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THE VAPOR PRESSURE OF NITROBENZENE AT LOW TEMPERATURES

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ABSTRACT

The vapor pressures of nitrobenzene were measured over a range of temperatures from 6°C to 23°C and at atmospheric pressure using a packed bed technique. The data could be correlated by the following relationship:

$$\log_{10} p_{\text{mm}} = 7.545 - \frac{2064}{t + 230}$$

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INTRODUCTION AND THEORY

In the study of the gas phase resistance to mass transfer in packed beds, it is advantageous to use an organic material of low vapor pressure as the transferable medium. Unfortunately the vapor pressures of such substances are generally not known with certainty because of the difficulty entailed in the direct measurement of pressures below 1 mm of Hg. A number of such vapor pressure measurements are reported in a review article by Stull⁴ for nitrobenzene. In general there is a considerable region of disagreement among the various authors, and in some cases there is even a lack of thermodynamic consistency. Since it is not possible to use such data with confidence, a study of the vapor pressure of nitrobenzene was undertaken to provide a basis for calculations in subsequent mass transfer experiments.

In the usual packed bed experiment, the desired information is the rate of mass transfer; consequently, the length of the bed is set so that the concentration of vapor in the exit gas stream is 50 to 80 percent of saturation. By increasing the length of the bed sufficiently, essentially complete saturation can be obtained. The partial pressure of the transferred component in the effluent gas can then be considered equal to the equilibrium pressure of the solid or liquid material of which the bed is composed. (For the poorest operating conditions used in these measurements, mass transfer calculations indicate that the exit gas stream was within 0.2% of saturation. This is an error of approximately 0.0004 mm in the vapor pressure.) In practice it is necessary to measure only the weight loss of the bed, the flow rate of the carrier gas, the total pressure, and the temperature of the exit gas stream. The application of Dalton's law then provides the desired vapor pressure.

EXPERIMENTAL

Materials

The nitrobenzene was Eastman Kodak's White Label Grade. This was distilled under vacuum in an Oldershaw column, the center cut being retained. The boiling point was measured as 210.8°C in good agreement with the accepted value of 210.9°C .

Apparatus and Experimental Procedure

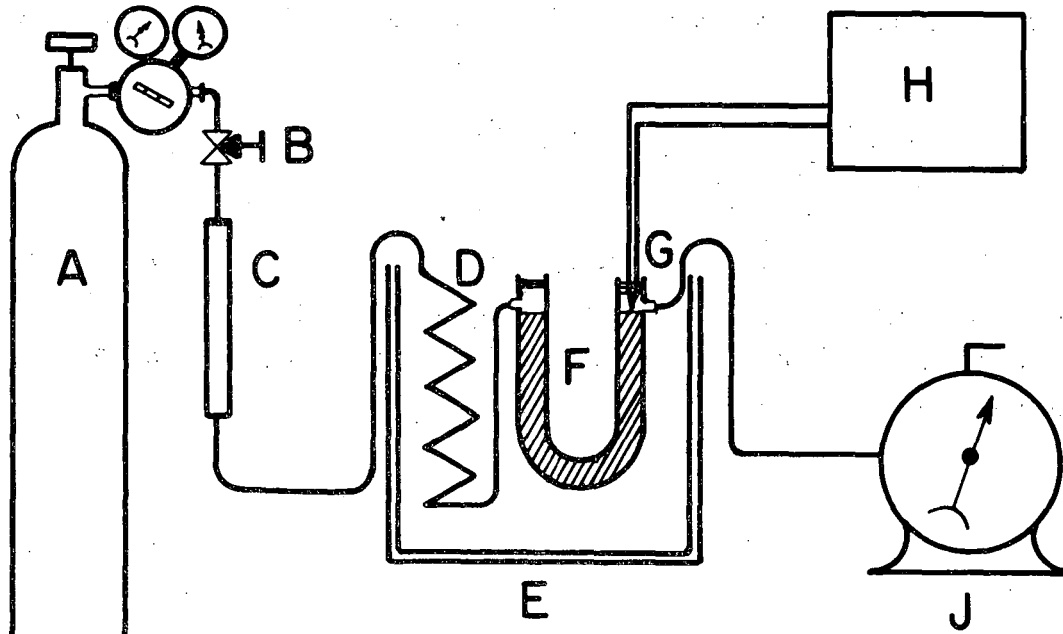
The apparatus used is shown schematically in Figure 1. Nitrogen gas from cylinder A was introduced into the system at a rate which was controlled by a pressure regulator and needle valve B. The gas was passed through drying tube C to remove any water that may have been present. A 25 foot length of coiled copper tubing, D, located in the thermostat, E, served to bring the incoming gas stream to the temperature of the packed bed, F. The bed was made of a glass U-tube with side arms which was packed with porous alundum spheres soaked with nitrobenzene. The temperature of the exit gas stream was determined with a copper-constantin thermocouple, G, and an L and N Portable Precision Potentiometer, H, to the nearest 0.04°C . The amount of gas passing through the bed was determined with the wet-test meter, J. The bed was weighed to the nearest 0.0001 gm on a chainomatic balance before and after the run to determine the weight loss.

