AN INDUCED DRAUGHT TYPE COOLING TOWER

By F. G. TREWREN

Huletts S.A. Refineries have had a water problem for many years. Its very existence depended upon the condition of the Umhlatuzana River. While the water level was high, all was well. As the level dropped, the temperature of the water in the spray cooling pond became of increased importance since hot condenser water did not go with increased production.

With new plant being erected and higher output imminent it became obvious that a scheme had to be evolved to cope with an estimated heat load of 157,000,000 B.T.U.'s per hour. The plant being new and efficient, the cooling range would have to be from 120°F to 85°F at a wet bulb temperature of 78°F.

The Fluor Corporation in America were approached and they offered an induced draught counterflow cooling tower with the following performance:

(a) It would cool 450,000 imperial g.p.h. of water from 120°F to 85°F at 76°F wet bulb.

or (b) It would cool 620,000 imperial g.p.h. of water from 112½°F to 87½°F at 76°F wet bulb.

This scheme was considered against the possibility of

(a) The complete redesign and rebuilding of the existing spray cooling pond;

and (b) the installation of an atmospheric concrete cooling tower.

The result: 138 tons of timber, etc., were consigned to the Refinery in mid-1954. Its erection by three fitters, one rigger, one carpenter and an apprentice fitter took approximately two and a half months, after which it was started up and has run without interruption to the present day.

The tower consist of two cells, each 48 feet by 24 feet, thereby occupying a space of 48 feet square with an overall height of 52 feet to the top of the fan stack. Provision has been made in the concrete basin for an extension of one cell.

Water to be cooled is pumped into the top of the tower by three Sulzer Helimax centrifugal pumps giving 2,500 g.p.m. each, at 55 feet head, and is discharged in a spray in the distribution chamber. As the water falls into the basin in the bottom of the tower the drops are further broken up, for greater surface exposure, by layers of grid decks. These layers also serve to retard the water and so permit longer air–water contact.

In this counterflow tower, as the water descends it is in constant contact with a stream of air drawn in at the bottom of the tower, the coldest air meeting the coldest water. As the air is drawn upwards by the fans located at the top of the tower, it accumulates heat from the water through evaporation.

