down flash section passes through the second tier of trays on the first leg of its cross-counterflow with respect to makeup water. The third tier then delivers only pure uncontaminated steam, Fig. 2, to the downcoming deaerated water streams.

An external-design vent condenser—steel shell with admiralty B metal tubes—was selected since it can provide pure condensate for feed pump seals.

Blowdown Questions. Up to 35% of the 200,000-lb-per-hr boiler output, or 70,000 lb per hr, can go to blowdown and this flashes directly into the heater in a separate flashing compartment to avoid long, large steam pipes and large flash tanks. An exchanger attached to the heater shell, Fig. 2, cools the blowdown liquid drains while a steam separator within the flash chamber dries the recovered steam and passes it to the second of the three tiers of trays in the deaerator section.

Selected volume of deaerated-water storage is in line with operating experience at other similar plants.

Npsh requirements prompted rather special considerations. The standard approach involves elevating the heater storage compartment above the boiler feed pump to where it has enough head to avoid flashing in normal operation. A second choice resorts to subcooling or chilling the deaerated water below the control pressure-temperature relationship after it leaves the deaerator on its way to the pump, located at substantially grade elevation with the heater storage-tank outlet. Two subcoolers went into this design equipped with controls to reduce water conditions from 316 to 296 F at 20 psi. One of these coolers takes inlet water as a coolant. The second draws on an emergency source that automatically enters the secondary subcooler if the deaerated water temperature gets above a preset, danger limit.

Absolute economy in steam-condensing capacity in this instance had to go by the boards. Each heater, weighing 50,000-60,000 lb empty, plus piping, would have to be hoisted 50 ft in the air to provide flooded boiler-feed-pump suction. Obvious costs were further aggravated by a need for piling work in the low bearing soils of the area. The arrangement of Fig. 2 gave immediate savings of about $50,000.

This problem of assured boiler-feed-pump suction at all times is a severe one at higher pressures. And it becomes particularly so when large quantities of deaerated water are in equilibrium with high-pressure steam. A sudden loss of steam pressure and a large-scale steam-flashing occurs, binding the feed pump so seizing and costly pump damage result. (Internal flash preventers in the heater-storage compartment is a preferred solution to this problem.)

STEEL MILLS

Quite a different set of conditions prevailed when a 1,000,000-lb-per-hr 2-spray deaerating heater went into a Midwestern steel mill as a follow-up for a 1,000,000-lb-per-hr hot-process zeolite plant for 650-psig boilers. Plant load fluctuates as high as 25% at infrequent intervals but each time load swing lasts from 5 to 10 minutes. Normal makeup runs somewhat less than 750,000 lb per hr.

Here is the picture the steel mill presents, Fig. 3. Incoming cold water fr city mains passes through an exter tubular vent condenser with a top tem perature rise of 20 F at maximum load It then sprays through a rosette spring-loaded, self-adjusting, cover *spray valves in a Sphericone* hot-proc unit. This heats water to within 2 F steam operating conditions of 227 F and 5 psig, and removes over 95% of non condensable gases in the water.

The now-heated raw water undergoes partial softening and silica reduction to 2 ppm with dolomitic lime. Precipitates separate out in a sludge bed featuring low upward rising rates that are continually decreasing to a minimum of 2.1 gpm per sq ft at the 1,000,000-lb-per-hr load. Effluent from this sphericone hot-process softener contains less than 5-ppm turbidity. It proceeds into a battery of six 10-ft-dia by 5-ft straight double-decked, hot, styrene-zeolite softeners where it is softened to zero hardness. When the water leaves this stage it is ready for deaerated heater processing and storage.

There were three possible arrangements, Fig. 4: Scheme A—thoroughfare hookup, providing maximum flow at low pressure of 5 psig in both heater and softener. Scheme B—stepwise hookup of heater at 40 psig and softener at 5 psig, requiring a separate, additional 40-psig heater raising equipment investment and operating costs. Scheme C—vent condenser assembly employing an external tubular design on the deaerator for top temperature rise of 20 F on incoming water, followed by a vent condenser on the hot-process softener for an extra 20-F pickup. This pre-

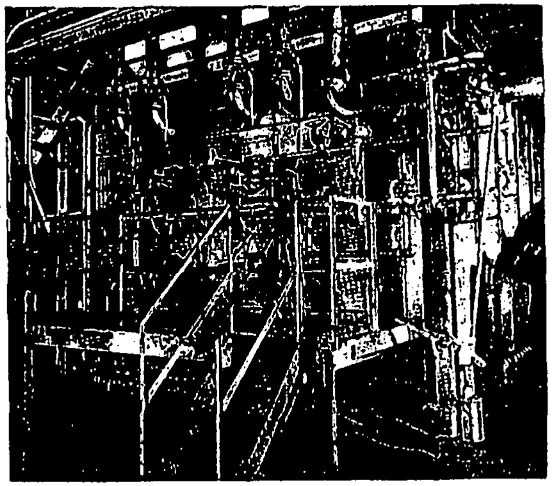
(*Continued on page 198*)

