complished by the use of coil rating tables. The practice of selecting coils from the load division indicated by the load calculation has worked out satisfactorily for the usual human comfort applications. Additional design precautions and refinements are being used for more exacting industrial applications and for improved results on all types of air conditioning in the more humid areas. One of these refinements is the use of a separate cooling coil to cool and dehumidify the ventilation air before admixture with recirculated air. This procedure takes care of one of the main sources of moisture in the usual application. Provision for reheat is required for some industrial applications, and is used for better results on very special commercial applications.

In checking the operating results obtained from cooling coils in various air conditioning installations, it is necessary to keep in mind the influence of the climatic conditions of the various areas encountered. The majority of problems are encountered at *light load* conditions when the cooling requirement is considerably less than at design conditions. In the hot dry climates, where the outside dew points are so constantly low that dehumidifying is not generally a problem, the *light load* condition does not pose any special problems. In the hot humid climates, where the outside dew points are generally high and close to the dry-bulb temperatures, the *light load* condition has a higher proportion of moisture and a correspondingly lower proportion of sensible heat. These climatic conditions result in higher dew points in the conditioned spaces during the *light load* conditions unless some of the special means for controlling the inside dew points are used. In the geographic locations where warm weather occurs with both high and low dew points, such as around the Great Lakes, the *light load* operating conditions with the higher percentage of moisture loading will be encountered less frequently and consistently than in the south coastal areas.

Care should be taken to avoid freezing at light loads. In general, freezing occurs when the coil surface temperature falls to 32 F. With usual coils for comfort installations, this does not occur unless the evaporating temperature at the coil outlet is about 20 to 25 F. The exact value depends on the design of the coil and the amount of loading. Although it is not customary to choose coil and condensing units to balance at low temperatures at peak loads, there is danger of this occurring when the load decreases. This is further aggravated if a by-pass is used so that less air is passed through the coil at light loads.

HEAT TRANSFER AND AIR FLOW RESISTANCE

The transfer of heat between the heating or cooling medium and the air stream is influenced by several variables:

1. The temperature difference.
2. The design and surface arrangement of the coil.
3. The velocity and character of the air stream.
4. The velocity and character of the medium in the tubes.

The driving force is usually taken as the logarithmic mean temperature difference for heating or cooling without dehumidification. The rating of cooling coils for combined cooling and dehumidification is discussed later in this chapter. With volatile refrigerants there is often an appreciable pressure drop and corresponding change in evaporating temperature through the refrigerant circuit. The problem is further complicated by the fact that the refrigerant is evaporating in part of the circuit, and superheating in the remainder. In the case of volatile refrigerants, a cooling coil is tested and rated in conjunction with a specific distributing and liquid metering device, and the capacities are stated for a given superheat condition of leaving vapor.

The design and surface arrangement of the coil include such items as materials, type, thickness, height, and spacing of the fins, and the ratio of this surface to that of the tube, the use of the staggered or in-line tube arrangement, and provisions to increase the air turbulence such as the use of corrugated as against flat fins. Staggered tubes increase the total heat transfer, as against the in-line arrangement, and corrugated fins may be more effective than flat. This design and surface arrangement has a large effect on the air film heat transfer resistance.

The velocity of the air usually considered is the coil *face* velocity. This bears a *varied relation to the actual velocity* over the surface, depending upon the individual coil design. As long as a fixed design of coil is under consideration face velocities may be used, but they may be unsatisfactory in comparing different designs, as it is the *actual surface velocity that is significant*. The air volume is often based on standard air at 70 F and a barometric pressure of 29.92 in. Hg

At the same mass air velocity, varying performance can be obtained depending upon the turbulence of the air flow into the coil, and upon the uniformity of distribution of air over the coil face. The latter is very important in obtaining reliable test ratings, and in realizing rated performance in practical installations. The resistance through the coils will assist in distributing the air properly, but where the inlet duct connections are brought in at sharp angles to the coil face, the effect is frequently bad and there may even be reverse air currents through a portion of the coils. This reduces the capacity, but can be avoided by proper layout or by the use of vanes or baffles.

Heat transfer information on plain pipe coils has been developed and verified through many tests. In the case of finned coils, the heat transfer from the cooling or heating medium to the air stream is dependent on so many factors that reliable rating and performance information for any design of coil must be based upon actual tests of the specific coil. Mathematical comparisons of different designs of coils on a square foot of surface and face area basis may be misleading. The selection of finned coils should be made from curves or tables of coil performance prepared from a series of adequate and reliable tests. There are cases in which the engineer must extend available data or design for a single unique installation. For such purposes the following coil calculations will be useful.

PERFORMANCE OF HEATING AND DRY COOLING COILS

The performance of heating and dry cooling coils depends in general upon:

1. The overall coefficient of heat transfer from the fluid within the coil to the air it heats or cools.
2. The mean temperature difference between the fluid within the coil and the air flowing over the coil.
3. The physical dimensions of the coil.

Thus, for any one definite operating condition, the heating or cooling capacity of a given coil is expressed by the following basic formula:

$$q_t = U \times (\Delta t_m) \times A \times N \tag{1}$$

where

q_t = total heat transfer the coil, Btu per (hour) (square foot of coil face area).