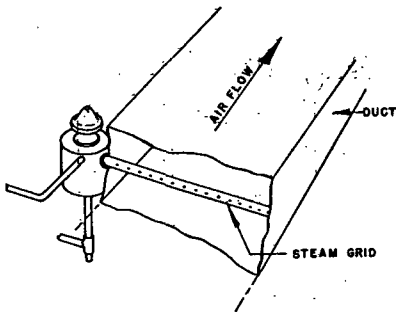


Fig. 15 .... Steam Grid Humidifier

lem should be considered in selecting equipment and in setting up maintenance schedules on installed equipment.

Industrial humidifiers are available in many types. Larger versions of the residential types. Figs. 11–14, are quite frequently used. In addition to those noted under the section on Residential Humidifiers, pans with steam or hot water pipes to heat the water are quite frequently used. Where steam is available, steam grids are also frequently used (Fig. 15). There are also commercial atomizing types using pneumatic sprays. Commercial air washers, also frequently used, have been discussed in previous sections, as were pad type evaporative coolers.

Calculations

The method used to calculate the moisture required for an industrial area is shown in *Example 1*. In addition to the factors noted, some locations may have the problem of maintaining humidity while cooling the area. The humidification engineer should work closely with the cooling engineer so that the cooling equipment is designed for maximum cooling with minimum dehumidification, and sufficient capacity to offset dehumidification should be included in sizing the humidifier.

Example 1: Determine the humidification required for a factory in Dallas, Texas, to maintain 45 percent relative humidity at 72 F. The factory has a volume of 100,000 cu ft. Machines within the factory will give off 5.8 lb per hr of moisture. There will be 10 workmen in the plant. No additional load will be necessitated by cooling (dehumidification) and no moisture will be absorbed by stored materials.

Solution: The quantity of moisture required to maintain the desired indoor conditions may be found from Equation 5.

The number of air changes per hour is assumed to be 1. The values of h_i and h_o are found from the ASHRAE Psychrometric Chart (Chart 1) to be 0.0077 and 0.0012 lb per lb dry air, respectively.

$$\text{Therefore, } H = \frac{100{,}000}{13.5}(1)(0.0077 - 0.0012)$$

$$= 49.2 \text{ lb of moisture per hour.}$$

This amount would be reduced by the moisture given off by the people in the area and by the machines in the area and would be increased by the amount of moisture required by the material stored in the area. If the area were cooled, the requirements would be increased by an amount equal to the dehumidification caused by the cooling equipment.

The moisture released by workers is $10 \times 0.4 = 4$ lb per hr, and the total moisture given off by workers and machines is $4 + 5.8 = 9.8$ lb per hr. Therefore, the net load for the humidifier is $49.2 - 9.8 = 39.4$ lb per hr.

The number and type of units to be used and the location will vary with the installation. In the example given, where the area is one large room, one large humidifier is economically more feasible than several small units. If, however, the area to be humidified consists of several isolated areas separated by vapor barrier walls and not interconnected by a duct system, then several small units would be recommended.

Where the size of the area is such that several units are used in one large area, they should be preferably distributed equally through the area being humidified. They should be located so that other air movement systems will assist the distribution of humidity rather than hinder it. The controls should be spotted where the closest control is desired.

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CHAPTER 34

AIR-COOLING AND DEHUMIDIFYING COILS

Uses for Coils; Coil Construction and Arrangement: Water Coils, Direct-Expansion Coils, Control, Flow Arrangement, Applications; Coil Selection: Application Range, Dry Cooling Coils, Dehumidifying Coils; Heat Transfer and Air-Flow Resistance; Performance of Dry Cooling Coils: Overall Coefficient of Sensible Heat Transfer; Performance of Dehumdifying Coils; Determining Refrigeration Load

COILS described in this chapter are used for cooling an air stream under forced convection. Extended-coil equipment may consist of a single coil section or a number of individual coil sections which are built-up into banks and assembled in the field. Coils are also used extensively as components in central station type air-handling units and in factory-assembled self-contained air conditioners. The applications of each type of coil are limited to the field within which it is rated. Other limitations are imposed by code regulations, by proper choice of materials for the fluids used and the condition of the air handled, or by an economic analysis of the possible alternates for each installation.

