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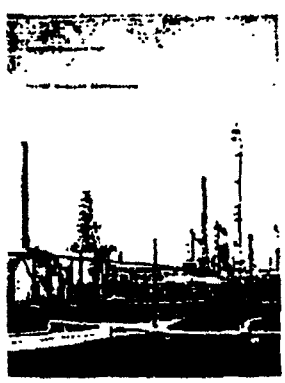
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ON THE COVER

Sectional view of Milford Haven Refinery recently placed "on stream" at Milford Haven, Wales by Esso Petroleum Company Limited. Photo shows refinery crude distillation facilities, *left*, and powerforming process area, right. Engineered and constructed by Foster Wheeler, this modern, fully-automated plant has a capacity of 100,000 BPSD. For details, see pp 178-183

OPPOSITE PAGE

Fractionation section of crude distillation overhead at Milford Haven Refinery showing at the right a bank of air condensers and coolers. Air, instead of water, is used exclusively for these functions at Milford Haven

Back Cover Photo Courtesy International General Electric Company

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Cooling Tower Test Center

by M. V. GRUBER*

As the primary implement in its long-range cooling tower design research and development program Foster Wheeler's Cooling Tower Test Center in the Richmond Refinery of the Standard Oil Company of California, is providing comprehensive data utilized by the Cooling Tower Department engineering staff in improving tower operating efficiencies and determining the acceptability of material components. Such data find practical application in the recommendations made by the engineering staff to large industrial users of cooling water for process purposes such as central station steam plants, chemical producers, and petroleum refiners with respect to tower framework design; water distribution systems, heat load capabilities, fan aerodynamic performance, fill configurations and spacing, and the ability of various types of surface coatings and construction materials to withstand corrosion.

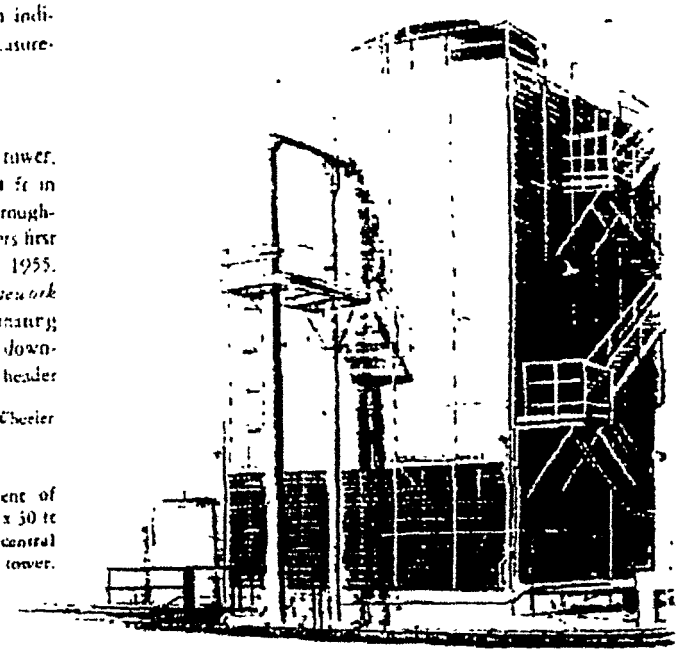
Established at its present site five years ago, this research installation replaces test facilities formerly located at Carteret, New Jersey. Major components used in the various test programs include a full-scale industrial size tower of induced draft counterflow design and a pilot tower for preliminary exploration. Both towers are completely instrumented with indicating and recording equipment for precise measurement of all test data.

Industrial Size Tower

The basic components of this commercial-size tower, which measures 30 ft x 30 ft in plan and 41 ft in height, are identical to those in actual service throughout the country in the new line of cooling towers first introduced to industry by Foster Wheeler in 1955. Important design features of this unit are *framework* having extern. l gusset connections thereby eliminating eccentric joints, *water distribution system* of the down-flow type having spiral welded galvanized steel header and laterals which distribute the circulating water through specially designed Bakelite nozzles having a full cone spray pattern, *drift eliminators* of the two pass chevron type installed above the water distribution system. The *mechanical equipment support* is a single framework of structural steel bolted to the tower columns.

Basic mechanical equipment on the tower consists of a 75 hp two speed, 1800/900 rpm, T.E.F.C. motor connected through a flexible coupling and tubular shaft to a spiral bevel speed reducer. The fan diameter is 18 ft which permits testing of the various fan designs utilized on Foster Wheeler towers. Prototypes are studied for their ability to withstand severe service (fans operate at a tip speed of 12,500 fpm) and to determine their exact aerodynamic performance.

