

In the case of heat rejection to the air by means of spray ponds or cooling towers, the quantity of make-up water used is made up of two components: (1) that which is lost mechanically as windage; and (2) that which is evaporated.

Windage losses for mechanical draft towers is usually less than 0.2 of one percent of the quantity circulated and is therefore negligible as an item of cost. Windage from natural draft towers is higher and could become an important cost factor. Windage from a spray pond and particularly from an unfenced spray pond is definitely a significant cost item.

Basically, a cooling tower or a spray pond is a heat exchanger in which heat travels between water and air by: (1) a flow of sensible heat from the warmer to the cooler, and (2) by an exchange of latent heat resulting from the evaporation of a part of the circulating water to increase the humidity ratio of the air by a corresponding amount. The amount of this heat involved in this exchange is numerically equal to the refrigeration effect being developed plus the heat of compression. The sensible heat flow is negligible from the standpoint of operating cost. For all practical purposes the quantity of water evaporated at any load can be calculated from the following equation:

$$G = \frac{15,000 T}{8.3 \times L} \quad (5)$$

where

G = rate of evaporation of water, gallons per hour.

T = tons of refrigeration.

L = latent heat of vaporization, Btu per pound.

Since the water evaporated is exactly proportional to the refrigeration accomplished, the seasonal water consumption can be calculated on a basis of equivalent full-load operating hours of the refrigeration equipment.

There will be pumps to circulate the water and in the case of mechanical draft towers there will be fans. The design of a plant may or may not be such that energy costs for pumps and fans will vary with load; they will often be constant for all degrees of loading.

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