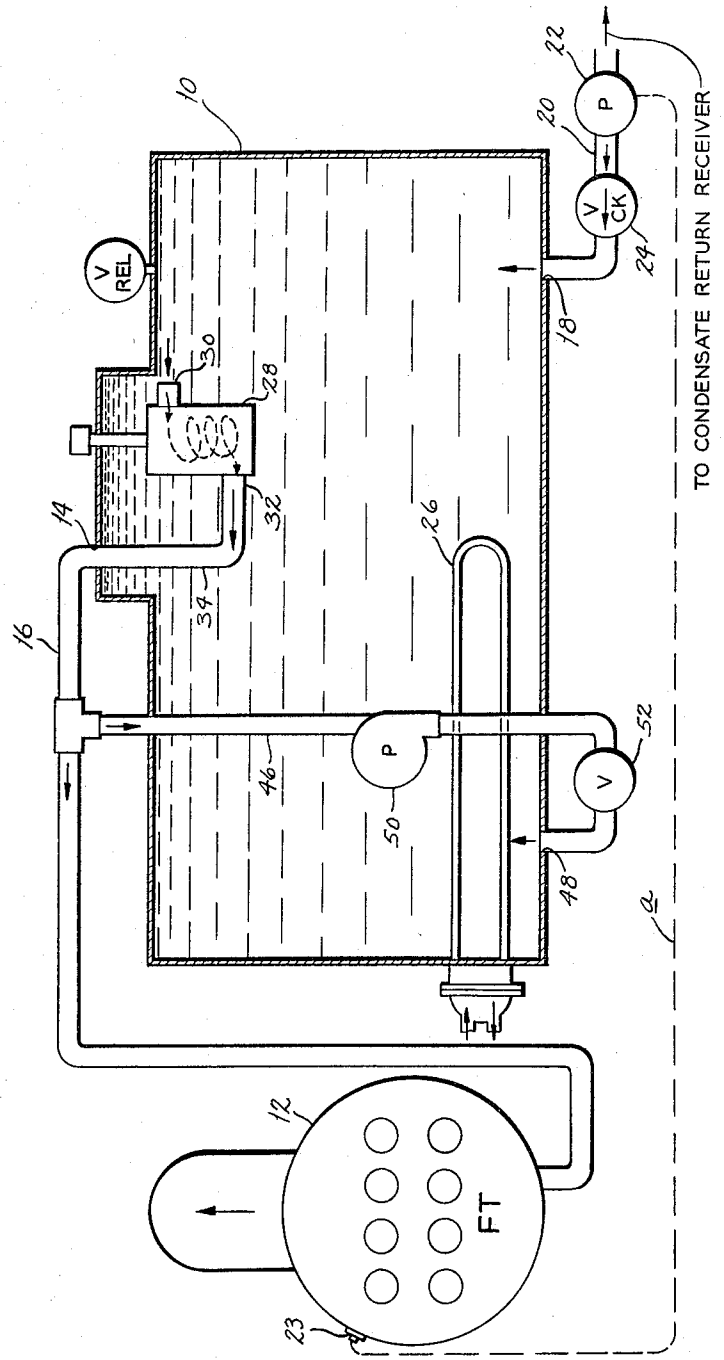
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PRE-HEATING AND DE-AERATION SYSTEM FOR BOILER FEED WATER

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PRE-HEATING AND DE-AERATION SYSTEM FOR BOILER FEED WATER

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The present invention relates generally to a pre-heating and de-aeration system for boiler feed water, and more particularly to continuous vortex-type de-aeration of such feed water.

Vortex-type de-aerators are well-known. In this type of de-aeration a pressure differential is created by means of acceleration of the water in a streamline-flow vortex, thus to separate gases from the water.

