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CHAPTER 23

AIR HEATING AND COOLING COILS

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

COILS described in this chapter are used for heating or cooling an air stream under forced convection. Surface-coil equipment may be made up of a number of banks assembled in the field, or the entire assembly may be factory constructed. 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

For *heating service*, coils are used as tempering coils, preheaters, reheaters, or booster heaters. The function of the coils is air heating only, but the apparatus assembly may include means for humidification and air cleaning. Steam or hot water are the usual heating media, although others are used in special cases, such as reheating by means of discharge gas from a refrigerating system.

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 handle both 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 usual functions, cooling coils are additionally and purposely wetted to aid in air cleaning and odor absorption.

The usual cooling media used in 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, 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 an 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 surface-coil system can be used with direct expansion of refrigerant, it is comparatively low in initial and operating costs. For comfort-conditioning applications, 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 plain tubes or pipe, and those having *extended* 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.

The heat transmission from air passing over a tube to a fluid flowing within it is impeded by three resistances. The first is that from the air to the surface of the tube and is usually called the outside surface resistance or air-film resistance. The second is the resistance to the conduction of heat through the metal itself. Finally there is another surface or film resistance to the flow of heat between the inside surface of the metal and the fluid in the tube. For the applications under consideration both the resistance of the metal wall to heat conduction, and the inside surface or film resistance are usually low as compared with the air-side surface resistance. Economy in space, weight, and cost makes it advantageous to decrease the external surface resistance, where it is proportionately large, to approach that of the tube wall, and that from the tube to refrigerant. This may be accomplished by increasing the external surface by means of fins. Sometimes water spray is applied to the same type surface as would have been used without it. The overall heat transfer is not necessarily