spray in which the water is being continually recirculated. The air, entering in an unsaturated condition, evaporates a part of the water at the expense of the sensible heat. As this is an adiabatic transfer, the total heat content of the air remains constant, while the dew point rises and the dry-bulb falls until the air is saturated. A system[1] of ducts and a propelling fan are used to distribute the air in a proper manner.

It will be seen that the reduction in dry-bulb temperature is a direct function of the wet-bulb depression of the air entering the dehumidifier and that the resulting air temperature is governed entirely by the entering wet-bulb temperature of the outside air.

Dehumidification

Dehumidification may be accomplished in three ways:

1. By cooling the air below the dew point and causing a part of the moisture contained to precipitate.
2. By extracting all or part of the moisture by absorption.
3. By extracting all or part of the moisture by adsorption.

As used in this discussion, the term *adsorption* pertains to the action of a substance in condensing a gas or vapor and holding the condensate on its surface without any change in the chemical or physical structure of the substance and with the release of sensible heat. The term, *absorption*, implies a change in the chemical or physical structure of a substance in the process of dehydrating air. Adsorption is distinctly a surface action and is thereby distinct from absorption. Adsorbers include lithium chloride, calcium chloride; silica gel, lamisilite, or any of the halides; absorbers include sulphuric acid.

Dehumidification by Refrigeration

Air conditioning imposes requirements on refrigeration equipment not usually found in general cooling work, so that specially designed apparatus is often needed to replace that normally used for industrial cooling. Standard equipment can be adapted to meet air conditioning requirements but extreme care must be taken to determine the limits of its applicability.

In industrial or process cooling systems the load is fairly constant, noise in operation is not of paramount importance, space is available or relatively cheap, condenser water is not a source of worry, and the cooling system is to a great extent separate and independent of other mechanical equipment. By contrast, air conditioning, especially as used for space cooling and comfort work in office buildings, theaters, and places where people gather requires special consideration of all these factors. Space in public buildings is limited and condenser water is expensive. Noise interferes with the occupants, and the cooling equipment must dovetail with the other air-handling apparatus. Most important, the load fluctuates tremendously and is seasonal.

A complete discussion of the thermodynamic problems of refrigeration is given in Chapter 2 on Refrigeration.

[1]See Air Washer Performance in Chapter 11; also Theory of Atmospheric Cooling in same chapter.

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 of this system is shown in Fig. 10, of Chapter 2 on Refrigeration.

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