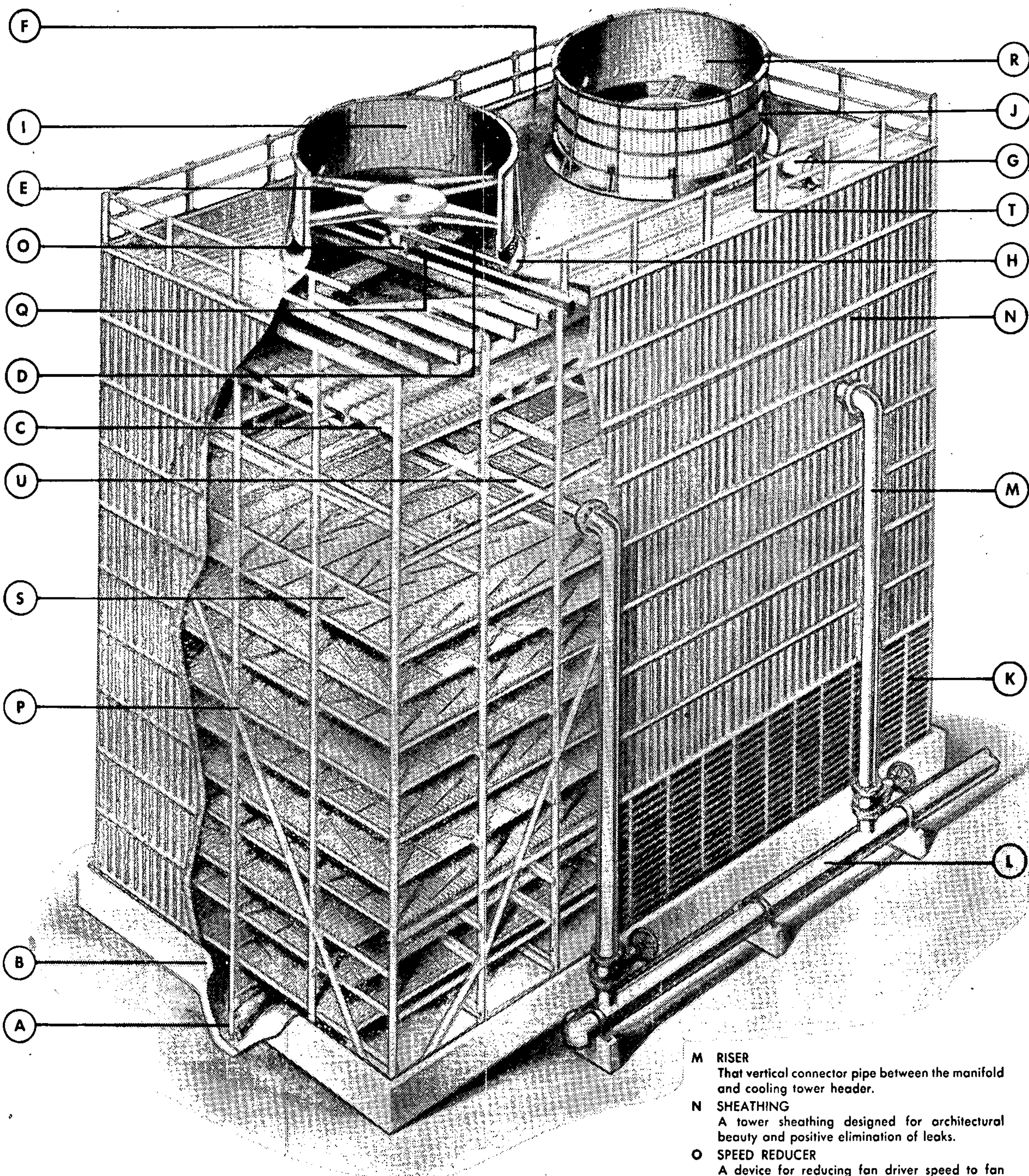
To prevent an extensive loss of water the air passes through drift eliminators at the top of the tower. The purpose of the drift eliminator is to knock out entrained drops of water before the air is exhausted to atmosphere through the fan stacks.

The entire tower is constructed of Canadian red cedar and was completely prefabricated prior to shipment. It consists of 4″×4″ columns on 6′ centres each way. Longitudinal and transverse chords are bolted at all column intersections. Diagonal braces are connected to the columns by bronze splice plates. All bolts are brass and nails copper. The walls, which bear no structural load, are made up of 2′ 6″ ×6′ panels which are held in place by 2″×4″ cleats. The filling consists of two grids for each 6′×6′ bay spaced vertically on 2′ centres with every other row in the reverse direction. These grids are designed to withstand a live load of 25 lb. per sq. ft. and were installed and used as a working platform during the tower's erection.

Each cell has two 14′-diameter stainless steel bladed variable-pitch fans driven through spiral bevel gear reducers by two-speed T.E.F.C. 40 h.p. motors.

These motors and reducers are supported on 6″× 6″ timbers. With these two-speed motors it is possible to control the water temperature by varying the amount of air in contact with the water. As the outside temperature falls, the fans are switched from high speed to low speed, thereby dropping their individual horse power consumption from 40 to 10 horse-power, and their air capacity from 266,000 to 133,000 c.f.m. A vibration cutout switch is installed on the oil filler pipe of the fan reducer and is located outside the fan ring. In case of excessive vibration in the gear and fan assembly, this switch automatically interrupts the electrical circuit and the unit shuts down. The switch must be reset before the circuit can be restarted.

The downspray water distribution system is located immediately underneath the two pass zig-zag drift eliminators. It consists of two central 12″ headers per cell, with side arms to which are attached branches and nozzles with stainless steel sprays. There are 96 nozzles per cell, each being 1¼″ diameter



A BASE CASTING
A cast footing provided to insure a uniform and solid connection between the tower columns and the basin pads.

