Air Conditioning Systems

An Online Continuing Education Course for Engineers

Course Number: HV-4015

Credit: 4 Hours / 4 PDH / 4 CPD

Air-Conditioning Systems

INTRODUCTION

Most people think an air-conditioning system's job is just to add "cold" air to the space. Actually air conditioning is a process by which air is cooled and dehumidified by mechanical means. In a broader sense, air conditioning includes both the cooling and heating of air, cleaning it and controlling its moisture level, and conditioning it to provide maximum indoor comfort. Engineers define the process as one in which a system of mechanical components—usually a compressor, a fan, condenser coil, evaporator coil, and a chemical refrigerant—extracts heat from indoor air and transfers it outside, leaving the cooled indoor air to be re-circulated. The cleaning function of air conditioners is performed by filters.

The intended use of the conditioned space is the determining factor for maintaining the temperature, humidity, air movement, and quality of air. Air conditioning is able to provide widely varying atmospheric conditions ranging from conditions necessary for drying telephone cables to that necessary for cotton spinning. Regardless of variations in outdoor weather, air conditioning can maintain any atmospheric condition.

This course explains the following subjects as they pertain to air conditioning: principles of air conditioning, heat pumps, chilled-water systems, periodic maintenance, cooling towers, troubleshooting, automotive air conditioning, and ductwork.

PRINCIPLES OF AIR CONDITIONING

Air conditioning is the process of conditioning the air in a space to maintain a predetermined temperature-humidity relationship to meet comfort or technical requirements. This warming and cooling of the air is usually referred to as winter and summer air conditioning.

Here, you are introduced to the operating principles of air-conditioning systems, the environmental factors controlled by air conditioning, and their effects on health and comfort. Refrigerative air conditioners and general procedures pertaining to the installation, operation, and maintenance of these systems are examined. Also, the operation and maintenance of the controls used with these systems are explained.

Temperature

Temperature, humidity, and air motion are interrelated in their effects on health and comfort. The term given to the net effects of these factors is effective *temperature*. This effective temperature cannot be measured with a single instrument; therefore, a psychrometric chart aids in calculating the effective temperature when given sufficient known conditions relating to air temperatures and velocity.

Research has shown that most persons are comfortable in air where the effective temperature lies within a narrow range. The range of effective temperatures within which most people feel comfortable is called the comfort zone. Since winter and summer weather conditions are markedly different, the summer zone varies from the winter zone. The specific effective temperature within the zone at which most people feel comfortable is called the comfort line (fig. 1).