Design Characteristics of Modern Deaerating Heater

Type	Steam to water flow	Vent Condenser: External tubular	Vent Condenser: Internal head	Incoming-water distribution	First-stage water heating	Second-stage deaeration	Steam-pressure drop, psi	Water pressure, psi
Tray: Cross flow Parallel, Counter	Cross-counter, parallel, directly counter	U-tube or straight	Self-adjusting spray valves (with spray valves these tray heaters are spray-tray type) Fixed orifices in distribution pipe.	V-notched weir box plus distribution pans and trays. Fixed orifices in pipes plus distribution pans and trays. Spray valves and distribution pan	Heater trays Spray valves	Trays	0.1-0.3	Weir distributor—0.5 Spray valves —2.0 Fixed orifices —0.5-3.0
Spray	Countercurrent flows in two-stage steps. Parallel flow in second stage.	Same as above	Same as above	Self-adjusting spray valves. Fixed orifices in pipe	Spray valves	Scrubber or reboiler	0.3-0.6	2.0
Atomizing	Countercurrent flows in two-stage steps. Atomization in second stage.	Same as above	Same as above	Same as above	Spray valves	Steam-jet atomization with fixed or variable-area orifices	0.5-2.0	2.0

By WM BRILL, *Chief Engineer Colorado Fuel & Iron Corp*
and
J F WHITE, *President The J F White Engineering Corp*

When this steel plant found that steam capacity for half their processing needs would be condemned, they swung into action fast. Smart engineering located and moved a big straight-tube boiler some 500 miles to . . .



COMBINATION BURNERS in final installation use natural gas, coke gas, fuel oil

Replace 100,000 Lb per Hr in 17 Wk

▶ MINNEQUA WORKS of Colorado Fuel and Iron Corp processes about 600,000 tons of steel, nearly 50% of total capacity, through a blooming mill driven by a 15,000-hp McIntosh-Hemphill steam engine. Up to 1951, 15 Stirling boilers, installed about 1906 in East Mill plant, generated steam for this engine and other small mill processes. The *blooming engine exhausts to atmosphere*, so the boilers operate on 100% hot-process-softened makeup water.

During routine semiannual inspection in 1951, the insurance company's engineers discovered a serious increase in intercrystalline cracks in No. 8 boiler's steam drum. There were cracks as long as 54 in., extending halfway through the drum shells on eight of the 13 operating boilers. The insurance company would not issue any insurance for six units, and only conditional insurance for temporary operation of the other two boilers with cracks.

The mill was faced with both immediate loss of substantial rolling capacity and increased heating demands during the approaching winter. CF&I engineers diverted steam from B plant, on the other side of the mill, and started inquiries for the fastest possible way to replace the capacity just condemned.

J F White Engineering Corp, of Denver, was then completing installation of a 15,000-kw turbine-generator in the mill power plant. Engineers from White joined forces with CF&I men to develop a plan for installing 100,000 lb per hr of used-boiler capacity. This would relieve the immediate shortage. Also, CF&I ordered two new 100,000 lb-per-hr units to modernize both East Mill and B plants.

Replacement Unit. Within two days after CF&I learned East Mill boilers would be condemned they asked White engineers to canvass the U.S. power industry for an available unit. In the idle Sinclair Refinery at Coffeyville, Kan., they located a Walsh-Weidner sectional-header boiler, with waterwalls and Foster-Wheeler superheater. After obtaining National Board inspection under *ASME Boiler Code*, they secured an option to buy this unit. It proved most suitable because:

(1) It could be diamantled immediately. (2) Straight-tube construction was most adaptable for rapid dismantling and reassembling. (3) It had a large furnace volume, as it was designed to burn acid sludge. (4) Superheater surface could be reused as an economizer. (5) *It could be shipped in* less than five days since it was on a branch of the AT&SF Railway, would require only one yard switching. (6) Inspectors had found it in virtually "as new" condition.

On Nov 6, 1951, CF&I accepted a lump-sum offer for engineering, design, dismantling, moving and re-erecting the boiler, complete with piping and auxiliaries. White personnel started dismantling operations the following day on a schedule of 9-hr days, 6-day weeks. Table I summarizes progress.

Before dismantling, White engineers marked pieces and checked controlling dimensions for re-erection. By carefully studying the construction, they found several procedures that saved considerable time in re-erection. Principally, they moved sectional headers and connected tubes as units. They field-cut the two connecting feeder and releaser tubes and a nipple to the mud drum. They cut waterwalls through the headers to fit railway clearances, and *shipped* the headers as units. Drawing at bottom of page 82 shows unit's arrangement, with arrows indicating tube cuts and field welds. Welders qualified under Section