BOILERS

A. NO. 1 & 2 BOILERS

No. 1 & 2 Steam Generators

Each of the steam generators is a Riley Stoker Corporation Unit with a continuous capacity of 560,000 pounds of steam per hour at 1,300 psig superheater outlet pressure, 1,425 psig maximum drum working pressure and 950° F. total steam temperature. The normal fuel is gas. Each unit is also capable of being fired with oil.

The steam generating unit includes a 60 inch I. D. steam drum; a 42 inch I. D. lower drum; a water cooled furnace; a continuous vertical loop; high velocity superheater; a continuous loop economizer; a tubular single pass cross flow air heater and a steam temperature control valve for bypassing products of combustion around the superheater.

The units are designed to permit free movement of parts, both vertically and horizontally, due to expansion, without placing strains on any part of the unit. The boiler drum and headers are suspended from overhead steel supports and the boiler and setting expands downward from the top. Refer to Procedures Manual for acidizing and/or startup instructions.

Water and Steam Paths

Circulation is based on the ring flow principle, that is, flow in each tube remains in one direction regardless of steam output fluctuations. All tubes exposed to high temperatures carry upward flows of water and steam mixtures and the down flow tubes receive water from the main drum after all steam has been removed. Steam is liberated above the working water level in the drum, the internals of which provide definite and rapid separation of steam and water.

Feedwater from the boiler feed system enters the economizer through the stop and check valves, passes through the economizer, and enters the steam drum through the condenser elements of the steam purifier unit. The feedwater passes through the condenser purifier so that the temperature of the purifier elements is lower than the steam temperature. A certain percentage of the steam is consequently condensed in the purifier fins as it passes over the purifier elements and dirt particles are washed away by the steam condensate. The steam then passes through the dryer section of the steam purifier which minimizes carryover of any entrained moisture and results in a high steam purity.

Water from the upper 60 inch drum flows by gravity through 2½ inch downcomer tubes, which are located behind the rear baffle, and

A. NO. 1 & 2 BOILERS (Contd.)

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also through 3½ inch downcomer tubes, which are located in front of the rear baffle, to the lower 48 inch drum. The 3½ inch generating screen tubes carry the water-steam mixture back to the upper drum. In addition, the lower drum supplies the 14 inch front and the 12-3/4 inch side wall bottom headers through 3½ inch feeder tubes. The water absorbs heat in the 3½ inch side and front wall tubes and rises to the drum in the form of a water-steam mixture which in the case of the side wall tubes rises to the top 12-3/4 inch side wall headers and then to the steam drum through the upper side wall header release tubes. The front wall header also has a row of 3½ inch screen generating tubes leading directly to the steam space of the upper drum.

Safety Valves

Each boiler is provided with two safety valves on the steam drum and one safety valve on the superheater outlet header. In addition, a power control valve is located in the main steam header which may be operated either by excessive pressure on the header or by operation of the selector switch on the Mechanical Console Board.

One steam drum relief valve is a welded Consolidated 1500 psi 3 inch valve set to pop at 1498 psig and close at 1438 psig. The other steam drum valve is a welded Consolidated 2½ inch 1500 psi valve set to pop at 1455 psig and to close at 1397 psig. The superheater relief valve is a welded Consolidated 1500 psi 2½ inch valve set to relieve at 1370 psig and close at 1330 psig. The power Control electromatic relief valve is a welded Consolidated 2½ inch valve set to pop at 1320 psig and close at 1307 psig.

Burners

Each boiler unit is provided with ten burners arranged on two horizontal rows of five burners each. Fuel is supplied to the boiler with ten Peabody type H-26 4 inch insulated burners with center fired gas units.

The burner consists of the air register with its simultaneously adjustable doors, the gas units inserted through the hub of the air register. The air for combustion passes along the gas burner placing it in the zone of active air flow, and thus keeping it relatively cool.

Fuel gas or oil to the burners will vary in pressure depending on the steam load and number of burners in service.

Refer to safety operating procedure section for lighting burners.

Steam Sampling

Four 1 inch tandem valved sampling lines lead from the boiler steam drum and connect to a common header in order to permit spot sampling or the steam just before it enters the superheaters. The steam sample is cooled and degassified in a Powell-McChesney type steam conductivity cell. In this type of apparatus, a stainless steel capillary sampling line throttles the steam flow and condenses part of the sample by radiation. The condensed part of the sample entering the condensate cell is kept at the boiling point and continuously swept by uncondensed vapor so that the gases in the steam cannot go into solution. The electrical conductiviey is measured in the condensate cell and is recorded on Recorder Number 27 on the Process Auxiliary Board.

Air Preheaters

The air preheaters are of tubular, single pass counterflow design. Hot gas from the furnace flows through the inside of the tubes and air flows over the outside in the opposite direction. Air distribution chambers are provided on the sides of the air heater, both at the cold air entrance and hot air exit. Air heater tubes are arranged in bundles with distributing air lanes between the bundles.

Miscellaneous Connections

On each boiler, the lower drum and the front lower header are each provided with two 1½ inch tandem valved blow-down connections, while the right wass header and the left wall header are each provided with a single 1½ inch tandem valved blow-down connection, for the purpose of intermittent blow-down of boiler solids and also for draining of the boiler. For draining purposes, the 1½ inch lines connect with a 3 inch line to waste which is blocked with a 3 inch gate valve. For intermittent blow-down purposes the 1½ inch lines connect to 4 inch line which drains into the intermittent blow-off tank. A 4 inch gate valve blocks this line. An elbow and block valve arrangement permits filling the boiler with condensate makeup through a 4 inch line and a 4 inch gate valve by means of of the condensate make-up pumps. An acid cleaning connection is provided in the 4 inch blow-off line.

On each boiler the following tandem valved lines discharge into a common 3 inch header which also leads into the blow-off tank where a 3 inch gate block valve is located: the 1½ inch economizer inlet header drain; the two 3/4 inch gauge glass blow-offs; the two water column drains; the two superheater header drains. An elbow and block valve arrangement in this 3 inch line permits filling with condensate through a 3 inch line from the condensate make-up pumps. The two superheater header drain lines are provided with acid cleaning connections.

Draft System

Air for combustion is supplied by two Westinghouse-Sturdevant turbo-vane forced draft fans driven by Westinghouse 200 HP, 1200 RPM motors. The fans discharge through the air heater, the wind box and into the furnace. The fan capacity is regulated by inlet louvers positioned by piston operators that are actuated by the combustion control system. The gases of combustion are drawn through the superheaters, the boiler gas passages, the economizer and air preheater by two Westinghouse-Sturdevant turbo-vane Induced Draft fans driven by Westinghouse 350 HP, 990 HP, RPM motors. The fans may be started and stopped either locally or from the Mechanical Console.

Thermocouples are located on both fan and motor bearings, and the temperatures are recorded on bearing temperature recorder located on the Mechanical Vertical Auxiliary Board. Annunciation of high temperature is provided on the Mechanical Vertical Board.

Continuous Blowdown System

The continuous blowdown system is provided to maintain the proper concentration of dissolved solids in the boiler water. Perforated lines, running lengthwise within the steam drums below the water level discharge through one end of the drums and into the boiler continuous blowdown tanks, one tank for Boilers 1 and 2 and a separate tank for Boiler 3. The blowdown rate is controlled by manual adjustment of the flow control valves located adjacent to the flash tanks. The drains from all flash tanks discharge through a six inch line to a heat exchanger which is used to heat demin water to the storage tanks. The flashed vapor discharges through steam separators to the deaerators.

By-pass lines are provided around the "flash-tanks" which allows either or both to be isolated for inspection, maintenance, etc.

Sample lines from each Boiler blowdown line to conductivity cells with sample coolers provide conductivity readings on the Boiler Conductivity Recorder on Process Auxiliary Board. Annunciation of high conductivity is also provided on the Process Auxiliary Board.

pH Cells, also located on these blowdown sample lines, provide pH readings on Boiler pH Recorder and annunciation of high or low pH on Process Auxiliary Board. Both continuous blowdown tanks are provided with high level alarms.

Boiler water from the continuous blowdown systems from Boilers 1 and 2 may be recirculated, if desired through a 1" line into deaerators 1 and 2 to control pH in these deaerators. This system however, has never been used since Boiler pH has been controlled by feeding Caustic directly to the steam drums.

Chemical Feed System

The chemicals used for boiler water conditioning are trisodium, disodium, and monosodium phosphate, sodium sulfite and caustic soda.

The phosphate reduces hardness and minimizes scaling by combining with any calcium in the boiler water to precipitate calcium phosphate. Calcium phosphate has very desirable properties for boiler sludge. It forms a finely divided fluid sludge which can be carried by the boiler recirculation and can, in general, be removed by blowdown. As calcium phosphate is the least soluble of the calcium salts that form in the boiler water, phosphate control prevents formation of all calcium scales such as calcium carbonate, calcium sulfate or calcium silicate.

