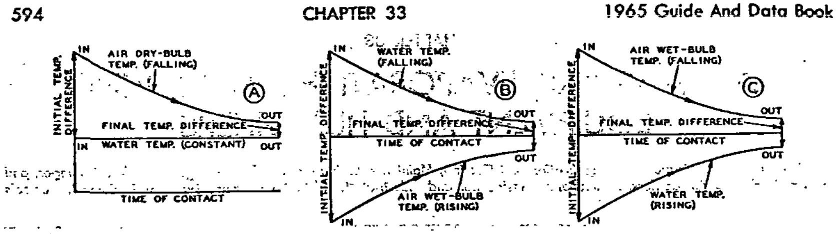

Fig. 1 .... Interaction of Air and Water in Evaporative Air Cooling Apparatus

single bank to 10 gpm for double banks per 1000 cfm. Pumping heads will usually be in the range from 55 to 80 ft of water depending on spray pressure, height of apparatus, pressure losses in pipe and strainers, etc.

The resistance to air flow through an air washer varies with the type and number of baffles, eliminators, and wetted surfaces; number of spray banks and their direction; air velocity; size and type of other resistances such as cooling and heating coils; and other factors such as air density. Resistance may be as low as $\frac{1}{4}$ in. or high as 1 in. water column. The manufacturer should be consulted as to the resistance of any particular washer design combination.

Casing and tank may be constructed of various materials, although galvanized steel is the most common. Casings are usually made of 18 gage steel reinforced with angles. Sides and top are bolted and gasketed for watertightness. One or more doors are commonly provided for inspection and access. The tank is normally not less than 16 in. high with a 14 in. water level and may extend beyond the casing on the inlet end to make the suction strainer more accessible. The tank may be partitioned by the installation of a weir, usually in the entering end, to permit recirculation of spray water for control purposes in dehumidification work. The excess returns over the weir to the central water chilling machine.

Eliminators consist of a series of vertical plates spaced about 1 to 2 in. on centers in the leaving end of the washer. The plates, usually 24 gage, are formed with a number of bends to deflect the air and obtain impingement on the wetted surfaces. Hooks are ordinarily provided on the edge of the plates to improve moisture elimination. Louvers may be installed on the inlet end of the washer to obtain more uniform air distribution through the spray chamber and to prevent backlash of the spray. They consist of horizontal or vertical plates with one or more surfaces, spaced about 3 in. apart. These plates are usually made up of 24 gage steel and are removable individually or in a group.

Spray nozzles are designed to produce a finely atomized spray and spaced to give a uniform coverage through which the air must pass. Pressures normally vary from 20 psig to 40 psig, depending on the duty. Small orifices, at pressures up to about 40 psig, produce a fine spray necessary for high humidifying efficiencies; while the larger orifices, at pressures around 25 psig, are common for dehumidification. Nozzles of the self-cleaning type have recently become available. Spray nozzle capacities vary from about 1 gpm to $3\frac{1}{4}$ gpm per nozzle, and spray densities are ordinarily 1 gpm to about 5 gpm per square foot of cross-sectional area per bank. Spacing varies from about 0.75 to 2.5 nozzles per square foot per bank. For lower spray densities smaller orifices should be used to avoid bypassing air because of a poor spray coverage. Flooding nozzles, for washing the eliminators, discharge about one gpm per nozzle in a flat stream at 3 to 5 psig pressure.

Strainers are usually made of fine mesh copper or brass screen extending across the width of the tank. They are sometimes placed in cylindrical shape over the pump suction

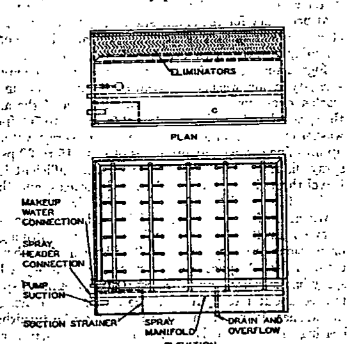

Fig. 2 .... Typical Single-Bank Air Washer

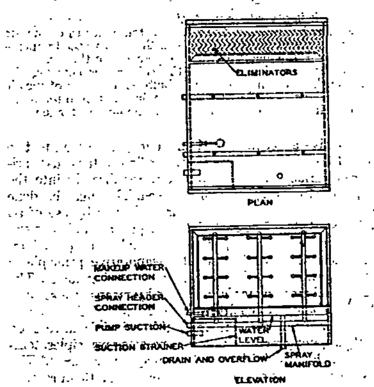

Fig. 3 .... Typical Two-Bank Air Washer

connection within the tank. Strainers should be readily removable for inspection and cleaning. The openings in the screen should be smaller than the spray orifice to minimize clogging of nozzles. Belt type, automatic and other specially designed strainers are available for use in textile mills and other industries where lint or heavy concentrations of dust are present. Accessories which should generally be included are a float valve to automatically maintain the minimum water level, a quick-fill connection, a trapped overflow, a tank drain opening, a suction connection, and a marine light on the spray chamber.

