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HEATING OF SALINE WATER AND MINING OF SULFUR THEREWITH

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

The invention is also concerned with the mining of sulfur involving the utilization of super-heated sea and other saline waters for such mining operations.

If sea water is heated to 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 requires that the equipment be taken out of use, opened up and scraped or turbined to remove the scale.

An 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 scale 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 unavoidably separate out during the heating of salt waters of intermediate salinity to deposit for the most part in the form of a soft, non-adherent layer removable from the tubes simply by flashing or by flushing with steam or other fluid for a few minutes.

In the process of mining sulfur by the Frasch or underground fusion method, a hole is drilled into the sulfur bearing formation and the well equipped with a system of concentric pipes within a well casing. Super-heated water is pumped into the well and discharged into the formations through perforations in the outer pipe. The melted sulfur enters one of the inner pipes and is raised to the surface by a suitable means such as an air-lift. The mine water required for melting the sulfur is relatively large in volume in proportion to the sulfur removed, and is super-heated to a temperature generally in the range of 300–345° F. and forced into the formation under pressure.

The conventional sulfur mining plant requires a substantial supply of fresh water and considerable difficulties are experienced when the water available contains in excess of 50 grains per gallon of sodium chloride. By the conventional Frasch system of mining sulfur, at least 30 per cent of the water consumed is converted to steam and used in this form. This fact requires that at least 30 per cent of the water consumed be of acceptable quality for boiler-feed purposes. In a conventional plant, fresh water, taken from local streams during periods of fresh runoff and impounded in storage reservoirs, or well water is treated in efficient systems, usually of the hot process type, to minimize the scale deposition encountered when the water is heated. Because of the large volumes of water handled, accurate control of the treatment processes is required to minimize the restriction of water flow by scale deposition and also to minimize the down-time of equipment dismantled for cleaning.

Another requirement of the water heating process is that corrosion to heaters, pumps, pipe lines and other equipment be minimized and this is normally accomplished by reducing the hydrogen-ion concentration of the water used in the treating processes. Scale depositions, held to a minimum, offer some corrosion protection to the equipment. The heaters are normally vented to remove dissolved gases which contribute to corrosion. A substantial portion of the water consumed is treated to an acceptable quality for boiler feed purposes and is converted to steam. A major portion of the steam is used to heat the mine water to sulphur mining temperatures by direct contact. The water entering the sulphur bearing formations, therefore, consists of about 25 per cent steam condensed in the heaters. In addition, steam is utilized for production of electric power, compressed air and other processing needs.

The mine water is usually treated by a hot process lime system which reduces the temporary or carbonate hardness to a low value, but by virtue of the availability of fresh water, the non-carbonate or permanent hardness present is relatively low and need not necessarily be removed from the mine water. Water containing larger amounts of total solids, or water containing more than 200 grains per gallon of chlorides expressed as sodium chloride cannot be used as such following prior practices.

A principal object of the present invention is to provide processes for mining sulfur which successfully utilize sea and other saline waters containing total solids in amounts which prohibit the heating of the water to sulfur mining temperature levels in conventional equipment by reason of scale formations.

Another object of the invention is to provide a means of mining sulfur by processes requiring large volumes of superheated water from certain salt domes located in the Gulf Coastal marsh region and tidal areas where fresh water is not available. The existence of sulphur in commercial quantities in a number of these salt domes has been known for years, but the unavailability of fresh water and the distance through which fresh water would have to be transported has prevented the mining of these domes.

As is well known, sea water contains large amounts of calcium and magnesium salts which deposit from solution when the water is heated. The water in the bays near the salt domes in question appear to vary between 100 and 2000 grains per gallon of chlorides expressed as sodium chloride. The scale forming constituents are present in marsh and sea water in almost direct ratio to the chloride content.

Because of the very large quantities of scale forming constituents present in sea water or in marsh water of intermediate salinities, a chemical treatment for the complete softening of the water would be impractical. Because of the necessity of transporting fresh water for boiler feedwater make-up or of resorting to expensive processes for the production of satisfactory boiler feedwater from the salty water, such as distillation or complete chemical treatment, the instant invention utilizes a heating system of the indirect type providing for the return of the steam condensate to the boiler make-up system.

The hydrogen-ion concentration of the sea or marsh water cannot be decreased substantially without the deposition of calcium and manganesium salts and their deposition would be further accelerated in the heating process to an impractical extent. The prevention of corrosion in a sea or marsh water heating system is therefore a very serious problem, since the desired protection must be secured without benefit of a decrease in hydrogen-ion concentration.

In view of the difficulties referred to briefly above, the mining of sulphur from these salt domes in marsh areas