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SALINE WATER HEATING PROCESSES AND SYSTEMS

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This invention relates to processes and heating systems for providing large quantities of process water at high temperatures using as the source of the raw water, particularly natural waters having scale-forming properties.

In the mining of sulfur from sulfur deposits located under salt marshes in coastal areas and under the sea, the large quantities of hot water required for the Frasch process are not available from the usual sources of relatively pure or fresh water, as that obtainable from wells, rivers or lakes. For economically successful operation in such areas, it is required that brackish water or sea water be used, but since these waters are scale-forming and corrosive when heated, the heating of the water cannot be effected by the use of ordinary boilers or of any type of heat exchanger where the heat is transferred through metal to the water, for scale deposits rapidly from such water even when it is only moderately heated.

The primary object of the present invention is to provide processes and an apparatus for heating large quantities of hot water to temperatures above 220° F. with substantial avoidance of scaling upon hot metal surfaces of the heating system used. Another object is to provide procedures for heating natural saline water or brines which are scale-forming or corrosive to temperatures and in quantities required for sulfur mining.

Other objects include the production of large amounts of hot process water without the use of large quantities of chemicals and without the use of expensive and sometimes inefficient corrosion-resistant alloys for the heating of such water. Another object is to heat scale-forming, natural water and brines in a manner which throws down scale-forming constituents in the body of the water being heated and does not deposit a prohibitive amount of scale upon any of the metal surfaces with which the water comes in contact.

Still another object is to improve the efficiency of water heating operations with respect to fuel utilization by avoiding scale deposition on any heating surfaces. A final object is to reduce the cost of operation and maintenance of hot water heating systems by avoiding scale and corrosion upon heat transfer surfaces.

Broadly considered the invention may be said to involve processes and heating systems for providing large quantities of hot process water at temperatures above 220° F. in a continuous stream in which the water to be heated is flowed under pressure into a heating vessel wherein it is directly contacted with superheated steam under pressure whereby the water is heated to a temperature above 220° F. and superheated steam is desuperheated forming water vapor or saturated steam in said vessel, and from which the said water vapor is withdrawn, converted into superheated steam and reintroduced into the heating vessel thereby to accomplish the heating of the water to the specified high temperature.

Before the water is introduced into said heating vessel in contact with the superheated steam it is desirable that the same be preliminarily heated to a temperature as high as about 195° F., but more suitably to from 140° to 190° F. by direct contact with hot gases or vapors, preferably combustion gases. The combustion gases may be derived from any suitable source but in a contemplated efficient embodiment of the invention, the heating gases used include the hot flue gases derived from the superheater later employed in the process.

In a more limited embodiment of the invention, the partially heated water after being subjected to the action of the hot flue gases is heated further by hot burner gases at a higher temperature, which gases may be obtained, for example, by the combustion of natural gas or oil.

The preliminary heating up to the temperature of 195° F. is preferably carried out in a tower heater wherein the raw water to be heated is introduced at the top and the heating gases are introduced at one or more lower levels, the said heating operation being carried out without the application of pressure.

For accomplishing the main or final heating of the process water, a heating vessel must be employed of a type which will cause or permit intimate contact of the water to be heated with superheated steam introduced into the vessel. It also must either be of a construction or be equipped with a spray eliminator or other device for collecting and discharging water vapor. A suitable heating vessel is one in which the hot water is sprayed into the side thereof at an intermediate level into contact with the superheated steam introduced into said vessel at a somewhat lower level and from which vessel water vapor is withdrawn from the top or at a level above a spray eliminator.

Since the heating of the water to the high temperatures reached in the heating vessel yields appreciable quantities of inert gas, it is desirable that the same be vented from the system along with any excess amount of water vapor before the vapor is converted into superheated steam. The heat of these withdrawn gases may be recovered by directly contacting the same in a preheater with the water subsequently introduced into the hereinbefore mentioned heating vessel.

For most efficient operation, the water vapor after it is separated from the inert gases is raised in temperature several degrees and converted into slightly superheated steam, then compressed and finally superheated to a very high temperature before being returned to the water heating vessel.

In the production of hot water for sulfur mining, the water is raised to a temperature in the range of 275° to 340° F. The process and heating system of the invention, however, may be used to provide process water at other temperatures under pressure, as where water is to be utilized in potash or soda ash mining.

A heating system exemplifying the present invention is illustrated in the accompanying diagrammatic drawing. With reference to the drawing there is illustrated a heating tower **10** composed of three parts—namely, a flue gas heat reclaimer section **11** near the top thereof, a burner gas heating section **12** at an intermediate point thereof and a purifying section **13** at the bottom thereof. A conduit **14** is connected substantially at the top thereof for introducing the raw water to be heated. A conduit **15** for the introduction of hot flue gases is connected to the tower at an intermediate point below the reclaimer section and a burner **16** for fuel and air is connected at a lower intermediate point below the higher temperature heating section.

The bottom of the tower constitutes a settling basin from which precipitated matter and other sediment may be withdrawn from time to time through a valved outlet **17**. Somewhat above the bottom of the tower, there is a cone **18** connected to an outlet conduit **19** leading to and connected into the water heating vessel **20** at an intermediate level thereof. This conduit is provided with a