

tion more than from a capacity of equipment standpoint. It is not only necessary to heat a building or space to its design conditions when there is but the merest fraction of normal occupancy, and when there are practically no lights, internal heat, or solar radiation, but it is also necessary to provide capacity to heat the building quickly when sudden cold follows relatively warm weather, as may occur after a week-end or holiday shut-down. However, in normal operation during week-ends and holidays, buildings are usually kept at a holding temperature to prevent the freezing of services. In many cases, less fuel is required to operate the heating plant at a near-normal rate and maintain the building or space at a temperature of 50 to 65 F at such times, than to shut the system down and then bring the temperature back to normal through forced operation of the heat-generating equipment with a consequent loss in efficiency.

AIR QUANTITY AND TEMPERATURE DIFFERENTIAL

The difference between the room-air temperature and the supply-air temperature at the outlet to the room is known as the temperature differential. In the theoretical case of a dehumidifier having 100 percent saturating efficiency, and where this air is delivered directly to the room without temperature increases due to heat gain, then the temperature differential is the difference between room temperature and apparatus dew-point temperature. If duct heat gains are considered a part of the room load, this still holds true. The apparatus dew point, as outlined previously, is fixed by the latent and sensible loads of the space, but in many cases, it is desirable to deliver more air to the spaces than is indicated by the difference between the room temperature and the apparatus dew point.

It has been indicated that where a percentage of air is passed through the dehumidifier without being treated, the relationship is modified in direct proportion, and that if room air is passed through untreated, no effect on the heat balance results. Similarly, if room air is passed around the dehumidifier and mixed with the treated air, the heat balance is not adversely affected. Therefore, if the quantity of air passed through the dehumidifier is determined by the usual methods, room air can be passed around the dehumidifier and mixed with the dehumidified air, increasing the supply air quantity and temperature and decreasing the temperature differential. Thus if the difference between the room temperature and the apparatus dew point indicates that 10,000 cfm at 30 deg below room temperature will be required to hold conditions, that quantity can be passed through the dehumidifier and cooled to 30 deg below the room temperature, then mixed with 10,000 cfm of room air, resulting in a supply-air quantity of 20,000 cfm and a temperature differential of 15 deg instead of 30 deg. Air supply outlets and grilles having a high induction ratio are available, and through their induction effect cause a large amount of room air to be mixed with the supply air within a short distance of the grille. A proper selection of outlets may make it possible to introduce air at low temperatures and high velocities without causing objectionable drafts or cold spots, but care must be used to see that too little air motion is not a result. Low temperature differentials may be required for this reason. While the use of a high temperature differential results in a saving in initial cost of fans and ducts, and in the operating cost of fans, this differential should be carefully considered. If the sensible heat load of a space is subjected to substantial variations, low temperature differentials should be considered, since systems employing low temperature differentials require less precision in controls.

Reduction of air quantity by slowing down the fans for the winter season, and increasing the temperature differential, often is feasible. A saving in fan power can thus be effected, provided the air distribution remains adequate.

Extremes should be avoided in all cases. For summer air conditioning, low supply-air temperatures result in larger heat gains to the air passing through the ducts, as well as in poor control. Too high a supply-air temperature may result in excessive initial and operating costs. Suggested limits for the temperature differential are from 12 to 25 deg, the actual selection being based on the requirements of the particular case. For winter air conditioning, too high supply-air temperatures result in excessive heat losses from the ducts and stratification within the room unless thorough mixing is assured, while too low supply-air temperatures may cause drafts, high operating costs, etc. Suggested limits are from 15 to 35 deg. There can be no set rule, and each case should be judged according to its particular requirements of the installation.

Reference may be made to Chapter 30 for further discussion of the most satisfactory design difference between the entering air temperature and volume in relation to the desired room condition.

UNITARY-CENTRAL SYSTEMS

Many different types of central air conditioning systems with room units of various designs have been developed for multi-room buildings, such as office buildings, hotels and hospitals. The primary object in using these systems is to save space by reduction of duct sizes or by entirely eliminating ducts. In new buildings, small ducts may reduce the overall building height; in existing buildings, the use of small ducts is frequently imperative, and may even play a decisive role in the acceptance of air conditioning for these buildings. Also, multi-room buildings frequently require a high degree of zoning or individual room control, which the systems must supply.

These buildings usually have a large perimeter relative to the floor area. Air conditioning units are usually installed beneath the windows. Where the spaces to be conditioned extend a considerable distance from the outer wall into the interior of the building, as in some office buildings, a separate system or zone for the conditioning of the interior portions may be required. In these cases the interior system handles the relatively small and steady loads, due to such items as lights and people; while the exterior system must cope with the relatively large and variable loads imposed by sunshine and temperature difference through walls and glass. Descriptions of the four common unitary-central systems follow.

Induction Convectors—Low Pressure Type

Induction convectors located in the room that is to be served, utilize a jet of primary conditioned air to mix with a stream of secondary room air as shown in Fig. 4. The mixture is discharged into the room through a grille at the top of the convector. Heating coils are located in the secondary air stream. The output is controlled either by manually or automatically throttling the air jet. Heat may be supplied to the coil in summer as well as in winter. These induction convectors present several advantages. Since the secondary air stream is thoroughly mixed with the high velocity low temperature air stream before leaving the discharge outlet of the device, the resultant temperature of the mixture is satisfactory even though the primary air is introduced at a temperature too