This tower includes provisions for testing the various tower heights manufactured by Foster Wheeler through installation of a "false" catch basin at varying elevations. The tower heat load can be varied over a wide range up to a maximum of 100 million Btu per hour. Thus considerable flexibility is possible in ad-



Industrial-size tower, a primary component of Cooling Tower Test Center, measures 30 ft x 30 ft in plan and 41 ft high. Pilot tower and central control center are located closeby the main tower.

*Chief Engineer, Cooling Tower Department, Foster Wheeler Corporation

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jusing water flow rates and inlet water temperatures. Instrumentation of the main tower incorporates:

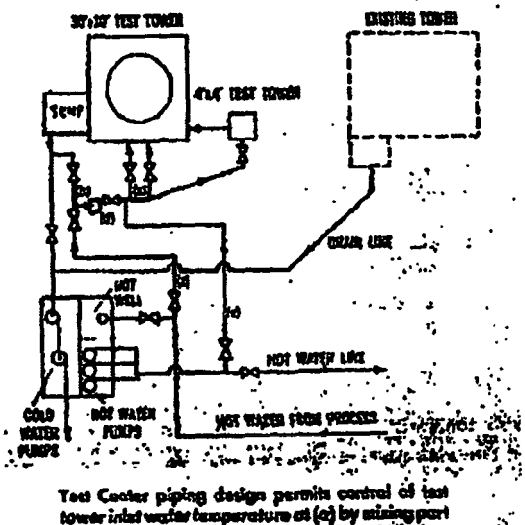
Water Flow: Inlet water flow is measured by means of thin plate orifices in each of the two inlet lines. Two inlets are used to obtain a high degree of accuracy over a wide range of water flows. The taps are connected to recording manometers. Calibration of the orifices is by means of a weir located in the sump and also by means of a pitot tube traverse of the inlet riser pipes.

Temperatures: Temperatures are obtained by means of thermal resistance elements connected to a recorder. All thermal resistance elements are calibrated prior to a particular test by means of mercury-in-glass thermometers divided into 0.2 F increments.

Fan Power Readings: The input to the fan motor is obtained from a recording wattmeter.

Pressure Drop: The pressure drop is measured by a series of screened taps located within the tower to determine such individual components as air inlet loss, fill loss, and eliminator loss. The taps are connected to inclined draft gauges located in the central control center.

Air Flow: The air flow is determined by two methods: first, by direct measurement with vane anemometer or air pitot tube, and second, by heat balance on the cooling tower. The latter requires an accurate determination of the exit air temperature, accomplished by a twenty point traverse above the fan stack at the points of equal fan area with recording thermal resistance elements equipped with wet bulb socks. Each of the twenty points is weighted with the air velocity obtained by measurement at the particular area.



Test Cooler piping design permits control of test tower inlet water temperature at (a) by mixing part of the cold water at (b) with hot water at (c) before entering the recirculating pump (d). The unit also takes water directly from the hot water pumps at (e).

Pilot Tower

A four foot square pilot tower of the forced draft design is used for determining relative values for various fill configurations and spacing. Air and water flow is determined by means of metering orifices on this unit. The air is delivered to the tower through ducting by a centrifugal blower. The wet bulb temperature of the entering air can be increased artificially by means of bleeding low pressure steam in the inlet ducting to study the effect of wet bulb temperature on tower performance. Fill designs that show promise from pilot tower study are tested for absolute values in the full scale tower.

Corrosion Studies

Steel test samples with various paints and plastic coatings are analyzed as to service life in the industrial-size tower for application in commercial service. In addition, various materials starting with redwood lumber and including plastics, metals, ceramics and even phenolic coated paper are studied before introduction in Foster Wheeler cooling towers. One wall of the tower is sheathed with various grades of cement asbestos board to determine the quality of material required for this type of service.

Test Data

Both the industrial-size induced draft tower and the pilot tower have been operated to the extent that more than 200 separate test conditions were obtained from the induced draft tower and more than 500 conditions from the pilot tower. Tests conducted on an aluminum fill rack led to the design of an all-aluminum cooling tower that has been satisfactorily in service since 1958. (See *Heat Engineering*, July-August 1959, pp. 62-63). All test data obtained from each tower is correlated automatically on the Bendix G-15 digital computer located in Foster Wheeler's New York City headquarters. The computer is programmed for calculation of all variables entering into cooling tower design.

Project data obtained from the test center during the past five years has enabled the Cooling Tower Department engineering group to effect substantial improvements with respect to tower operating efficiencies as well as providing a reliable determination as to the acceptability of material components. The recent modification of the full-scale counterflow tower to a crossflow design has permitted a comparison of the performance and structural characteristics of these two designs.

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