refrigerant, and a compressor is employed to withdraw enough low-pressure saturated gas to keep the cooling action of the evaporator continuous. The withdrawn gas is discharged from the compressor to the condenser in the form of a high-pressure superheated gas which includes the heat added through its compression. In the condenser, because heat is taken from the gaseous refrigerant by the condensing medium, usually water, the refrigerant again becomes the high-pressure saturated liquid with which the cycle started.

The cooling water, which may come from a deep well or from a city main, may be utilized for some purpose after it has been warmed a few degrees in the condenser, or after use it may be exposed to the atmosphere

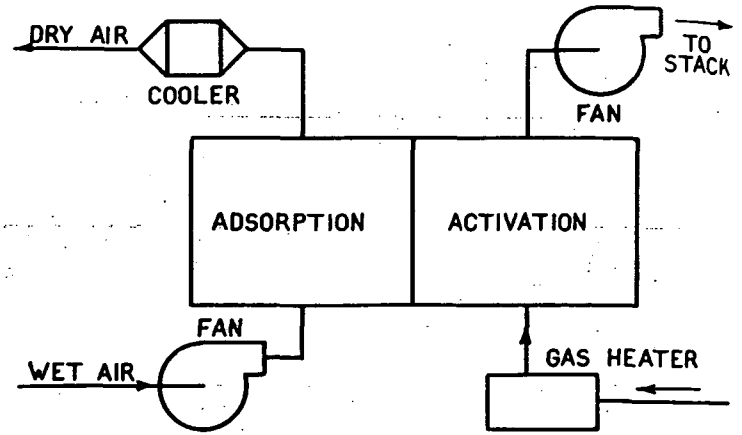

Fig. 2. Silica Gel Air-Conditioning System—Single Stage Adsorption

in a spray pond or cooling tower and have its temperature reduced to a point where the water may be used again. (See Chapter 11.)

Silica Gel System

Silica gel is a chemical composition made from sodium silicate and acid, the chemical formula being SiO_2. It has an appearance greatly resembling that of clear quartz sand but it differs in structure in that the crystals are highly porous, with voids constituting 41 per cent by volume although the pores are microscopic in size. This material possesses the property of being able to adsorb a substantial portion (about 25 per cent of its own weight) of moisture from the air without any increase in its volume. After the silica gel has become "saturated" or has adsorbed moisture to the limit of its capacity, the moisture may be driven from it by the application of heat, again without change in the structure, volume, or chemical composition of the silica gel. This cycle may be repeated indefinitely. When applied to air conditioning the silica gel which is exposed to the air reduces the moisture content in the air and releases sensible heat which may be readily removed from the air. A typical diagram is shown in Fig. 2.

Practical Application of Silica Gel

Silica gel has two applications when used to replace refrigeration. In the one principally used, the air from which moisture is to be extracted is taken through silica gel beds by suction or pressure fans, and by means of this process the moisture becomes adsorbed by the silica gel and the air leaves at a lower dew point and a higher sensible temperature than those at which it entered. If this air is passed over surface coolers in which tap water or another cooling medium is flowing through tubes, a certain amount of sensible heat will be removed. The air leaves the surface cooler or interchanger with the same dew point with which it emerged from the silica gel beds, but with a lower dry-bulb temperature, although the dry-bulb temperature may be higher than the temperature of the air entering the silica gel beds.

In another method, the first two of the steps outlined are duplicated, and in addition the air is carried through a spray type washer. Because the air enters the washer with a low wet-bulb, and because adiabatic saturation will take place at a temperature close to the entering wet-bulb, considerable cooling of the air can be accomplished; but this can be done only with a consequent increase of the dew point.

It is necessary to reactivate the silica gel after it has adsorbed about 25 per cent of its own weight in the form of moisture. As reactivation requires a high temperature and since silica gel is only active at low temperatures, cooling of the beds must also be completed before they can be used again. This necessitates three stages in the silica gel containers and requires either three beds of silica gel or one bed divided and automatically put in position. The reactivation is usually done by means of gas or oil fires and the cooling of the beds by means of indirect water cooling or by means of small quantities of dehydrated air taken from the system beyond the interchanger.

Alumina System of Adsorption

Activated alumina contains a trifle over 91 per cent of aluminum oxide, Al_2O_3, which material will adsorb nearly 100 per cent of the vapor in the air up to about 8 or 10 per cent of the weight of the adsorbing material, after which the adsorption falls off gradually as the saturation point is approached. The application is quite similar to that employed for silica gel; that is, the material is exposed to the air flow and after reaching about 75 per cent saturation is reactivated by removing the moisture adsorbed by means of applied heat. The actual scheme generally followed in the use of this material for continuous service varies somewhat from silica gel inasmuch as the material is placed in three units which are used consecutively for the different steps. These steps permit each unit to operate as follows:

a. In series with the preceding unit.
b. Alone.
c. In series with the following unit.

This plan allows for adsorption, reactivation, and cooling, in a manner similar to that used with silica gel.

Taking a single unit, when it is in the *a* step and operating with the