EXPERIMENTAL RESULTS

The vapor pressures of nitrobenzene are given in Table 1 and Figure 2 for the temperature range from 6.09 to 23.14°C. Figure 2 is plotted according to an empirical method suggested by Calingaert and Davis¹ based on the Clausius-Clapeyron equation. The equation of the line representing the data is:

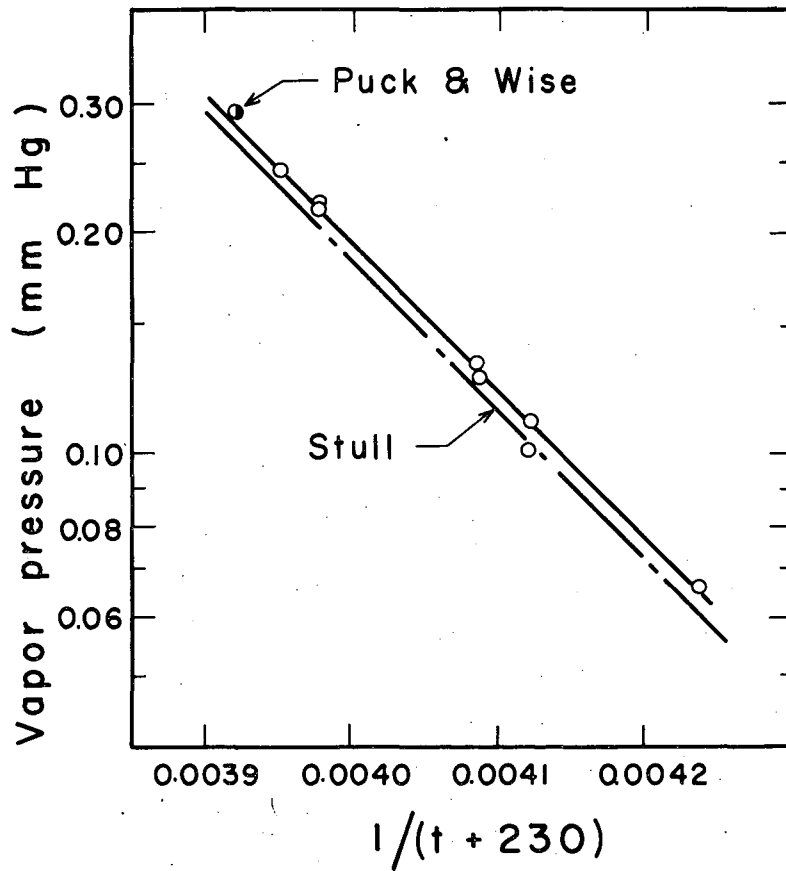
$$\log_{10} p_{\text{mm}} = 7.545 - \frac{2064}{t + 230}$$

where p_{mm} is in millimeters of mercury, and t is in degrees centigrade. Also shown on Figure 2 are the datum point of Puck and Wise³ at 25°C and the extrapolation of the data of Stull⁴ which were given for a range of pressures from 1 to 760 mm.



MU-16753

Fig. 1. Vapor pressure apparatus.



MU-16754

Fig. 2. Vapor pressure of nitrobenzene.

Table I

Vapor Pressure of Nitrobenzene

<u>Temperature</u> °C	<u>Vapor pressure</u> mm Hg
6.09	0.066
12.57	0.111
12.67	0.100
14.67	0.127
14.72	0.133
21.37	0.218
21.54	0.220
23.12	0.242
23.14	0.242

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