United States Patent Office 2,756,029 Patented July 24, 1956



2,756,029

# HEATING SYSTEMS FOR WATER CONTAINING DISSOLVED SCALE-FORMING SOLIDS

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Application February 19, 1952, Serial No. 272,410

11 Claims. (Cl. 257—51)

This invention relates to heating systems capable of providing hot saline and other waters in large volume for process purposes but at the same time requiring a lesser quantity of fresh or purer water for boilers, service or other purposes. Examples of such heating systems and processes are described in the copending applications of Bernard A. Axelrad and Vas Hubert Brogdon filed September 1, 1951, Serial Number 244,854, now abandoned, and Serial No. 253,306, filed October 26, 1951.

In such applications, it is proposed to heat salt water and other water containing scale-forming solids to temperatures above the normal boiling point in pressurized direct heaters employing flame or combustion gases and proposed to heat such water to intermediate temperatures in direct heaters operated substantially at atmospheric pressures followed by heating in indirect tube exchangers under pressure in which steam is employed as the heating medium. In these and similar processes, some fresher water or non-scaling water is generally required for boiler feed and service purposes as for operating pumps, air-compressors and other equipment. In such processes the salt or other water containing the scale-forming solids is utilized as process water for the reason that fresh or non-corrosive water is not available at all or is not economically obtainable. Under such conditions, purer water also may not be available for the stated auxiliary purposes.

An object of the present invention is to provide boiler feedwater, fresh service water and other like water where natural fresh water suitable for such purposes is not available, in connection with operations wherein large volumes of saline or scale-forming process water are to be heated to temperatures at an elevation ordinarily causing scale deposition when the water comes in contact with metal surfaces, as in ordinary steam boiler tubes.

Another object is to provide a process for securing such boiler feed and other fresh water at high thermal efficiency. Another object is to reduce the cost of operating steam boilers in conjunction with processes employing large quantities of hot process water. A further object is to avoid the high cost of the usual evaporation processes which heretofore would have been considered necessary in such operation.

Yet another object is to provide water suitable for boiler feed and service purposes from a raw water supply which is scale-forming, corrosive or brackish in character by procedures which substantially overcome the problems which scale formation causes.

Broadly considered the invention may be described as relating to heating systems in which large quantities of hot process water containing dissolved scale-forming solids are produced and lesser quantities of water for boiler, service or other purposes are needed, and as involving (1) the flowing of impure or scale-forming water into and through a direct gas contact heating zone, (2) the introduction of hot combustion gases into said heating zone and into direct contact with the water to be heated whereby the water becomes heated and the gases take up moisture, and (3) the flowing of the moisture-laden gases so produced while still hot from said heating zone and into a heat exchanger zone in indirect contact with the cool impure water flowing to the direct heating zone wherein the moisture of the gases separates as condensate. Through such procedure the scale-forming water flowing from the direct heating zone becomes heated and a condensate of fresher water freed of the scale-forming solids flows from the direct heat exchanger zone.



The preferred specific features of the present invention may be readily understood from the embodiment of the invention illustrated in the accompanying schematic flow sheet drawing.

Saline water or other raw water containing scale-forming solids dissolved therein after being collected by a suitable system of pumps and screens and settled in a reservoir for the removal of heavy silt is pumped through an inlet pipe **10** into a screen box **11** into the top of a direct contact heater or tower as shown. This heater is preferably provided with superimposed spaced layers of contact material **12, 13** and **14** composed of ceramic rings, coke or other conventional surface extending substances. The water sprayed into the top of the tower is first heated by waste flue gases introduced into the tower through pipe **15** and is then raised to a higher temperature by combustion gases produced in or introduced into the tower from the chamber **16**. These gases are preferably produced from exactly proportioned air and fuel to provide carbon dioxide gases devoid of free oxygen or excess air components. The heated water descends to the bottom of the tower wherein a settling pool is formed and from which any algae and other colloidal matter present settles out below the cone **17**. The indirect contact heater is operated substantially at atmospheric pressure and the saline water is heated therein to a temperature above 140° and preferably of from 150° to 195° F.

The thus heated water leaving the tower at a point above the bottom flows out through the conduit **18** to the pressure raising pump **19** and thence to the indirect heat exchanger **21**. In transit, an addition of a scale-inhibiting agent may be introduced into the line **18** at any suitable point as through the inlet conduit **22** with the assistance of pump **23**. The hot water flows from the heat exchanger **21** through the outlet conduit **24** to the process or operation utilizing the same.

The steam for the indirect heat exchanger **21** is provided by the boiler **25** from which it flows through the conduit **26** to heat exchanger **21**.

In accordance with a primary feature and preferred embodiment of the present invention, the boiler feed water and service water are obtained by withdrawing part of the combustion gases, which quickly become saturated with moisture, from an intermediate level in the direct heating zone or tower through the conduit **27** and introducing the same into an indirect heat exchanger or condenser **28** wherein the cooling is effected by means of raw feed water flowing from the inlet conduit **10** through the branch conduit **29**. The said cooling water after flowing through the condenser **28** flows to the heating tower through the conduit **31** preferably connected at an intermediate point, whereby the heat taken up from the gases is, for the most part, returned to the tower.

The condenser water returned to the direct heating zone is advantageously introduced at a point where the saline water is at substantially the same temperature as that of the condenser water and preferably not introduced into the tower at a point where the saline water flowing therethrough is colder than the condenser water.

After having given up their moisture content in the condenser **28** the partially cooled flue gases are preferably returned to the upper portion of the tower through conduit **32** connected at an intermediate level, wherein the re-