As its general purpose, the present invention provides a unique arrangement including a vortex-type de-aerator in a boiler feed water pre-heating system, by which maximum air separation from the water and positive removal of such separated air from the system is insured. Among the detailed objects of the present invention are the provisions of a pre-heating and de-aeration system for boiler feed water wherein:

De-aeration takes place at a location in the system where sufficiently elevated pressure and temperature are present to permit maximum air separation and minimum air re-absorption; and

Water is hermetically stored prior to delivery to the boiler and continuously passed through the de-aerator, and undergoes a final pass through the de-aerator upon its delivery to the boiler.

These purposes (as well as others apparent herein) are acheived generally by providing a de-aeration system for a boiler of the type maintained at greater than atmospheric pressure and including a vortex-type de-aerator which is completely submerged in the stored feed water. The storage tank is provided with a heater which heats the feed water above 212° F. Boiling and turbulence of the heated water is prevented by subjecting it to the pressure of the boiler itself.

Condensate and make-up water are pumped to the storage tank to keep it full and to deliver water from it to the boiler. The stored feed water within the storage tank is constantly re-circulated through the de-aerator and undergoes a final pass through the de-aerator on its delivery to the boiler.

The apparatus herein disclosed takes advantage of the fact that as water is heated above 212° F. and yet maintained by pressure in its liquid phase, entrapped air is readily removed. Such pressure is applied, in the present invention, by the boiler itself through the conduit which provides the feed water to it.

Utilization of the present invention will become apparent to those skilled in the art from the disclosures made in the following description of a preferred embodiment of the invention, as illustrated in the accompanying drawing, in which:

FIG. 1 is a semi-diagramatic view of the boiler feed water pre-heating and de-aeration apparatus of the present invention.

Referring now to the drawing, there is shown in FIG. 1 a pre-heating storage tank, generally designated **10**, which is provided between a condensate receiver (not shown) and a fire tube boiler **12**. The boiler **12** is of the type in which the water to be converted to steam is maintained during operations at a pressure substantially greater than atmospheric pressure. At the present time, such systems are usually operated at a maintained pressure of 75 p.s.i. or greater, but pressures as low as say 10 p.s.i. are sufficient to avoid "flashing-off" of the water at the elevated

temperature utilized for separation of entrapped air. Condensate returned from the apparatus which utilizes the steam is received by a condensate receiver (not shown) and returned to the pre-heating storage tank **10**.

Pre-heating storage tank

The pre-heating storage tank **10** is preferably a steel shell. It is completely filled with boiler feed water and hermetically sealed to insure that the water cannot absorb oxygen and other gases from the atmosphere and other portions of the system. The tank **10** must be capable of withstanding a pressure substantially greater than atmospheric pressure so that the water stored therein may be heated under elevated pressure conditions.

An outlet opening **14** located near the top of the tank is directly connected to the fire tube boiler **12** by means of a pipe **16**. In this manner the pressure established at the boiler **12** is applied to the water stored in the tank **10**, so that it is maintained at the boiler pressure.

Near the bottom of the tank **10** there is provided an inlet opening **18** which communicates with the condensate receiver (not shown) by means of a feed line **20**. A pump **22** and a check valve **24** are provided in the feed line **20**. As indicated by the dashed line *a*, shown connecting the pump **22** and the fire tube boiler **12**, the pump **22** is responsive to and actuated by demands for feed water at the boiler **12**. Any suitable arrangement for sensing the water demand and controlling the actuation of the pump **22** may be employed. For example, a liquid level sensor **23** may be used at the boiler **12** to sense the water demand and an electrical circuit provided between the liquid level sensor **23** and the pump **22** to energize it in response to such demand.

The pump **22** communicates with the stored water within the tank **10** through the check valve **24**. When the pump **22** is actuated, the check valve **24** opens and water is propelled from the outlet opening **14** of the tank **10** and supplied to the boiler **12** through the outlet pipe **16**. Simultaneously with the flow of stored water from the tank **10**, the pump **22** introduces additional water to the tank **10** from the condensate receiver (whose supply is supplemented by the water main in any conventional manner) to keep the tank **10** completely filled. After the pump **24** has stopped pumping, the check valve **24** returns to its closed position to seal off the interior of the tank **10**.

