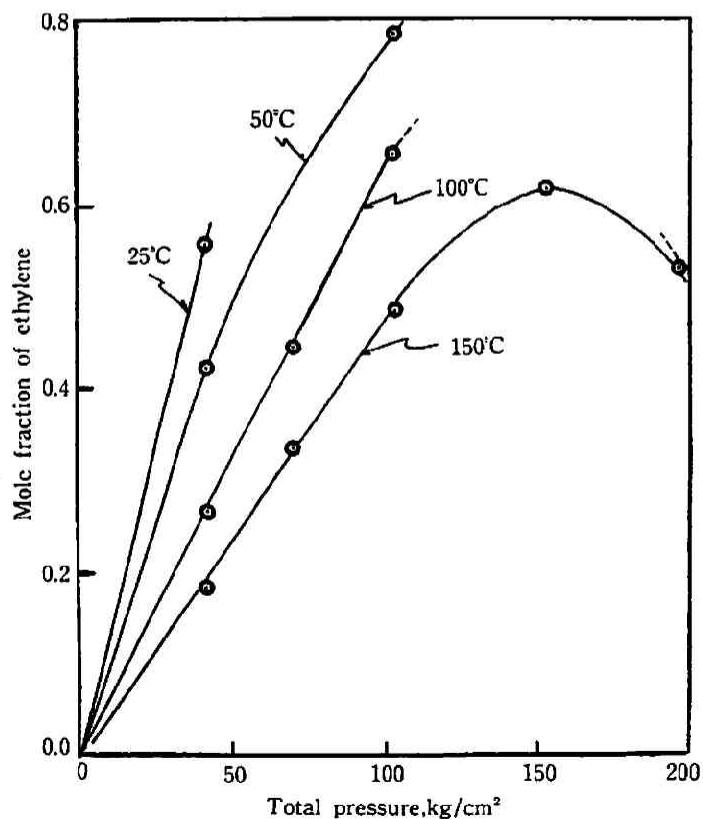


Fig. 2 Solubility of ethylene in benzene

Table 1 Solubility of ethylene in benzene
(mole fraction of ethylene)

Pressure kg/cm ²	Temperature, °C			
	25	50	100	150
42	0.559	0.421	0.264	0.186
70		—	0.445	0.333
103		0.786	0.654	0.483
154			—	0.617
197			0.526	0.527

diagrammatically in Fig. 2. At 150°C the solubility of ethylene in benzene at 200 kg/cm² is smaller than that at 150 kg/cm². The same behavior was observed at 100°C. The measurement at this point was conducted three times and the fluctuations of the data within 6 per cent, whereas at lower pressures than 150 kg/cm² the maximum deviation was as large as 2 per cent from the mean.

According to Horiuti, the solubility of ethylene in benzene at 25°C and 1 atm is 0.0124 mole fraction of ethylene. Hence Henry's law is nearly followed at this temperature.

In conclusion, the author wishes to express his hearty thanks to the late prof. R. Kiyama and Dr. J. Osugi and is also indebted to the Department of Education for the Grant in Aid for Fundamental Scientific Researches.

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