crease performance to any great extent, but increases operating hazards considerably. Water-cooling towers operated in sub-freezing weather are subject to ice formation on the louvers and the outer portion of the filling.

To prevent icing in cold-weather operation, the cold raw water (tower circulating water) temperature should be maintained as high as practicable, taking into consideration the effect upon the economy of the equipment served. One or more of the following procedures are recommended for induced draft towers: (a) run two-speed motors on low speed, or shut off some of the fans; (b) shut down some cells completely and put all of the water over the remaining cells; (c) reduce water flow to the tower and shut off some of the cells; (d) by-pass the cooling tower with part of the water and shut off some of the fans or cells of the tower.

If ice should form on the louvers and filling, one of the following methods of removal can be used: (a) reversing (for not more than 10 minutes) the rotation of the motor driving the fan and thus blowing the warm air out through the louvers; (b) shutting down fans on some sections temporarily, but not the water. When these cells have thawed out, use the same procedure on other cells.

Where intermittent operation of a system is employed, water in outside basins may cause considerable damage due to freezing. To prevent this, such basins are drained when out of service and therefore in some small roof installations a tank large enough to hold all the water in the system may be installed inside the building.

Maintenance. Well-maintained equipment provides the best operating results and the least overall maintenance cost. A regular schedule should be set up for the structural and mechanical upkeep of water-cooling towers. The life and continued utility of any cooling tower is directly dependent upon its inherent qualities, climatic environment, type of service, severity of operation, and general care and maintenance.

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CHAPTER 35

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 on 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