Storage tank heat exchanger

A U-shaped heater **26** is provided within the storage tank **10** and is connected externally to a source of heat (not shown). The heater **26** may take the form of a steam heater, wherein a portion of the steam generated by the fire tube boiler **12** is supplied to the heater **26**. Another, or additional arrangement if needed, may include a flue-gas heated economizer unit, such as that shown in the U.S. Patent 1,255,170 to D. S. Jacobus. In any event, it is essential that the heater **26** (or heaters) be capable of heating the water within the storage tank **10** to a temperature above its atmospheric pressure boiling point. It has been found that entrapped air is most readily separated from water maintained by pressure in liquid phase with its temperature elevated to approximately 220° F. Heating the water above 220° F. does not significantly change the amount of air separation attained at a temperature of 220° F. Any boiler pressure over say 10 p.s.i. will be sufficient to avoid "flashing-off" of the water.

De-aeration apparatus

Submerged within the stored feed water is a vortex-type de-aerator **28** such as is in popular use. Its inlet **30** is provided in direct communication with the water

within the tank. An outlet 32 of the de-aerator 28 is connected to the tank outlet 14 by means of a pipe 34.

Water which is introduced tangentially to the de-aerator by means of the inlet 30 is accelerated in a streamline-flow vortex. As it flows in its vortex downward to the outlet 32, the entrapped air (which is lighter and less subject to the centrifugal force attendant rotation) is separated inwardly from the water and is gathered and passed upward, to be periodically vented to the atmosphere by the venting valve (not shown).

A re-circulation passage 46 is provided between the outlet pipe 16 and an inlet 48 near the bottom of the storage tank 10. The re-circulation passage 46 includes a centrifugal booster pump 50 and a flow-control valve 52. By means of this re-circulation passage 46 the water stored within the tank 10 is re-circulated through the vortex-type de-aerator 28. Such re-circulation of the stored feed water, at the elevated temperature and pressure described, insures maximum air separation and removal.

Operation

When there is no demand for feed water at the boiler 12, the water stored in storage tank 10 is continuously circulated through the vortex-type de-aerator 28 by means of the re-circulation passage 46 and the booster pump 50. The interior of the tank 10 communicates directly with the pressure at the boiler 12 by means of the pipe 16. Thus, the water within the tank is maintained at the same elevated pressure as that developed at the boiler 12. The stored feed water is heated by the heater 26 to a temperature of approximately 220° F. Because the tank 10 is under the pressure of the boiler, this heating takes place without the water being converted from its liquid phase into steam. By raising the water to such elevated temperature, as described, optimum conditions are achieved for air separation. The actual air separation is then accomplished by circulating the water through the vortex-type de-aerator 28 submerged within the stored feed water.

When there is a demand for feed water at the boiler 12, the pump 22 is actuated and the feed water within the tank 10 is propelled through the outlet opening 14 and the pipe 16 to the boiler 12. It should be noted that the feed water undergoes a final pass through de-aerator 28 just prior to its leaving the tank 10. Simultaneously with the propelling of water from the tank 10, the pump 22 delivers condensate from the receiver and through the feed line 20 to replenish the supply of water in the tank 10.

Thus it may be seen that the present invention provides a pre-heating and de-aeration system wherein air that may oxidize and damage boiler tubes or plates is removed. Positive removal is brought about by separating air in a vortex-type de-aerator which is maintained at elevated temperatures. The sealed-off re-circulation system eliminates the possibility of air re-absorption. A final pass of the feed water through the de-aerator upon its delivery to the boiler is a further assurance of thorough removal, in the event additional water has just been supplied from the condensate tank.

