the result that water is extracted by the adsorbent and its weight increased, while the moisture content of the gas is correspondingly reduced. (The adsorbent is said to be saturated for a given condition when equilibrium is attained.) The weight of water a given adsorbent will extract is dependent upon the relative humidity (ratio of the partial pressure in the gas to the saturation pressure at a given temperature) and the temperature of the adsorbent. The process is reversible; if the temperature of the adsorbent is raised until the vapor pressure of the adsorbed water becomes greater than the partial pressure of the vapor in the surrounding atmosphere, water will be released by the adsorbent. After the adsorbent cools to room temperature, for instance, the vapor pressure of the water in the adsorbent falls below the partial pressure of the vapor in the atmosphere, and the adsorbent will again start extracting water. The elimination of water by the addition of heat is known as reactivation, and is a means of regenerating the adsorbent so that it may be used repeatedly.

Adsorption is proportional to the amount of surface (internal and external) of the sorbent. The materials that are used commercially as solid adsorbents have a porous structure of sub-microscopic dimensions, which gives them extensive surface area. An adsorbent should meet the following requirements in order to be satisfactory for dehumidification purposes:

1. Have a high adsorptive capacity under normal atmospheric conditions.
2. Be chemically stable, resisting contamination from impurities.
3. Be physically rugged to resist breakdown from handling and use.
4. Be capable of reactivation at temperatures generally obtainable.
5. Be heat-stable at reactivation temperatures.
6. Have a weight per unit volume such as to avoid excessive bulk.
7. Be available at reasonable cost.

Activated Alumina

Activated alumina is a granular porous material which removes by adsorption substantially 100 percent of the moisture from gases, vapors, and certain liquids. Regeneration or reactivation may be accomplished by employing a heating medium at temperatures ranging from 350 to 600 F. After many cycles of adsorption and reactivation it is substantially as effective as originally, and retains its original size and shape.

Activated alumina is produced by chemically controlled precipitation from a sodium aluminate solution resulting from the extraction of alumina from bauxite by the Bayer process. By subsequent processes this precipitate is converted into a highly porous adsorptive material. It is low in iron and silica, each normally less than 1/10 of 1 percent. Commercially produced material is uniform in analysis and physical form.

Activated alumina is a partially dehydrated aluminum trihydrate containing about 7 percent water and small amounts of soda, oxides of iron, silicon, and titanium, as well as very minor amounts of other elements indicated spectrographically. Substantially all of the soda is combined with silica and alumina as an insoluble constituent.

Activated alumina is inert chemically to most gases and vapors, is nontoxic, and will not soften, swell or disintegrate when immersed in water. High resistance to shock and abrasion is one of its more important physical characteristics. Commercial sizes range from a powder passing through 300 mesh screen to particles 1 in. in diameter. The sizes commonly used are 8–14 mesh and ¼ in. to 8 mesh. The average weight for most forms is

50 lb per cubic foot. Its high degree of purity warrants classification among commercially pure chemicals.

Silica Gel

Silica gel is a prepared form of silicon dioxide (silica) having an extremely porous structure which makes it an efficient adsorbent. It is made by mixing predetermined concentrations of an acid, such as sulfuric acid, and a soluble silicate, usually sodium silicate, and allowing the mixture to set to a jelly-like mass called hydrogel. The product takes its name from its condition as a colloid at this stage of its manufacture. After setting, the hydrogel is broken into small lumps, washed, dried, crushed, and screened to the desired particle sizes and then given a final heat treatment or activation. The surface area of silica gell has been found to be in excess of 50,000 sq ft per cubic inch of product. Silica gel has high adsorptive capacity per unit weight, and may be reactivated repeatedly at temperatures up to 600 F. Reactivation is generally accomplished by blowing gases through the silica gel at approximately 300 F, or by heating in a well vented oven maintained at this temperature until no more moisture is given off. Silica gel is a high purity, rugged, non-toxic, heat-stable material, having a specific heat of 0.2, and is most inert. There is no change in the size or shape of the particles as it becomes saturated, and no corrosive or injurious compounds are given off. It is available commercially in a number of grades, ranging in particle size from a 3 to 8 mesh product to an impalpable powder passing through a 325 mesh screen. The product generally used for dehumidification applications has a particle size of 6 to 12 mesh, and a bulk density of between 40 and 45 lb per cubic foot.

Activated Bauxite

Activated bauxites are certain natural products which, after controlled heat treatment, have properties which make them suitable for use as solid adsorbents. They are marketed under different trade names by several processors. The activated bauxites consist primarily of Al_2O_3, Fe_2O_3, SiO_2, TiO_2, and H_2O in varying percentages. The surface area, adsorptive capacity, and other properties of the several products differ to some extent, depending upon the source of the original material and its subsequent treatment. The available activated bauxites are durable products having a specific heat of about 0.24, and can be regenerated at temperatures between 300 F and 500 F. They are usually supplied in a number of particle sizes, and have a bulk density of between 55 and 65 lb per cubic foot.

There are other solid substances having marked adsorbent properties, but details concerning them are not available.

DEHUMIDIFICATION BY SOLID ADSORBENTS

Since adsorption is primarily a condensation process, heat, equivalent to the latent heat of evaporation of the vapor, plus the heat of wetting (which is an additional amount of heat, depending upon the vapor being adsorbed and the adsorbent used) is liberated. The sum of the latent heat of evaporation and the heat of wetting is known as the heat of adsorption. During adsorption it might be said that latent heat is transformed into sensible heat, which is dissipated into the adsorbent, into the metal of the adsorbent container, and into the gas mixture, resulting in a rise in temperature. Fig. 1 shows the relationship between temperature, vapor pressure, and moisture content of a solid adsorbent. These curves indicate the general performance of solid adsorbents, although the exact values vary for the