B BASIN
A pick-up pan for collecting the tower water and providing structural support for tower.

C DRIFT ELIMINATORS
A multi-pass baffle section constructed to minimize the entrained water in exit air stream.

D DRIVE SHAFT
Floating shaft and flexible coupling assembly for transmitting power from driver to speed reducer.

E FAN ASSEMBLY
A high efficiency, low speed, axial type, cooling tower air prime mover.

F FAN DECK
Heavy redwood deck at fan level structurally supported for concentrated or distributed loads.

G FAN DRIVER
A prime mover for fan service that may be an electric motor, gas engine, steam turbine, or hydraulic motor.

H FAN RING
Bell-mouthed transition between fan deck and fan stack to increase overall fan efficiency.

I FAN STACK
A sturdy circular stack that serves as an efficient exit orifice as well as a safety guard feature.

J FAN STACK GUY ROD
A stabilizer rod giving stability to the fan stack.

K LOUVERS
An air inlet grill for the purpose of eliminating splashout and guiding air deep into the tower.

L MANIFOLD HEADER
A hot water pipe manifold distributing water to individual risers and cells.

M RISER
That vertical connector pipe between the manifold and cooling tower header.

N SHEATHING
A tower sheathing designed for architectural beauty and positive elimination of leaks.

O SPEED REDUCER
A device for reducing fan driver speed to fan operating speed. May be single or double reduction gear or hydraulic motor.

P STRUCTURAL FRAMING
Redwood columns, braces, and chords, through-bolted, utilizing connector plates.

Q SUPPORT FOR DRIVER AND SPEED REDUCER
Structural unit support for driver and speed reducer.

R TIP SCOOPS
Metal blades attached to the inside of the fan stack to increase fan efficiency by minimizing tip recirculation.

S TOWER FILLING
Decking placed internally to cause the air water system to trace a longer time and area of contact.

T VIBRATION CUTOUT SWITCH
In case of excessive vibration of mechanical assembly, automatically shuts down fan driver.

U WATER DISTRIBUTION SYSTEM
Includes central header, laterals and nozzles.

and spraying upwards on to a stainless steel umbrella which directs the water downward in a fine spray, nozzle pressure being 3 p.s.i. Maintenance on this distribution system is negligible due to the unusually large size of the orifice.

Since erection, no estimate has been made of evaporation or spray losses. The makers, however, claim that on very hot days the evaporation loss is as much as 1 per cent of the water circulation rate per 10° of cooling; while on cool humid days it might be as low as .75 per cent. The spray loss is guaranteed not to be over .2 per cent. They estimate the make-up requirements for the cooling tower to be approximately 300 g.p.m. Since approximately 250 g.p.m. of vapour is condensed in the barometric condensers the make-up water required for the cooling circuit would be of the order of 50 g.p.m.

The water passing through the cooling tower is not treated in any manner. A growth has been found to form on all the internal components but it is of a soft nature and is easily washed off by a jet of water. The formation of this growth is kept in check by the washing out of one cell per month with a fire hose.

The following table shows a series of readings taken at the cooling tower some months after commissioning:

	°F Before	°F After	°F Diff.	°F River	°F D.B.	°F W.B.	RH %
27/4/55—*Fans Full Speed*							
6.30 a.m. ...	94	72	22	66	64	57	65
2.30 p.m. ...	104	78	26	74	76	67	62
7. 0 p.m. ...	99	71	28	70	70	64	64
3/5/55—*Fans Stopped*							
1. 0 p.m. ...	96	89	7	70	76	72	82
10/5/55—*Fans Half Speed*							
1. 0 p.m. ...	103	88	15	73	78	72	75
8. 0 p.m. ...	104	90	14	70	71	68	86

Fig. 1 shows a cutaway view of a typical Fluor Cooling Tower whereby a clear indication is given of the components referred to in the above text.

Note: For discussion on this paper, see page 55.