Obviously many modifications and variations are possible in view of the above teachings. Therefore, it is to be understood that the invention may be practiced other than as specifically described.

We claim:

1. A feed water pre-heating and de-aeration system for that type of boiler in which water is maintained at greater than atmospheric pressure, comprising

means for hermetically storing water under pressure,

means at such storage means to heat such water above its atmospheric boiling point temperature,

means at said storage means and connectable to such boiler for applying the pressure of such boiler to such heated water, whereby to maintain the water in its liquid phase,

means at said storage means for introducing additional water into said storage means on demand and propelling the water, so pressurized and at such temperature, to such boiler, and

means to conduct the water, so propelled, in a vortex and simultaneously to remove entrapped air from the center of the vortex,

whereby application of such boiler pressure and elevated temperature to the boiler feed water during de-aeration effects maximum air removal and minimizes air re-absorption, together with

means at said storage means for recirculating the pressurized and heated water through such vortex-effecting means and returning same to the storage means,

whereby water is continuously passed through said vortex-effecting means.

2. A feed water pre-heating and de-aeration system for use with a boiler of the type in which water is maintained at a pressure greater than atmospheric pressure, comprising

a pre-heating storage tank hermetically sealed and having an outlet passage and inlet means to introduce condensate into said tank,

a heat exchanger contained within said tank and connectable externally with a source of heat for heating water in said storage tank to a temperature above its atmospheric boiling point,

the outlet passage of said storage tank communicating with the pressure at such boiler, whereby the boiler and water within the tank are maintained at substantially the same elevated pressure above atmospheric pressure,

means at such storage tank for introducing additional water into said storage tank on demand and propelling the water, so pressurized and at such temperature, to such boiler, and

a vortex-type de-aerator contained within said storage tank, said de-aerator having a de-aerated water outlet connected to said outlet passage of said tank and a gas-venting outlet presented to the atmosphere outside of said tank, whereby to prevent re-absorption of removed air, together with

a re-circulation passage connected between the outlet passage of said storage tank and said inlet means thereof, said re-circulation passage having a pump for effecting re-circulation of stored water through the vortex-type de-aerator.

3. The pre-heating and de-aeration system as defined in claim 2, wherein

said means for introducing and propelling the water includes

a boiler feed pump whose discharge side communicates with such storage tank through said inlet means, for propelling water from said outlet passage into such boiler, and

a check valve interposed between said delivery pump and said tank inlet means, said check valve being switchable between open and closed positions in response to the demand for water by such boiler.

4. The pre-heating and de-aeration system as defined in claim 2, wherein

said heat exchanger within such storage tank heats the water to a temperature of approximately 220° Fahrenheit, and

the pressure at which the feed water within said storage tank is maintained above 10 p.s.i.

5. A feed water pre-heating and de-aeration system for use with a boiler of the type in which water is maintained at a pressure greater than atmospheric pressure, comprising

a pre-heating storage tank hermetically sealed and having an outlet passage and inlet means,

a heat exchanger contained within said storage tank and connectable externally with a source of heat

for heating water in said storage tank to a temperature above its atmospheric boiling point,

the outlet passage of said tank communicating with the pressure at such boiler, whereby the boiler and water within the tank are maintained at substantially the same elevated pressure, above atmospheric pressure,

a boiler feed pump whose discharge side communicates with said storage tank through said inlet means, for propelling water from said outlet passage to such boiler,

a check valve interposed between said delivery pump and said tank inlet means, said check valve being switchable between open and closed positions in response to the demand for water by such boiler,

a vortex-type de-aerator contained within said storage tank, said de-aerator having a de-aerated water outlet connected to said outlet passage of said tank, and a gas-venting outlet presented to the atmosphere, outside of said tank, whereby to prevent re-absorption of removed air,

a re-circulation passage connected between the outlet passage of said storage tank and said inlet means, said re-circulation passage having a pump for effecting re-circulation of the stored water through the vortex-type de-aerator.

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