MECHANICAL DRAFT WATER COOLING TOWER

Fig. 1

Fig. 2

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MECHANICAL DRAFT WATER COOLING TOWER

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1. This invention has to do generally with improvements in air-cooled heat exchange equipment of the type used for industrial and large capacity cooling or condensing of liquids and gases, and having the structure of a vertically extending chamber through which air is displaced upwardly from inlets in one or both lower sides of the chamber by a power driven fan. The heat exchanger or fluid cooling tubes are positioned in the path of the air stream after its entry to the chamber, for example as by arrangement in banks located above the fan in an induced air flow type of equipment or units.

As will be understood, the cooling capacity of the unit is dependent in considerable measure upon the temperature of the atmospheric air and consequently, normally where the unit is designed for operation in a given location, its overall size (and therefore cost) is subject to variations according to the acceptable maximum atmospheric temperatures in that location. Such maximum temperatures, on the other hand, may exist only during a short seasonal period, but nevertheless, the equipment must be designed for that condition, notwithstanding that for operation during the remainder of the year, the equipment may be considerably oversized. Particularly is this true since it is found most feasible to operate the fan at constant speed, rather than to attempt to vary the cooling capacity of the unit by controlling the fan speed.

In accordance with the invention, provision is made for controlling or varying the temperature of atmospheric air being displaced at substantially constant rate by the fan against the exchanging tubes, to an important end result of avoiding having to oversize the unit (with relation to normal operation requirements) in order to meet the abnormal conditions existing during warm weather. Specifically, provision is made for precooling the air in advance of the exchanger, by direct and intimate contact with water so that, if desired, the inlet air can be lowered below its atmospheric temperature and toward the wet bulb temperature, and thus increase by many degrees the temperature differential at the exchanger between the air contacting tubes and the fluid passing therethrough.

Structurally the invention contemplates placing at or within the lower walls or cells of the equipment chamber, one or more removable units so constructed as to accommodate wetted extended surface areas contacted by the inlet air in such intimacy as to extensively precool the air. While it is to be understood that the invention broadly contemplates use of any suitable structure thus capable of extensively filming the water in intimate exposure to the inlet air, I may cite as typical, the use of one or a series of frames removably positioned at or within the chamber inlets and containing masses of fiber or strand-like material, such as wood excelsior, which not only filters the water but effectively filters the air for removal of dirt particles.

Another major consideration given the water film aging medium is that it be capable of effecting intimate and extended surface contacts between the water and air, and yet impose no excessive resistance (and therefore a load upon the fan) to the air passage therethrough. Specifically, the invention contemplates the provision of water filming surfaces of such arrangement and extent as to present to air being displaced therethrough and at velocities under 500 feet per minute, a resistance not in excess of about 0.15 inch of water as measured by the pressure differential at opposite sides of the filming medium or material. Accordingly, in using wood excelsior as a water film and air contacting material, the excelsior is but lightly compacted and used in a quantity or thickness sufficient to present the water-air interfaces necessary for cooling and filtering of the water, while giving the material sufficient openness to avoid excessive air pressure drop in flowing therethrough.

All the various features and objects, as well as the details of an illustrative embodiment, will be understood more fully from the following description of the accompanying drawings, in which:

Fig. 1 is a general view illustrating in perspective a corner portion of the equipment;

Fig. 2 is a fragmentary cross section taken transversely through the lower portion of the structure of Fig. 1 and in the plane of line 2—2;

Fig. 3 is an enlarged fragmentary elevation showing the outside water distributing header and the air-cooling panels below;

Fig. 4 is a vertical section on line 4—4 of Fig. 3, extended to include the collecting trough at the bottom of the panel; and

Fig. 5 is an enlarged fragmentary section on line 5—5 of Fig. 1.

While the general structure of the equipment, as to the shape and arrangement of the housing or chamber walls, may be subject to variation in accordance with preferred specific designs, I have shown as typical, the cell frame structure to comprise an external framework including end columns 10, intermediate horizontal members 11, and top horizontal braces 12. The end of the...
structure above member 11 is formed by a vertical wall 13, and extending along opposite sides of the structure from the end wall, are inclined walls 14, terminating at the top in vertical extensions 15. The heat exchanger tubes 16 may be suitably mounted, as by the walls 18, and arranged above and lower tube bands 17 and 18.

Referring to Fig. 2, the wall structure thus defines vertically extending chambers 19 divided by partition 20 extending longitudinally of the structure, 15 being understood that each chamber 19 constitutes a cell and that an entire air cooling structure may include any number of cells 19 in end to end relation, depending upon the designed cooling capacity of the equipment.

For more particular details concerning structures of this type, reference may be had to the application of George H. Dieter, Serial No. 627,387, filed November 18, 1944, on "Air-Cooled Heat Exchangers."

The chambers 19 contain a horizontal floor 21 within which is placed the usual fan rings 22 individually encircling a fan 23 driven as by way of shaft 24 from a conventionally illustrated motor or other power unit 25. The fans 23 operate to induce air flow into the bottoms of the chambers 19 through spaces 26 below the walls 13 and 14, which may be left open as indicated at 26a in Fig. 1, or closed by the air-passing panel assemblies 27. After being drawn into the lower portion of the chamber 19, the air is discharged by the fans upwardly in high velocity heat-exchange contact with the exchanger tubes 16.

As previously indicated during normal or cooler weather conditions, the panels 27 may be retracted so that air at atmospheric temperature and humidity is drawn openly into the fan chambers through the openings 26a. At such times as the atmospheric air temperature may rise to the point wherein proper cooling differential cannot be maintained by the temperatures of the air outside and fluid inside the tubes 16, the panels 27 may be mounted as shown in Figs. 1 and 2, in order that the inlet air may be temperature conditioned in advance of its contact with the exchanger tubes.

