mentioned. Cooling by evaporation is satisfactory only when the air to be cooled is very dry; air motion as a means of producing cooling effect is never entirely adequate in the range of high temperatures. Of the two, evaporative cooling, or adiabatic saturation of the air, is a much more dependable method which will make more reduction in the effective temperature than will an increasing air motion within permissible limits.

As an example of this, consider an outdoor condition of 96 F dry-bulb and 80 F wet-bulb. The effective temperature is 85.7 F and, if the still air is moved with a velocity of 300 fpm, the effective temperature will be reduced only 2.0 F while saturation at the wet-bulb temperature would reduce the effective temperature 5.7 F. At 300 fpm velocity this saturated air would reduce the effective temperature to 75.6 F, thus making a total improvement of 10.1 F.

Evaporative Cooling

Evaporative cooling is accomplished by passing air through a water 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. Adsorbers include silica gel and lamisilite; 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.

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

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.

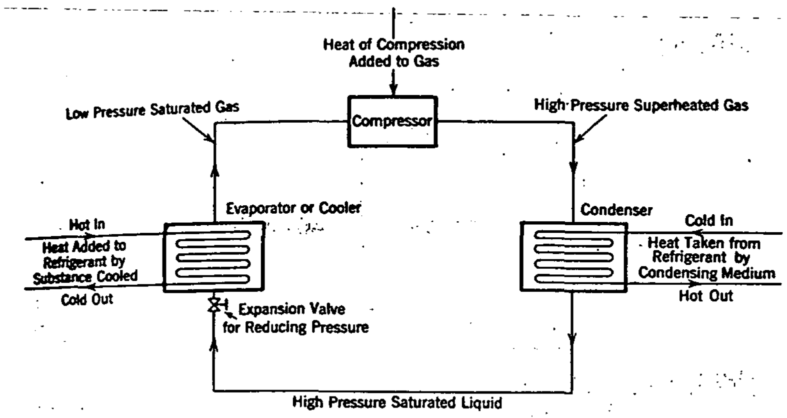

FIG. 1. TYPICAL REFRIGERATION DIAGRAM

A complete discussion of the thermodynamic problems of refrigeration is given in the Refrigerating Data Book[2], 1934, so only a brief description of the cycle will be given here before the problems peculiar to air conditioning are considered.

The refrigeration system consists of three main parts, the evaporator, the condenser, and the compressor. Fig. 1 shows a diagram of the cycle. Heat is absorbed in the evaporator and released in the condenser. The compressor changes the level of the heat by taking it from a lower to a higher plane. There are also many valves, accessories, and special devices necessary for proper operation, which vary somewhat with different types of cooling systems and different refrigerants.

In a simple illustrative cycle of a refrigeration system, the liquid refrigerant under high pressure has both its pressure and temperature reduced by being expanded through a suitable valve into an evaporator or cooler. Within the evaporator the low temperature of the refrigerant allows it to absorb heat from the substance to be cooled, which surrounds the evaporator. This absorption of heat increases the pressure of the

[2]Published by *American Society of Refrigerating Engineers.*