

high adsorptive capacity per unit of weight, and is non-toxic. It may be repeatedly re-activated after becoming saturated with adsorbed moisture without practical loss of its adsorptive ability. In the grade frequently used for air drying the re-activation may be accomplished at temperatures under 350 F. Specific gravity is 3.25 and the pores are reported to occupy 58 per cent of the volume of each particle. For most estimating purposes the volume-weight relation on a dry basis may be taken as 50 lb per cubic foot although in the smaller sizes the packed weight may be as much as 64 lb per cubic foot.

Silicon Dioxide, (Silica), in a special form obtained by suitably mixing sulphuric acid with sodium silicate, is another solid adsorbent and is commonly called *silica gel*. Its capillary structure is exceedingly small, so small that its exact structure has to be deduced rather than observed. The gel is available commercially in a wide variety of sizes of granules ranging from 4 to 300 mesh. It has high adsorptive capacity per unit of weight and is non-toxic, may be repeatedly re-activated without practical deterioration. Re-activation may be accomplished at temperatures of air up to 600 F although it is frequently accomplished with air or other gases at temperatures not over 350 F. Volume of the capillary pores is reported to be from 50 to 70 per cent of the total solid volume. For most estimating purposes the volume-weight relation can be assumed as from 38 to 40 lb per cubic foot on a dry basis.

Other substances having properties which make them available as solid adsorbents include lamisilate and charcoal but details of their physical properties are not available.

Nature of Adsorption Process

Adsorption is accomplished without chemical change between the air and the adsorbent substance. The adsorbent does not go into solution but water vapor is extracted from the air-vapor stream passing through the bed of adsorbent material and is caught and retained in the capillary pores. The exact nature of the process which goes on during adsorption is not known but it is stated that the action is brought about by surface condensation, and also by a difference between the vapor pressure of the water condensing inside the pores and the partial pressure of the water vapor in the air-vapor mixture. The adsorbing process in the bed can continue until the vapor pressures come into equilibrium. The amount of vapor adsorbed will depend on the adsorbent substances being used but for any single substance the amount depends on the temperature of the bed as well as on the partial pressure of the air-vapor mixture being passed over it.

As the process of adsorption goes on heat is liberated in the bed. The heat so liberated is the latent heat of the water vapor condensed together with the so-called heat of wetting. For a pound of water vapor at 60 F the latent heat released by condensation is approximately 1057 Btu. The heat of wetting for silica gel, for example, is about 200 Btu, making a total heat of adsorption of approximately 1257 Btu per pound of water adsorbed from the air-vapor mixture passing through the silica gel bed. The heat of wetting varies with the substance being used as the adsorbent while the latent heat of condensation depends only on the temperature and pressure of the water vapor.

Temperature-Pressure-Concentration Relations

Since the adsorptive ability of an adsorbent depends on the temperature of the bed and on the partial pressure difference between the pores and the air-vapor mixture it is important to know the pressures and temperatures at which pressure equilibrium is reached.

Evidently the equilibrium conditions represent the limits beyond which adsorption of vapor cannot continue. The relationship can be

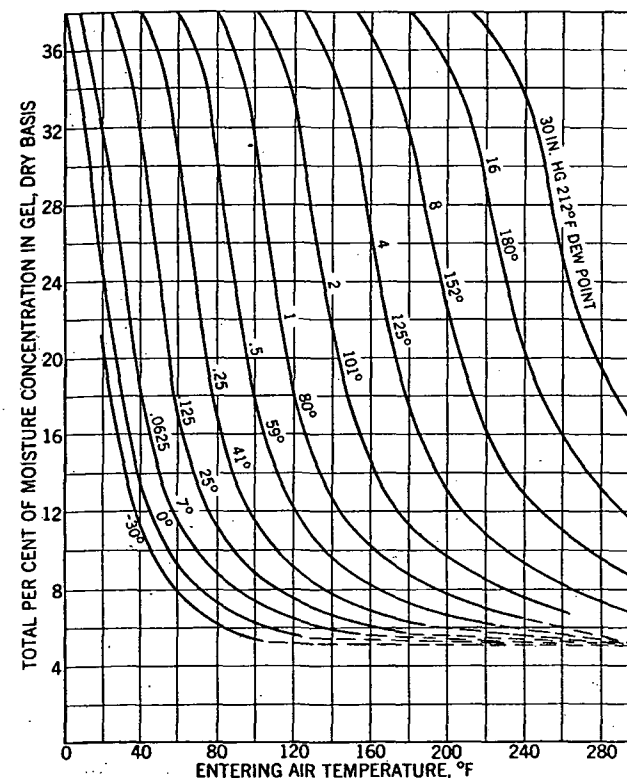


FIG. 1. TEMPERATURE-VAPOR PRESSURE-CONCENTRATION RELATION FOR A SILICA GEL BED AT CONSTANT TEMPERATURE

shown graphically and Fig. 1 is such a chart for silica gel. Charts of like nature can be plotted for other adsorbent materials.

Fig. 1 shows the equilibrium conditions for a gel bed maintained at constant temperature while the water vapor adsorption is allowed to continue until pressure equilibrium is reached. Each curve on the chart shows a certain dew-point temperature, and therefore a certain pressure, of the saturated water vapor.

As an example in the interpretation of the chart consider the case when