

Literature Cited

- Becker, H. A., Hottel, H. C., Williams, G. C., Eleventh Symposium (International) on Combustion, p. 791, Combustion Institute, 1967.
- Cairns, E. J., Prausnitz, J. M., *A.I.Ch.E.J.* **6**, 400 (1960).
- Gibson, C. H., Ph.D. thesis in chemical engineering, Stanford University, Stanford, Calif., 1962.
- Gibson, C. H., Schwarz, W. H., *J. Fluid Mech.* **16**, 357, 365 (1963).
- Keeler, R. N., Ph.D. thesis in chemical engineering, University of California, Berkeley, 1964.
- Keeler, R. N., Petersen, E. E., Prausnitz, J. M., *A.I.Ch.E.J.* **11**, 221 (1965).
- Kiser, K. M., *A.I.Ch.E.J.* **9**, 386 (1963).
- Lamb, D. E., Manning, F. S., Wilhelm, R. H., *A.I.Ch.E.J.* **6**, 682 (1960).
- Lawrence, W. J., Ph.D. thesis in chemical engineering, University of California, Berkeley, 1965.
- Lee, J., Brodkey, R. S., *A.I.Ch.E.J.* **10**, 187 (1964).
- Lee, J., Brodkey, R. S., *Rev. Sci. Instr.* **34**, 1086 (1963).
- Manning, F. S., Wilhelm, R. H., *A.I.Ch.E.J.* **9**, 12 (1963).
- Nye, J. O., Brodkey, R. S., *Rev. Sci. Instr.* **38**, 26 (1967).
- Prausnitz, J. M., Wilhelm, R. H., *Ind. Eng. Chem.* **49**, 978 (1957).
- Prausnitz, J. M., Wilhelm, R. H., *Rev. Sci. Instr.* **27**, 941 (1956).
- Rosensweig, R. E., Hottel, H. C., Williams, G. C., *Chem. Eng. Sci.* **15**, 111 (1961).
- Torrest, R. S., Ph.D. thesis in chemical engineering, University of Minnesota, Minneapolis, 1967.
- Wagner, H. G., Wolborsht, M. L., MacNichol, E. F., Jr., *Science* **132**, 1309 (1960).

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MEASURING THE EQUILIBRIUM PRESSURE OF SUPPORTED AND UNSUPPORTED ADSORBENTS

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A simple experimental technique for measuring the equilibrium (vapor) pressures of unsupported and supported adsorbents was employed to determine the vapor pressure data for the lithium chloride-water-Torvex system at 32° C., for impregnation of 3% anhydrous salt by weight, and for the lithium chloride-water system at several temperatures.

AN ATTEMPT was made to select and develop a simple technique to measure low vapor pressure of hygroscopic salts accurately for both supported and unsupported adsorbent systems.

The static method was used. The hydrate and supporter were placed in a sample flask and the system was allowed to reach equilibrium. The vapor pressure was measured by a cathetometer and the composition determined by measuring the displacements of a calibrated spring.

A schematic diagram of the apparatus is shown in Figure 1. The apparatus consists of a sample tube housing a spring holder, a calibrated spring with a hook, and a sample block; an isothermal bath (Bailey Instrument Co., Model 136) capable of maintaining the temperature within $\pm 0.01^\circ$ C. between -10° and 150° C.; manometers; a vacuum pump with a trap; and a cathetometer.

Apparatus and Procedure

Determination of Equilibrium Pressure of Supported Hygroscopic Salts. The system, lithium chloride impregnated on a solid supporter (Torvex), was chosen for the investigation because lithium chloride is widely used commercially in drying; its potential application in air conditioning has been recognized; and its desirable properties include a high drying rate, high moisture capacity, high efficiency, easy regenerability, chemical stability, and low relative humidity.

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Torvex, produced in alumina and mullite compositions, was selected for its large peripheral surface area, low resistance to flow, and inertness to chemicals.

First the spring constants were determined for weight ranges of interest at various temperatures. Then a cylindrical Torvex block 2 inches in diameter and 1 inch in length was preconditioned in an oven at 300° F. for 12 hours or more, weighed, and dipped into the lithium chloride salt solution.

The sample block was hooked to the calibrated spring inside the sample tube. The tube was immersed in the isothermal bath at a specified temperature and connected to the system. The spring displacements and the vapor pressures were measured with the cathetometer after enough time was allowed for the system to attain equilibrium. Then the system was evacuated from 3 seconds to several hours to reduce the adsorbate content in the adsorbent. Because the evaporation of moisture cools the block and because of the poor heat transfer in the low-pressure system, several hours were generally required for the system to equilibrate thermally. The process may be repeated at different isothermal bath temperatures and for other samples with varying degrees of salt impregnation. The accuracies of the reported measurements are: temperature control $\pm 0.01^\circ$ C., vapor pressure reading ± 0.01 mm. of water, and weight ± 0.1 mg.

The vapor pressure data thus obtained for the lithium chloride-water-Torvex system as a function of the water concentration in lithium chloride at 32° C. with salt impregnation of 3% anhydrous lithium chloride by weight are shown in Figure 2. This figure compares the vapor pressure of the

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