different adsorbents, and may vary even for different types of the same compound. The effects of vapor pressure and temperature upon the moisture content of an adsorbent may be observed by referring to Fig. 1. When the given type of solid adsorbent is in equilibrium with air having a dry-bulb temperature of 70 F and 70 percent relative humidity, that is, having a dew-point of 60 F or a water vapor pressure of 13.2 mm Hg, the water content of the adsorbent is 33 percent. With air having the same dry-bulb

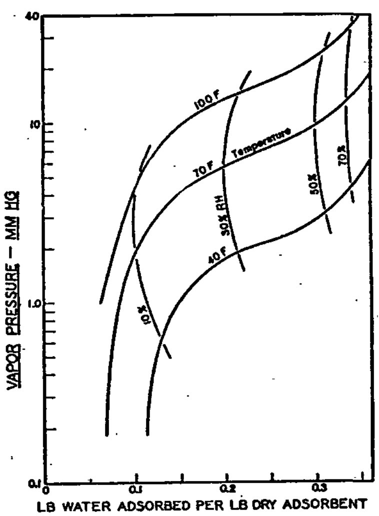

Fig. 1. Temperature—Vapor Pressure—Concentration Characteristics for a Typical Solid Adsorbent

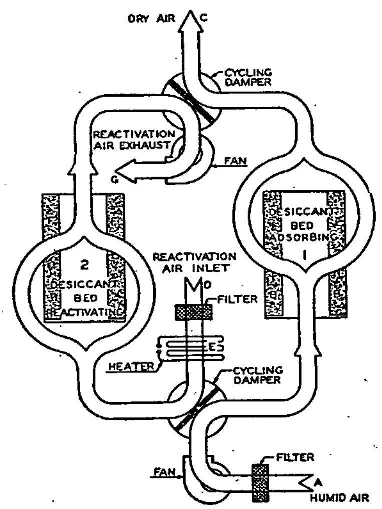

Fig. 2. A Typical Solid Adsorbent Dehumidification Unit Air Flow Diagram

temperature and a dew-point of 37 F, or a vapor pressure of 5.6 mm Hg, the water content is 20 percent. The increase in weight for an activated solid adsorbent, after it reaches equilibrium with a gas of any given water vapor content, may be found by subtracting the residual water content (for example 6 percent) from the equilibrium value. In the case of the two examples cited, the actual water gain would be 27 percent and 14 percent, respectively. The effect of temperature upon the adsorptive capacity may be observed by following the 5.6 mm Hg vapor pressure line. At a temperature of 70 F, the moisture content of the adsorbent is 20 percent, while at 100 F, the equilibrium water content is 11 percent.

In practice, the temperature rise in the dehumidified air caused by the adsorption heat, is approximately 10 deg F for each grain of moisture removed per cubic foot of air at atmospheric pressure. This temperature rise occurs progressively through the adsorbent bed, and is an important consideration in predetermining the performance of a given design of apparatus. Data such as these, together with information covering other characteristics such as specific heat, resistance to air flow, etc., are of value in the basic design of adsorption apparatus. In the solution of air conditioning prob-

lems, however, reference must be made to performance data on established apparatus designs.

DEHUMIDIFICATION EQUIPMENT USING SOLID ADSORBENTS

A typical solid adsorbent dehumidification unit air flow diagram is shown in Fig. 2. The apparatus consists of two adsorbent containers (adsorbers) with necessary interconnecting piping, valves, and auxiliaries consisting of filters, fans, activation air heater, controls, and, in some instances, a cooler for the dehumidified air. Before entering the adsorber, the air to be dehumidified is drawn into a filter to remove dust and other impurities. In passing through the adsorbent bed, the moisture content of the air is reduced and the dehumidified air is then introduced into the space or process requiring it. While the first adsorber is dehumidifying the air, the second adsorber is being reactivated by means of outside air drawn through a filter and heater in which its temperature is raised to 300 F. The heat may be supplied by electric heating elements, steam coils, the direct products of combustion of gas, oil, waste heat, or any other convenient source. In passing through the adsorbent bed, the hot gases supply the necessary heat for releasing adsorbed water from the adsorbent, and then carry it out of the adsorber to the activation gas outlet, where it is exhausted to the outside atmosphere. In some instances a thermostat placed in the activation outlet connection shuts off the activation fan and heater when the adsorbent is completely reactivated, as indicated by a rapid rise in the temperature of the outlet activation gas. The length of the adsorption period may be controlled by a timing device which changes the valves or dampers from the adsorbing to the activating position, or by a humidistat located in the dehumidified air connection or in the dehumidified space. The majority of commercial units are time controlled.

In applications where a continuous stream of dehumidified air is not required, a single adsorber type unit may be used, while in other cases where a continuous stream of dehumidified air is required, a multiple number of adsorbers, or even a continuously rotating system, may be used.

If the air to be dehumidified is very warm, and especially where exceedingly low dew-point dehumidified air is required, it is advantageous to install a pre-cooler to reduce the temperature of the inlet air. In this way the working temperature in the adsorber is lowered, and the overall performance appreciably increased. Some equipment manufacturers install cooling coils in the adsorbent beds for the same purpose, while others divide the adsorbent bed and install coolers between the sections.

Dehumidification equipment is employed to the best advantage where the air conditioning problem is primarily one of obtaining low relative humidity control rather than temperature control. This requirement is found in the case of the preservation of inactive naval vessels where the interior of the ship must be kept at a relative humidity below 30 percent to avoid corrosion, mold, mildew, and other moisture damage that occurs at humidities substantially in excess of this figure. Other advantageous applications for dehumidification systems are found in industrial processes where low relative humidity atmospheres are required during the manufacture, as well as for preservation of the finished products. Dehumidification with cooling may be used to advantage in work-rooms or other spaces occupied by humans, where the moisture load is high in comparison to the sensible heat load. In many instances, where independent control of temperature and humidity is important, dehumidification is used to advantage in conjunction with cooling.