United States Patent Office

2,756,207

Patented July 24, 1956

1

2,756,207

SEA WATER HEATING

Bernard A. Axelrad, Freeport, Tex., assignor to Freeport Sulphur Company, New York, N. Y., a corporation of Delaware

No Drawing. Application September 4, 1951, Serial No. 245,090

9 Claims. (Cl. 210—14)

This invention relates to a process for heating sea and other saline waters to high temperatures and more particularly to the heating of such waters in indirect heat exchangers to temperatures of at least 250° F. without causing the usual high rate of deposition of hard scale on the surfaces of the heating equipment.

If sea water is heated to such high temperatures under ordinary indirect heat exchange practice, salts therein rapidly precipitate out and form a hard scale which reduces the heat transfer efficiency and soon require that the equipment be taken out of use, opened up and scraped or turbined to remove the scale.

The ultimate object of the invention is to provide large quantities of very hot salt water at low cost. An intermediate object is to heat such water in indirect heat exchange equipment by a procedure which avoids a prohibitive rate of deposition of salts on the hot heating surfaces of the equipment.

A specific object of the invention is to cause scale-forming compounds including magnesium hydroxide and calcium carbonate which separate out from the salt water during the heating operation, to deposit for the most part in the form of a soft, non-adherent layer primarily in the lower temperature portion of a multi-stage indirect heating tube. This soft sludge may therefore be removed from the heating tubes with a minimum of disturbance in, and delay in the use of, the heating equipment, and a substantially continuous stream of hot water can be maintained.

In its primary embodiment, the invention involves heating salt water containing the usual calcium sulfate and other scale-forming compounds to temperatures above 250° F. in a two stage indirect heat exchanger and controlling the heat transfer in the first stage such that scale-forming compounds in the water which separate out will deposit primarily or substantially only in the form of a soft, non-adherent layer in the first stage and controlling the heating in the second stage such that the thus obtained water can be and is heated to a higher temperature without causing deposition of appreciable amounts of hard scale on the heating surfaces of said stage.

In the two stage indirect heat exchanger the water is forced under superatmospheric pressure into the tube or bank of tubes constituting the first stage and is heated therein to a temperature at which scale-forming compounds in the water deposit substantially only as a soft, non-adherent layer by applying heat to the water from the heat exchange surfaces at a temperature predetermined to be below that at which the scale-forming compounds present in the water of the specific salinity treated will deposit as a hard adherent scale during the period the water is present in said stage. Next, the altered hot water thus obtained is flowed under the pressure through the tube or tubes of the second stage of the heat exchanger and therein heated to a higher temperature but below that predetermined to cause the calcium sulfate present to precipitate out in such stage during the period the water is present in said stage, by applying heat to the water from the heat exchanger surfaces maintained at temperatures predetermined to be below those at which calcium sulfate present in the altered hot water being heated will form a scale at a prohibitive rate during the period the water is present in said stage. Finally, the heated water is flowed from the said second stage before calcium sulfate precipitation has occurred. To maintain acceptable heat transfer rates, the soft layer deposited is periodically removed by forcing a fluid at high velocity through the tube.

The invention may be utilized for heating any natural salt water, marsh water, bay water, tidal water and other like natural waters containing a salinity (total solids content) of at least about two hundred grains per gallon (G. P. G.), and it is particularly applicable to the treatment of brackish waters or sea water of intermediate salinity, as those having a total salinity of from about 600 to 1700 G. P. G. All of such waters invariably contain in addition to the sodium chloride various scale-forming salts principally calcium sulfate, magnesium salts, calcium carbonate, and minor amounts of other compounds.

These salts can be removed or altered by known procedures for example ion exchange and distillation such that the water containing the same can be heated to high temperatures without causing scale formation, but such processes are too expensive for use in providing large quantities of hot water required for a number of industrial purposes.

The heating of the salt water in accordance with the process of the present invention is accomplished by the following series of steps and controls.

The salt water is first pumped into the tubes of a two stage heat exchanger under superatmospheric pressure of a magnitude sufficient to provide a pressure at the exchanger outlet greater than the vapor pressure of the water and preferably also above that of the dissolved gases. The initial pressure applied varies with the ultimate temperature, the particular construction of the exchanger and other minor factors. Pressures of 250–350 p. s. i. are suggested minimums, for contemplated embodiments.

The ultimate temperature to which the water is heated may depend upon the use to which the heated water is to be put, but the maximum temperature possible is determined to a large extent by the salinity of the water being heated and the success of the first step in removing scale-forming compounds. The greater the salinity, the lower the maximum temperature possible. Heating to excessive ultimate temperatures leads to unavoidable precipitation and deposition of hard calcium sulfate scale. By limiting the ultimate temperature to a level below that at which the precipitation takes place from the hot water from which some of the scale-forming compounds have been removed, such scale deposition can be substantially avoided.

The ultimate possible maximum temperature to which a salt water of any specific salinity can be successfully heated is influenced to some extent by the particular heat exchanger construction or system employed, the velocity of the water travelling through the tubes and the skin temperature of the heating surfaces. In actual operations, if salt water is desired at the maximum possible temperature, such temperature must be determined by trial and error in the specific exchanger to be used. As a general guide to possible maximum temperatures at various salinities the following table is given by way of example: