

collects until its weight causes damage. To obviate freezing during continued operation, the efficiency of the apparatus may be lowered. This is done on the spray pond and the spray cooling tower by reducing the quantity of water fed to the apparatus, thereby lowering the pressure at the nozzles and increasing the size of the drops produced. On the deck

TABLE 4. COMPARISON OF VARIOUS TYPES OF ATMOSPHERIC WATER COOLING EQUIPMENT

Figures indicate order of desirability

	COOLING POND	SPRAY POND	SPRAY TOWER	DECK TOWER	MECHANICAL DRAFT	INDOOR TOWER
Cost.....	x	2	1	3	4	5
Area.....	5	4	3	2	1	x
Height.....	1	2	3	4-5	4-5	x
Weight per sq ft.....	x	x	1	3	4	2
Independence of wind velocity.....	6	3	4	5	1-2	1-2
Drift nuisance.....	1	6	5	4	2-3	2-3
Make-up water required.....	1	6	5	4	2-3	2-3
Pumping head.....	1	2	3	4-5	4-5	6
Maintenance.....	2	1	3	4	5	6
Suitability for congested districts.....	x	5	4	3	1	2
Water quantity required for definite result.....	6	5	4	1-2	1-2	3

*Not comparable.

tower the upper system may be shut off and a secondary distribution system put in service midway down the height of the tower. The water will be kept above freezing because it will have shorter contact with the air. The mechanical draft tower can be protected by reducing the air flow through the tower, by stopping or reducing the speed of the fans, or by partially closing dampers.

If the system is operated intermittently in freezing weather, water in the basin may freeze and the expansion of the ice may do harm. Freezing during intermittent operation can be prevented only by draining the water basin when it is out of service. On small roof installations, a tank large enough to hold all the water in the system is often installed inside the building and the basin is drained into this by gravity, the pump suction being taken from this inside tank.

A comparison of various types of water cooling equipment is given in Table 4.

APPARATUS FOR INDUSTRIAL CONDITIONING

Apparatus for industrial air conditioning may be divided into two distinct groups, namely, (1) *humidifiers* for increasing the moisture content of the air and for producing cooling by evaporation and (2) *dehumidifiers* for removing moisture from the air and for producing cooling by contact with water or surfaces at a lower temperature than the air.

Strictly speaking, humidity control alone, whether it involves humidification or dehumidification, is not *air conditioning*. To be entitled to this classification according to the definition in Chapter 44, the process should include the *simultaneous control* of temperature, humidity and air motion.

Industrial humidifiers may be divided into the following general types, according to the method of operation:

1. *Direct*, which spray into the room.
2. *Indirect*, which introduce moistened air.
3. *Combined direct and indirect*.

Spray Generation

Spray generation is obtained by (1) atomization, (2) impact, (3) hydraulic separation, and (4) mechanical separation.

Atomization involves the use of a compressed air jet to reduce the water particles to a fine spray. With the *impact* method, a jet of water under pressure impinges directly on the end of a small round wire. Where *hydraulic separation* is employed, a jet of water enters a cylindrical chamber and escapes through an axial port with a rapid rotation which causes it immediately to separate in a fine cone-shaped spray. In the *mechanical separation* process, water is thrown by centrifugal force from the surface of a rapidly revolving disc and separates into particles sufficiently small to be utilized in certain types of mechanical humidifiers.

Spray Distribution

Spray distribution is obtained by (1) air jet, (2) induction, and (3) fan propulsion.

The air jet which generates the spray in atomizers also carries the spray through a space sufficient for its distribution and evaporation, and this method of distribution is termed *air jet*. Where distribution is obtained by *induction*, the aspirating effect of an impact or centrifugal spray jet is utilized to induce a current of air to flow through a duct or casing, and this air current distributes the spray. *Fan propulsion* obviously consists of the utilization of fans to entrain and distribute the spray.

Industrial type direct humidifiers are commonly classified as (1) atomizing, (2) high-duty, (3) spray and (4) self-contained or centrifugal.

Atomizing Humidifiers

There are several types of atomizing humidifiers, all of which rely upon compressed air as the atomizing and distributing agency, similar to the familiar method used in ordinary nasal atomizers. Compressed air (ordinarily about 30 lb per square inch) is supplied from a centrally-located air compressor through pipe lines to the atomizing units. The air lines are usually horizontal and parallel to water lines which supply water by gravity from a float tank. The water in the tank is maintained at a constant level slightly lower than the outlets of the atomizers themselves and is drawn constantly to the atomizer by aspiration when compressed air is supplied. This aspiration ceases and the flow of water stops when the air supply is cut off. The water should not be supplied under pressure to atomizers because of the possibility of leakage, drip, or coarse spray which cannot be permitted when water is supplied by aspiration.

High-Duty Humidifiers

Water is supplied to high-duty humidifiers under high pressure (usually about 150 lb per square inch) through pipe lines from a centrally-located