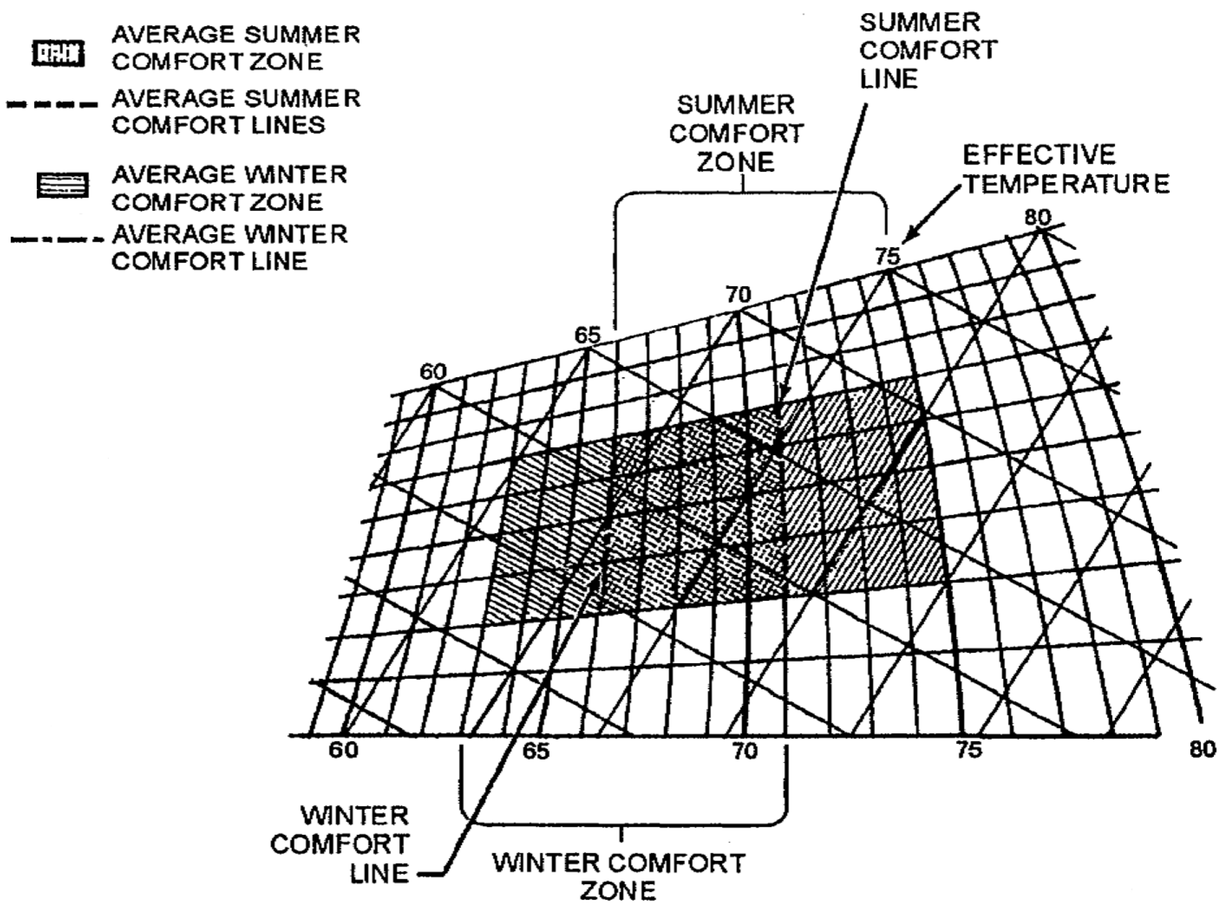

Figure 1.—Comfort Zones and Lines

Humidity
Air that is at a high temperature and saturated with moisture makes us feel uncomfortable. However, with the same temperature and the air fairly dry, we may feel quite comfortable. Dry air, as it passes over the surface of the skin, evaporates the moisture sooner than damp air and, consequently, produces greater cooling effect. However, air may be so dry that it causes us discomfort. Air that is too dry causes the surface of the skin to become dry and irritates the membranes of the respiratory tract.

Humidity is the amount of water vapor in a given volume of air. Relative humidity is the amount of water vapor in a given amount of air in comparison with the amount of water vapor the air would hold at a temperature if it were saturated. Relative humidity may be remembered as a fraction or percentage of water vapor in the air—that is, DOES HOLD divided by CAN HOLD.

Relative humidity is determined by using a sling psychrometer. It consists of a wet-bulb thermometer and a dry-bulb thermometer, as shown in figure 2.

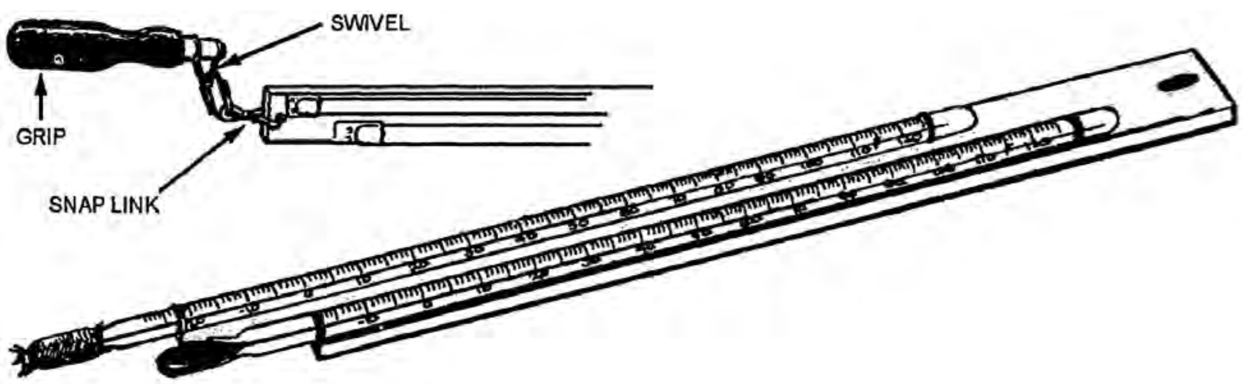

Figure 2.—A Standard Sling Psychrometer

The wet-bulb thermometer is an ordinary thermometer similar to the dry-bulb thermometer, except that the bulb is enclosed in a wick that is wet with distilled water. The wet bulb is cooled as the moisture evaporates from it while it is being spun through the air. This action causes the wet-bulb thermometer to register a lower temperature than the dry-bulb thermometer. Tables and charts have been designed that use these two temperatures to arrive at a relative humidity for certain conditions.