The phosphate for Boilers 1, 2, 3, 4 and 5 is mixed in neoprene-lined tanks with covers, one for each boiler. Condensate from the condensate makeup line is admitted to the bottom of the tanks through a 3/4-inch swirl jet connection for dissolving the phosphate. Chemicals for each individual boiler are mixed in their respective tanks. Each tank is connected to a diaphragm pump for injecting solution into boilers. Boilers 1, 2 and 3 have interconnecting piping allowing chemicals to be pumped to each boiler with any one of the three pumps. Boilers 4 and 5 feed stations are at different locations, so piping is not interconnected. Dosage can be adjusted by chemical weight and stroke on pump.

For standby purposes, we have surge bottles at each of the three chemical feed stations. The solution is drained by gravity through a one-inch line to the surge bottle where feedwater taken off the feedwater header through a 3/4-inch line injects the solution into the boilers.

No matter how efficiently a deaerator is designed or operated, some oxygen, however little, passes through with the water coming out of a heater. Therefore, sodium sulfite is added to the water in order to scavenge this oxygen and minimize corrosion by combining with the oxygen to form sodium sulfate. It is fed into feedwater line downstream of feedwater regulators to each boiler.

The sulfite for Boilers 1, 2 and 3 is mixed in one neoprene-lined tank with cover. Condensate from the condensate makeup line is admitted to the bottom of the tank through a 3/4-inch swirl jet connection for dissolving the sulfite. Suction from the tank goes to three diaphragm pumps used for injecting the solution into each individual boiler. Boilers 1, 2 and 3 have cross-connecting piping off the discharge of these pumps allowing the feeding of any of the three boilers with any pump. Boilers 4 and 5 have their own neoprene tanks and each has a diaphragm pump.

In addition, an EDTA chelant is fed to all boilers to aid in the control of iron. Necessary storage, mix, and pumping facilities are provided for each boiler.

Low level in the mixing tanks is annunciated on the Mechanical Vertical Board and also on the Process Auxiliary Board. The pumps are started and stopped at local pushbutton stations.

Chemical Feed System (cont'd)

Caustic soda is added to regulate the pH of the feedwater and of the boiler water. It is mixed when necessary directly with the phosphate in the phosphate mixing tanks.

Refer to safety operating procedure section for feeding chemicals to boilers.

B. NO. 3 BOILER

No. 3 Steam Generator

Boiler No. 3 is a Babcock and Wilcox unit with a continuous capacity of 750,000 pounds of steam per hour at 1,300 psi superheater outlet pressure, 1,450 psi maximum drum working pressure and 950° total steam temperature with natural gas or oil as fuel.

The steam generating unit includes a 66 inch nominal diameter steam drum, a 48 inch nominal diameter lower drum, a water cooled furnace, a continuous vertical loop high velocity superheater, a double flow economizer, a Ljungstrom rotary type air preheater and a spray attemporator steam temperature control valve.

The unit is designed to permit free movement of parts, both vertically and horizontally, due to expansion without placing strains on any part of the unit. The boiler drum and headers are suspended from overhead support steel and the boiler and setting expand downward from the top supports.

Refer to Procedures Manual for startup curve.

Water and Steam Paths

Water and steam path in #3 Boiler is basically the same as on Boiler 1 and 2. Only the tube, drum and header sizes are different.

Safety Valves

The boiler is provided with three safety valves on the steam drum and one safety valve on the superheater outlet header. In addition, a power control valve is located on the main steam header which may be operated either by excessive pressure on the header or by operation of the selector switch on the Mechanical Console Panel.

All three steam drum relief valves are welded Consolidated 3 inch valves. One is set to pop at 1460 psi and close at 1392 psi, another set to pop at 1470 psi and close at 1411 psi, and the third to pop at 1490 psi and close at 1430 psi. The superheater relief valve is a welded Consolidated 1500 psi 3 inch valve set to pop at 1370 psi and close at 1305 psi. The power control electromatic relief valve is a welded Consolidated 2½ inch valve set to pop at 1340 psi and close at 1327 psi.

Burners

The unit is provided with twelve B & W Multispud type gas burners arranged in three horizontal rows of four burners each. This type gas burner can be effectively used to burn natural gas, refinery gas, butane gas and propane gas. The design of this type burner is such that it can be used either as a gas burner only, or arranged in multifuel burner arrangements for (a) gas or oil firing (b) gas, oil or pulverized coal firing.

