

adsorbed. In spite of a porous structure these substances retain sufficient mechanical strength to resist the wear and handling to which they are subjected. To be suitable for dehumidification purposes such substances must fulfill the following requirements:

1. Possess suitable water vapor pressure characteristics.
2. Be available at a reasonable cost.
3. Adsorb sufficient moisture per pound of material to avoid excessive bed dimensions.
4. Be chemically stable, resisting contamination from impurities.
5. Be physically rugged to resist breakdown from handling, abrasion, etc.
6. Be able to withstand breakdown from indefinitely repeated reactivation cycles.
7. Be capable of reactivation at reasonable temperatures.

Activated Aluminum Oxide (Alumina) is a porous, amorphous form of aluminum oxide and is called by the common name Activated Alumina. Commercial activated alumina commonly used for dehumidification contains about 92 per cent of Al_2O_3 combined with hydrated aluminum oxide. It is available in granules ranging from a fine powder to pieces approximately 1.5 in. in diameter. It has high adsorptive capacity per unit of weight and is non-toxic. It may be repeatedly re-activated after adsorbing moisture without practical loss of its adsorptive ability. In the grade frequently used for air drying the reactivation may be accomplished at temperatures between 350 and 600 F. Specific gravity is 3.25 and the pores are reported to occupy 51 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 prepared form obtained by suitable mixing of 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 as it cannot be observed. It has high adsorptive capacity per unit of weight; it is non-toxic, and may be repeatedly re-activated at temperatures up to 600 F without practical deterioration. Re-activation is generally 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. Silica gel is available commercially in a wide variety of sizes of graded granules ranging from 3 to 8 mesh granules to impalpable powder (through 325 mesh). The 6 to 16 mesh granules are generally used in dehumidification applications and will vary in density from 40 to 45 lb per cubic foot.

There are other solid substances having marked adsorbent properties, but details concerning them are not available. Most adsorbents have the ability to absorb some gases and condensable vapors other than water vapor, a property sometimes useful in air conditioning applications, and one which accounts for the extensive use of adsorbent materials in the field of chemistry.

Air to be dehumidified is drawn or blown through a screened bed of dry, solid adsorbent and the water vapor in the air-vapor mixture is caught and retained in the pores of the medium. 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 reach equilibrium. The amount of vapor adsorbed will depend on the

characteristic of the adsorbent being used, the temperature of the air and the bed, the vapor pressure of the water vapor in the air being passed through it, and its final vapor pressure or moisture content.

As the bed of material adsorbs moisture, its vapor pressure approaches that of the contacting air and the efficiency of adsorption gradually decreases. Equilibrium throughout the whole bed will not be reached for an extended period depending on bed thickness. Because of this diminishing efficiency of adsorption, commercially designed systems do not approach the state of equilibrium, but generally operate on a predetermined cycle or contact time and at partial saturation.

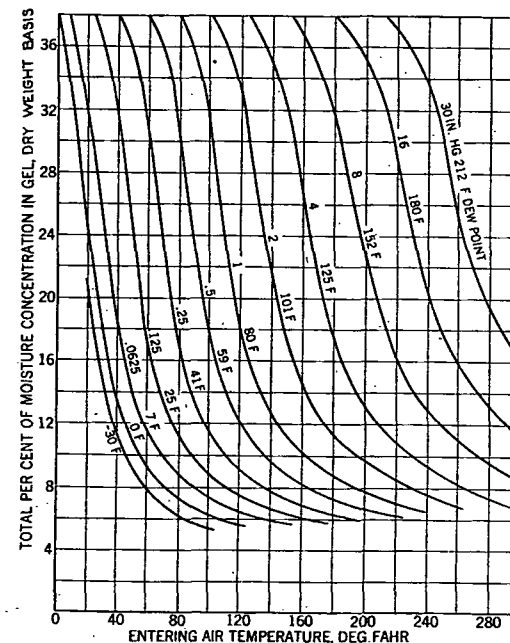


FIG. 1. TEMPERATURE—VAPOR PRESSURE—CONCENTRATION RELATION FOR A SILICA GEL BED AT CONSTANT TEMPERATURE

As the process of adsorption goes on heat is liberated in the bed. The total heat so liberated consists of the latent heat of the water vapor condensed together with the so-called heat of wetting of the adsorbent. The heat of wetting varies with the substance used as adsorbent while the latent heat of condensation depends only on the temperature and pressure of the water vapor.

Since the adsorptive ability of an adsorbent depends on the temperature of the bed and on the vapor 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. This relationship for one com-