USES FOR COILS

Coils are used for *air cooling* with or without accompanying dehumidification. Examples of cooling applications without dehumidification are precooling coils using well water or other relatively high temperature water to reduce the load on the refrigerating machinery, or water-cooled coils removing sensible heat in connection with chemical moisture-absorption apparatus. A major portion of coil equipment is designed to provide, simultaneously, both air sensible cooling and dehumidification. The assembly usually includes air cleaning means to protect the coil from accumulation of dirt, and to keep dust and foreign matter out of the conditioned space. Although cooling and dehumidification are the principal functions, cooling coils are additionally and purposely wetted with water or a hygroscopic liquid to aid in air cleaning, odor absorption, or prevention of frost.

The usual cooling media used in extended-surface coils are *cold water or Group I (ASA Classification) refrigerants*, but others are used in special cases. Brines are seldom required for the range of applications covered by this chapter, although there are cases where low entering-air temperatures with large latent heat loads require a refrigerant temperature so low that use of water becomes impracticable. Sometimes, also, brine from an industrial system already installed is the only convenient source of refrigeration.

For combined cooling and dehumidifying, extended-surface coils present an alternate to spray dehumidifiers. For many applications it is possible, by proper selection of apparatus, choice of air velocities, refrigerant temperatures, etc., to perform the same duty with either. In a few cases both sprays and coils are used. The coils may then be installed within the spray chamber, either in series with the sprays or below them. In making the selection between spray and surface dehumidifiers, certain advantages of each should be considered. The fact that a spray dehumidifier is usually designed to deliver nearly saturated air, tends to simplify the control problem. In this case, the dry-bulb temperature is also the dew point, and hence, a dew-point control can be arranged by using a simple duct thermostat. Spray dehumidifiers have the advantage over unwetted coils of obtaining more air cleaning and odor absorption. On the other hand, coils make possible a closed and balanced cooling-water circuit, obviating the unbalanced pumping head, the complication of water-level control, and danger from possible floods incidental to multiple-spray dehumidifiers, especially if located on different levels. The use of coils often makes it possible for the same surface to serve for summer cooling and winter heating by circulating cold water in one season and hot water in the other, with consequent saving in apparatus and piping. Another advantage is that where the extended surface-coil system can be used with direct expansion of refrigerant, it is comparatively low in initial and operating costs.

The regulations of the applicable national and local safety codes should be consulted by the design engineer.

COIL CONSTRUCTION AND ARRANGEMENT

Coils are basically of two types, those consisting of bare tubes or pipe, and those having *extended or finned* surfaces. The former are little used for the applications covered by this chapter, but are often employed where conditions cause frost accumulation, and for cooling within spray dehumidifiers.

In fin or *extended-surface* coils the external surface of the tubes is known as *primary*, and the fin surface is called *secondary*. The primary surface consists generally of round tubes or pipes which may be staggered, or placed in line with respect to the air flow. The staggered arrangement is usually preferred because it obtains a somewhat higher heat transfer value. Numerous types of fin arrangement are used, the most common of which are smooth spiral, crimped spiral, flat plate, and configurated plate, all as shown in Fig. 1. While the spiral fin surrounds each tube individually in all cases, the plate types may be continuous (including several rows of tubes), or they may be round or square, with individual

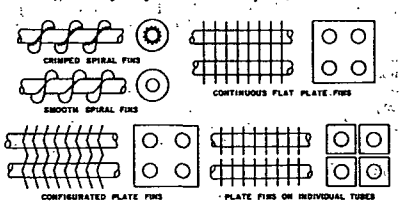


Fig. 1 .... Types of Fin-Coil Arrangement

The general responsibility for this chapter is assigned to TC 9.1, Coils, Fan-Coil Units, Air-Cooled Condensers.