The burner consists of the air register with its simultaneously adjustable doors, the eight gas burner spuds inserted through the hub of the air register, an impeller plate to diffuse combustion air at the burner tips and electric igniter and gas pilot for lighting the burner. The combustion air passes along the burner spuds and through the impeller plate placing them in the zone of active air flow, thus keeping them relatively cool. Each burner spud is provided with two quick connective couplings to be connected by hose to high pressure air for removal of individual spuds while the boiler is on the line.

Air Preheater

The boiler is provided with a Ljungstrom Rotary, vertical, type VIX, air preheater. This air preheater is of the regenerative type in contrast to the tubular recuperative types on Boilers 1 & 2.

The unit consists of the rotor and associated heat transfer elements; a rotor drive unit consisting of two General Electric 10 h.p. drive motors (one for service and the other for stand-by) and a Falk speed reducer; rotor housing; an oil immersed rotor guide bearing mounted on the lower end of the rotor post; an oil immersed rotor support bearing (of the Kingsbury type) mounted on the upper end of the rotor post to support the weight of the rotor; a thermostatically controlled integral rotor support bearing oil circulating system consisting of a pump and cooler mounted on the rotor support bearing housing; a heating element cleaning device consisting of a drive motor, speed reducer and oscillating nozzle connected to the 235# process steam system.

The air preheater absorbs waste heat from the flue gas, then transfers this heat to incoming cold air by means of continuously rotating heat transfer elements of specially formed metal plates. Thousands of these high efficiency elements are spaced and compactly arranged within twelve sector shaped compartments of a radially divided cylindrical shell, called the rotor. The housing surrounding the rotor is provided with duct connections at both ends and is adequately sealed by radial and circumferential sealing members -- forming an air passage through one half of the preheater and a gas passage through the other.

As the rotor slowly revolves the mass of elements alternately through the gas and air passage, heat is absorbed by the element surfaces passing through the hot flue gas stream; then, as these same surfaces are carried through the incoming air stream, they release the stored up heat -- thus greatly increasing the temperature of the incoming combustion air.

Miscellaneous Connections

On this boiler the drains and valve arrangements differ from Boilers No. 1 and 2. Each of the two side wall headers is provided

with three single valved 1½" drain connections on a 1½" header with a downstream block valve of the same type. The floor header and rear wall header are each provided with four single-valved 1½"drain connections on a 1½" header with a downstream block valve of the same type. The lower drum and the intermediate header are each provided with two 1½" tandem-valved drain connections. Since no intermittent blowdown of this boiler is required, all these connections are referred to as drains rather than blowdowns. If it is necessary to blowdown because of high drum level, it is recommended that only the lower drum be blown.

For draining purposes, the 1½" lines connect with a 3" line to waste which is blocked with a 3" gate valve. For blowdown purposes the 1½" lines connect with a 4" line which drains into the blow-off tank. A 4" gate valve blocks this line. A removable elbow permits filling the boiler with condensate make-up through a 4" line and 4" gate valve by means of the make-up pumps. An acid cleaning connection is provided in the blow-off line.

On this boiler the following tandem-valved lines discharge into a common 3" header which also leads into the blow-off tank: the 1½" economizer inlet header drain; the two 1" gauge glass drains; the two 1½" water column drains; the two 1½" primary superheater drains; the two 1½" secondary superheater drains. A removable elbow in this 3" line permits filling with condensate make-up through a 3" line by means of the make-up pumps. The four superheater drains are provided with acid cleaning connections.

Draft System

Air for combustion is supplied by two turbo-vane forced draft fans driven by Allis-Chalmers 400 HP, 1700 RPM motors. The fans discharge through the air heater, the wind-box, and into the furnace. The fan capacity is regulated by inlet louvers positioned by piston operators that are activated by the combustion control system.

The furnace, being pressurized (No ID fans), the gases of combustion are forced through the superheaters, the gas passages, the economizer, the air pre-heater and out the stack.

The fans may be started and stopped either locally or from the Mechanical Console. Thermo-couples are located on both fan and motor bearings and temperatures are recorded on the Bearing Temperature Recorder in the Control Room. Annunciation of high temperatures is provided on the Mechanical Vertical Board.

To allow for inspection of the furnace or maintenance on burner lighters while boiler is on the line, 100# air off the plant service air system is supplied at each furnace opening or inspection port for sealing purposes. Low pressure air off the FD fan discharge duct is piped to each opening for cooling purposes.