As particularly illustrated in Figs. 3 to 5, each panel 27 comprises a rectangular frame 28 adapted to be secured by suitable fasteners 29 to the corner columns 15 and horizontal members 11, the bottoms of the panels being rested on a suitable support 30. Adjacent sides of successive frames may be interconnected or attached to the vertical supports 30, by appropriate fasteners 31. Secured to each face of the panel is an open arrangement of wires 32 spaced sufficiently close to retain the water-filming material 33.

Typically, the material 32 may have a strand or fiber-like form, such as wood excelsior, which is separated between the wires 31 to a degree sufficient to require the air to pass in intimate and dirt-filtering contact with the surfaces of the excelsior, the latter however being sufficiently loose to avoid excessive air pressure drop through the panels. By reason of the tendency of the horizontal air to displace water inwardly and in the direction of the air flow, it may be desirable to provide for redistribution of the water during the course of its flow downwardly through the panels. Accordingly, in Fig. 4, the panel is shown to contain a vertical series of inclined baffles 34 which serve to collect and redirect the downward flowing water from the outlet toward the air inlet side of the panel.

Water is delivered to the tops of the panels 27 by way of headers 33 mounted to the frame members 11 by brackets 34 and connected to a supply pipe 35, the headers being perforated at 36 (see Fig. 3) for uniformly distributed and restricted feed to the panels. Uniformity of water delivery at the desired rate may be facilitated by covering the headers 33 with a porous (e.g., felt-like) material 37 held to the headers by clamps 38, there being at the underside of the header a depending saw-tooth web 39 from which the water drips continuously into the excelsior fillings of the panel 27. Ordinarily water is fed to the panels at a rate sufficient for the water to pass completely down through the excelsior. Any residual water is collected in troughs 40 underlying the panels and leading to a sump.

As will be apparent from the foregoing, by reason of its intimate contact with the extended water-filming surfaces of the excelsior masses 32, the inlet air becomes cooled during the course of its passage through the panels, to a degree constituting a major approach to the wet bulb temperature, and which may be so much, typically, as 15 degrees below the atmospheric air temperature. Air flow through the panels at a rate below the water-entraining velocity, the cooled air displaced by the fan upwardly against the exchanger tubes may be kept substantially free from liquid particles tending to deposit on the exchanger surfaces.

I claim:

1. In mechanical draft air-cooling heat exchanger equipment, walls forming a vertically extending chamber, a horizontal wall in said chamber, a fan in an opening in said horizontal wall and operating to produce displacement of air in a stream flowing into the chamber through an inlet in its lower side wall below said horizontal wall and thence upwardly therethrough, a heat exchanger in the path of the air stream above the fan, a frame vertically and removably positioned in said inlet below said horizontal wall and containing a fibrous mass, and means for continuously filming the surfaces of said mass with water.

2. In mechanical draft air-cooling heat exchanger equipment, walls forming a vertically extending chamber, a horizontal wall in said chamber, a fan in an opening in said horizontal wall and operating to produce displacement of air in a stream flowing into the chamber through an inlet in its lower side wall below said horizontal wall and thence upwardly therethrough, a heat exchanger in the path of the air stream above the fan, a frame vertically and removably positioned in said inlet below said horizontal wall and containing a fibrous mass of wood excelsior, and means for continuously filming the surfaces of said mass with water.

3. In mechanical draft air-cooling heat exchanger equipment, walls forming a vertically extending chamber, a horizontal wall in said chamber, a fan in an opening in said horizontal wall and operating to produce displacement of air in a stream flowing into the chamber through an inlet in its lower side wall below said horizontal wall and thence upwardly therethrough, a heat exchanger in the path of the air stream above the fan, a frame vertically and removably positioned in said inlet below said horizontal wall and containing a fibrous mass, means at the top of said frame for passing water in uniform distribution downwardly over the surfaces of said mass, and water-collecting means at the bottom.
4. In mechanical draft air-cooling heat exchanger equipment, walls forming a vertically extending chamber, a horizontal wall in said chamber, a fan in an opening in said horizontal wall and operating to produce displacement of air in a stream flowing into the chamber through an inlet in its lower side wall below said horizontal wall and thence upwardly therethrough, a heat exchanger in the path of the air stream above the fan, a frame vertically and removable positioned in said inlet below said horizontal wall and containing a fibrous mass, means at the top of said frame for passing water in uniform distribution downwardly over the surfaces of said mass, baffle means within said mass for redistributing water against displacement out of the mass in the direction of air flow therethrough, and water collecting means at the bottom of said mass.

5. In mechanical draft air-cooling heat exchanger equipment, walls forming a vertically extending chamber, a horizontal wall in said chamber, a fan in an opening in said horizontal wall and operating to produce displacement of air in a stream flowing into the chamber through an inlet in its lower side wall below said horizontal wall and thence upwardly therethrough, a heat exchanger in the path of the air stream above the fan, a horizontal series of frames vertically and removable positioned in said inlet below said horizontal wall and containing fibrous masses presenting large surface areas, and a water supply conduit extending above said frames and from which water is fed into said fibrous means for downward flow therethrough.

6. In mechanical draft air-cooling heat exchanger equipment, walls forming a vertically extending chamber, a horizontal wall in said chamber, a fan in an opening in said horizontal wall and operating to produce displacement of air in a stream flowing into the chamber through an inlet in its lower side wall below said horizontal wall and thence upwardly therethrough, a heat exchanger in the path of the air stream above the fan, a horizontal series of frames vertically and removable positioned in said inlet below said horizontal wall and containing fibrous masses presenting large surface areas, means detachably interconnecting adjacent frames, and a water supply conduit extending above said frames and from which water is fed into said fibrous means for downward flow therethrough.

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