A comfort zone chart is shown in figure 3. The comfort zone is the range of effective temperatures within which the majority of adults feel comfortable. In looking over the chart, note that the comfort zone represents a considerable area. The charts show the wet- and dry-bulb temperature combinations that are comfortable to the majority of adults. The summer comfort zone extends from 66°F effective temperature to 75°F effective temperature for 98 percent of all personnel. The winter comfort zone extends from 63°F effective temperature to 71°F effective temperature for 97 percent of all personnel.

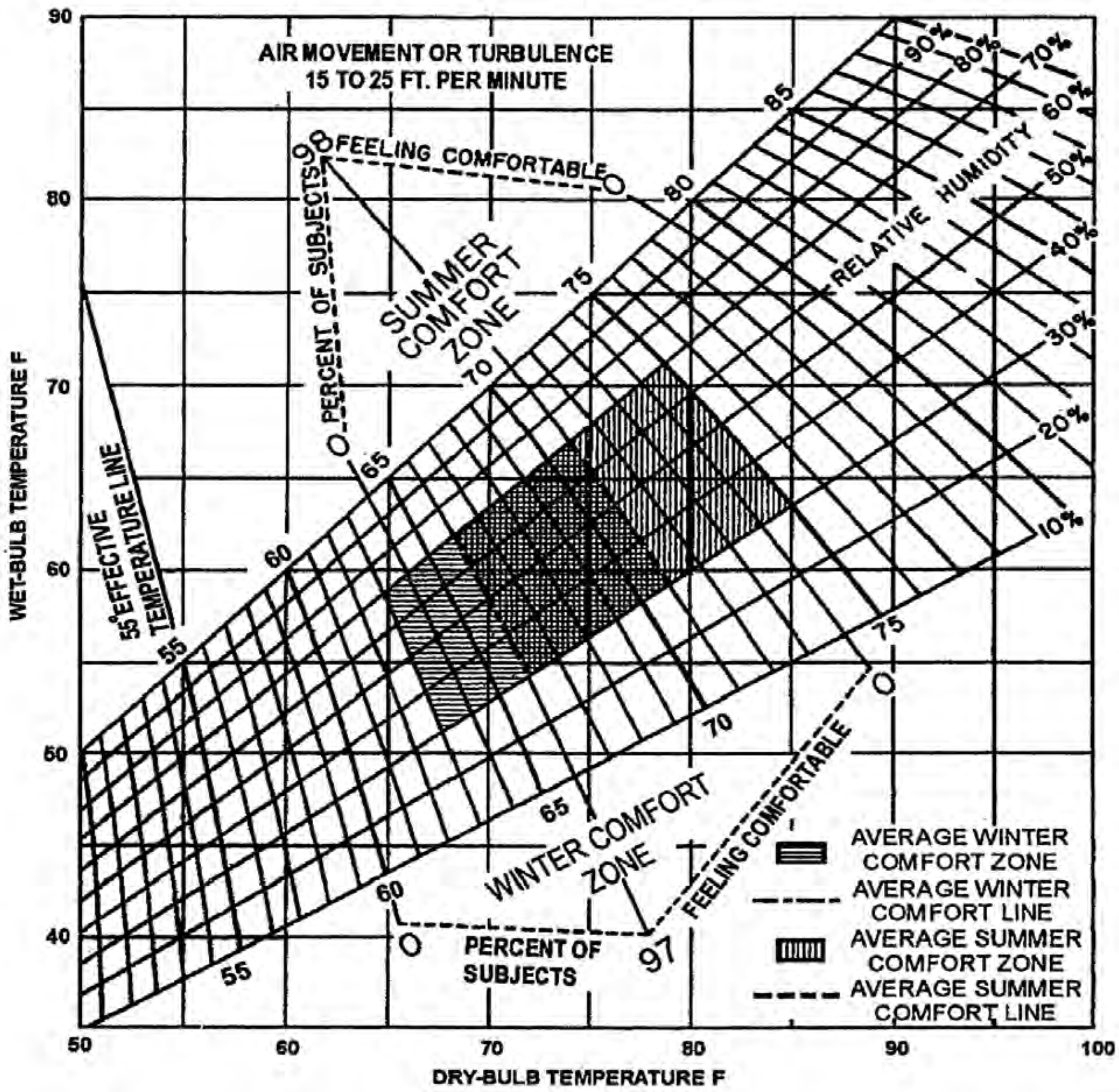

Figure 3.—Comfort Zone Chart

Dew-Point Temperature

The dew point depends on the amount of water vapor in the air. If the air at a certain temperature is not saturated (maximum water vapor at that temperature) and the temperature of that air falls, a point is finally reached at which the air is saturated for the new and lower temperature, and condensation of the moisture begins. This is the dew-point temperature of the air for the quantity of water vapor present.

Relationship of Wet-Bulb, Dry-Bulb, and Dew-Point Tem

A definite relationship exists between th mperatures.
These relationships

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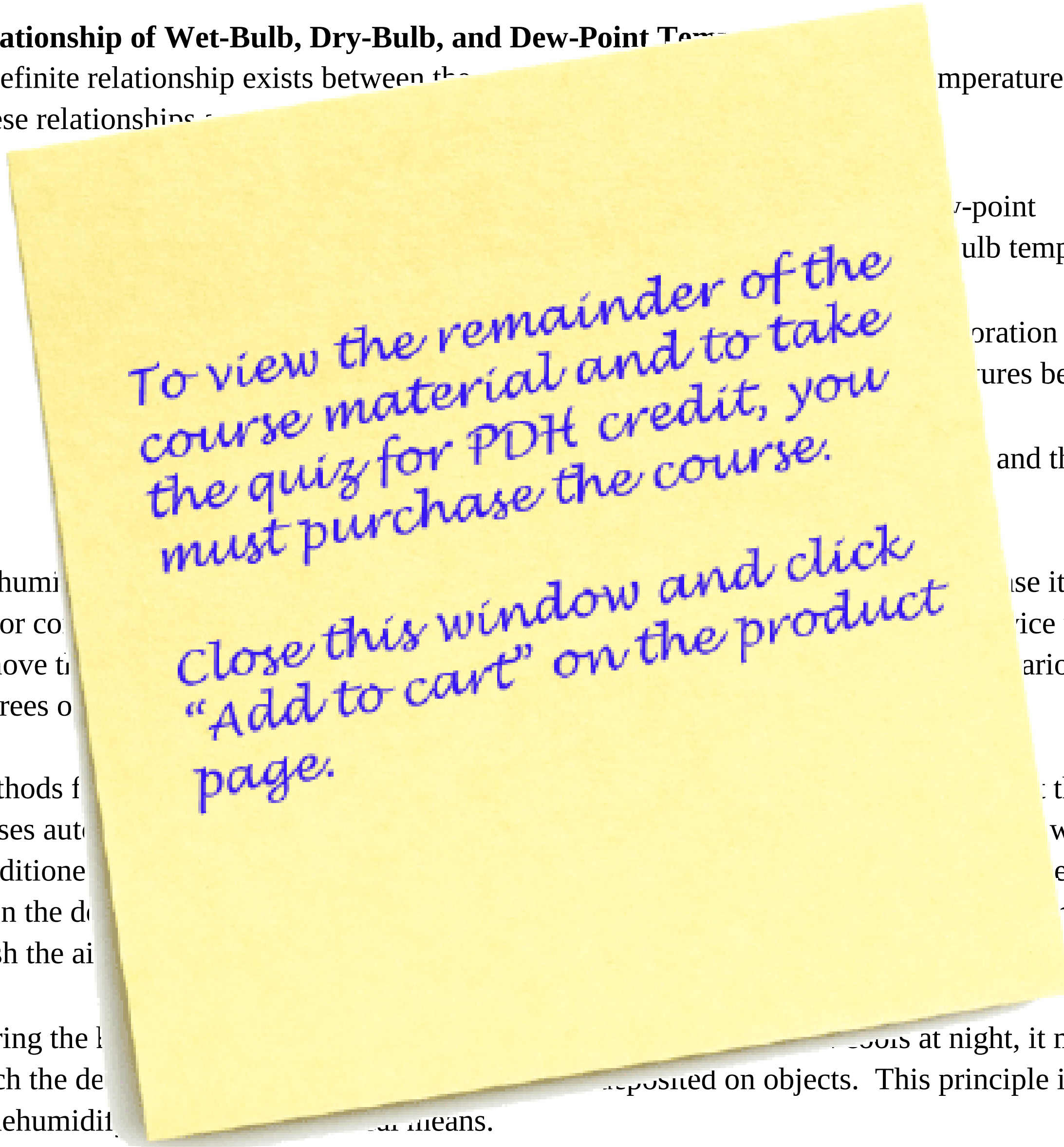

During the ools at night, it may
reach the de posited on objects. This principle is used
in dehumidif eans.

Dehumidifying equipment for air conditioning usually consists of cooling coils within the air conditioner. As warm, humid air passes over the cooling coils, its temperature drops below the dew point and some of its moisture condenses into water on the surface of the coils. The