Cell-Type Washers[4]

These washers obtain intimate air-water contact by passing the air through cells packed with glass, metal, or fiber screens. See Fig. 4. The cells are arranged in tiers over which water is distributed and are followed by conventional blade type or glass mat eliminators. Most cell-type washers are arranged for concurrent air and water flow. They are also constructed for special duty with counter-current flow characteristics or combinations of both arrangements. Cell washers are made in a range of sizes in either uninsulated or insulated construction. Standard washers are available up to 10 cells high by 12 cells wide with a capacity of 130,000 cfm. They are also built in unitary apparatus up to 33,000 cfm complete with fan, motor, pump, and external spray piping.

Cell-type washers do not require atomization of the spray water, but good water distribution over the face of the cells is essential. The quantity of water required for near saturation of the air is very low. A saturation effectiveness of 90 to 97 percent is typical. Water requirements vary from $2\frac{1}{4}$ to 4 gpm per 1000 cfm with resistance to air flow ranging from 0.15 to 0.65 in. depending on the water circulated and the air velocity through the cells.

Each washer consists of a number of cells, normally 20 in. square, arranged in tiers. A typical cell consists of a metal frame packed with glass fiber strands. The glass occupies only 3 to 6 percent of the volume of the cell but presents a total wetted area, when sprayed, of approximately 100 to 125 sq ft. Wire mesh screens are employed at both faces of the cell frame to retain the glass pack. Each tier is independent of the other and has its own spray header, drain sheet, and conduit to the tank below except for the lowest tier.

The tank is provided with either a flat or sloping bottom as a reservoir for the circulating water and for dirt flushed from the cells. The sprays consist of a pipe header with nozzles for each tier of cells. These are usually manifolded externally with a valve and pressure gage in the connection to each header. Nozzles deliver approximately 2 gpm at 6 psig. Eliminators are provided downstream from the cells to remove entrained moisture from the air stream. They may be of a metal blade type, providing 30 deg deflection of the air stream with hooks for trapping impinged droplets, or glass mat type arranged in tiers similar to the cell arrangement. The glass mat type is 2 in. deep, random packed with glass fiber in a metal frame. Connections are provided for internal spray headers, drain, overflow, steam injector for cleaning the cells in place, pump suction, water quick fill, and make-up water controlled by a float valve. When dehumidifying, a weir and weir outlet for returning chilled water to the refrigeration system is usually included.

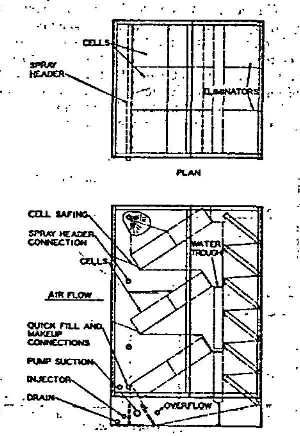

Fig. 4 .... Typical Cell-Type Air Washer

High-Velocity Spray-Type Washer

Recently a high-velocity type of air washer has come into use which employs a rotating eliminator. The unit operates on the same general principle as the conventional spray-type washer. However, the casing is cylindrical and the eliminator consists of a revolving assembly of sheet metal blades extending radially from a central hub. See Fig. 5. The higher air velocity permissible with the rotary design reduces the cross-sectional area of the unit, while high saturation efficiencies are maintained by use of more nozzle banks and a deeper spray path. Velocities as high as 2400 fpm have been applied.

High-velocity washers, with axial flow fans designed for 1 in. external pressure, are presently built in sizes from 10,000 to 45,000 cfm. They are furnished with from 1 to 6 spray banks, making possible a saturation effectiveness as high as 98 percent. Recommended spray pressure is 30 to 40 psig with a nominal water flow ranging from 80 to 400 gpm, depending on size of washer. The high-velocity air drives the rotating eliminator which discharges moisture by centrifugal force so that the water and its entrained material drain from the unit into a central storage tank. Return and outdoor air dampers are built into this unitary design of washer. Operation with velocities 3 to 4 times those of conventional air washers substantially reduces space and weight requirements.

Humidification with Air Washers

Air humidification can be accomplished in three ways with an air washer. These are: (1) use of recirculated spray water without prior treatment of the air; (2) preheating the air and washing it with recirculated spray water; and (3) using

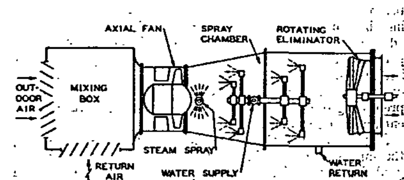

Fig. 5 .... High Velocity Spray-Type Washer