United States Patent Office 3,173,874
Patented Mar. 16, 1965

3,173,874
PROCESS FOR REMOVAL OF VANADIUM DEPOSITS

Richard B. H. Sewell and James R. Brown, Victoria, British Columbia, Canada, assignors to Her Majesty the Queen in the right of Canada as represented by the Minister of National Defence, Ottawa, Ontario, Canada

No Drawing. Filed Oct. 9, 1961, Ser. No. 143,590
1 Claim. (Cl. 252—95)

This invention relates to a process for the removal, or the assistance in removal of solid vanadium compound deposits from surfaces. More particularly, it is directed to the removal, or assistance in removal, of combustion product deposits from the heat transfer surfaces of steam- or hot water-producing boilers.

It is well known that solid deposits are found on the heat transfer surfaces of steam- and hot water-producing boilers. Such solid deposits are of such a tough and refractory character that their removal is extremely difficult. It has been found that these deposits, which are products of the combustion process carried out in the boiler installations, are particularly resistant to removal when fuels having a high vanadium content, are used in the boiler installations.

The deposits on the heat transfer surfaces, e.g., superheater tubes, are deleterious for they involve a heavy loss in heat transfer efficiency, and contribute to tube failures.

In the past, such deposits have been removed by dismantling the superheaters having the heat transfer surfaces and containing such deposits, and mechanically cleaning them. Not only is such method only partially successful, but also it is fairly time-consuming and consequently expensive.

Accordingly, it is the primary object of the present invention to provide a convenient process for the removal of such deposits from surfaces.

This, and other objects of the present invention which are evident from the following description, are achieved in a composition for removing vanadium-containing deposits from surfaces which comprises a dilute solution of a peroxide or precursor thereof and a surface tension reducing amount of a peroxide compatible wetting agent. The present invention also provides a process for removing vanadium-containing deposits from surfaces, which process comprises alternately spraying said surfaces with a dilute solution comprising a peroxide or a precursor thereof and a surface tension reducing amount of a peroxide compatible wetting agent, and contacting said surfaces with a high velocity jet of water.

The present invention is more particularly applied to heat transfer surfaces of steam- or hot water-producing boilers on which there is deposited solid vanadium-containing material as a result of combustion of vanadium-rich fuels in the associated boiler installations. However, it is applicable to the removal of solid vanadium compound deposits from any surface, providing the vanadium or the majority of it is in the same valence state as it is in vanadium pentoxide (V_2O_5).

The solution used in the present invention contains a peroxide or a peroxide precursor. The most convenient peroxide is hydrogen peroxide, although other peroxides such as Na_2O_2, BaO_2, K_2O_2 or SrO_2 may be used.

The rate of reaction of the peroxide with the vanadium-containing deposits is a direct function of the concentration of the peroxide. While, theoretically, any concentration of peroxide is useful, practical considerations impose optimum concentrations. Taking, for example, hydrogen peroxide, a concentration of about 2% by weight results in such a slow reaction rate as to be impractical. A concentration in excess of about 20% by weight involves hazards in the safety of the user of the solution. Accordingly, balancing reaction rate against safety of operation, an optimum concentration of hydrogen peroxide is within the range of about 2 to about 20% by weight. An especially practical concentration is 10% by weight.

The solvent for the peroxide is usually water, because of its availability, convenience of use and relative cheapness. The water should preferably be deionized, since the stability of the peroxide solution is enhanced by such purified water. In fact, it is sometimes preferred to add an agent for stabilizing peroxide solutions to the composition of the present invention. Examples of such stabilizing agents include sodium stannate, phosphoric acid, uric acid and phenacetin.

While any pH of the solution will permit operativeness of the present invention, it is preferred that the solution be slightly acidic. It is appreciated that peroxide solutions are slightly less stable in basic than in acidic solutions.

An important ingredient in the composition of the present invention is a wetting agent. This has been found to be desirable in order to reduce surface tension and hence to aid the penetration of the deposits by the solution of the present invention. Any wetting agent which is compatible with the peroxide, i.e., any wetting agent which has heretofore been used in bleaching processes, may be used in the present invention. Examples include the sulfated fatty alcohols, the sulfated esters of amides of oleic and ricinoleic acids, the fatty alkyl ester sulfonate, the aliphatic sulfates, the aliphatic sulfonates and the alkyl aryl sulfonates. Specific examples include Kreelon (a synthetic organic detergent of the sodium alkylarylsulfonate type manufactured by Wyandotte Chemicals Corp., Wyandotte, Michigan, U.S.A.) and Triton X–100 (the registered trademark of an alkyl aryl polyether alcohol, manufactured by Rohm and Haas Co., Philadelphia, Pennsylvania, U.S.A.).

The amount of wetting agent used is sufficient to aid penetration but is suitably within the range of 0.1–0.2% by weight.

Before giving an example of the process of the present invention, it is desired to give a typical analysis of the deposits on a superheater which the process of the present invention is adapted to remove.

Constituents:	Percent
Vanadium (as vanadium pentoxide)	55–83
Sodium (as sodium oxide)	7–15
Sulfur (as sulfur trioxide)	6–14

The following example describes the process of the present invention applied to the removal of this type of vanadium containing deposit from a superheater on board a ship.

A diluted solution of hydrogen peroxide was prepared by adding, to an aluminum mixing tank, 25 gallons of 35% by weight hydrogen peroxide and 62.5 gallons of water. Because of the susceptibility of hydrogen peroxide to decomposition from the catalyzing action of heavy metal ions, the mixing tank should preferably be of high purity aluminum (99.5% by weight Al). However, stainless steel tanks may also be used because of the stability of the protective oxide layer. In addition, it is preferred to use deionized water as the diluting agent.

The 10% hydrogen peroxide solution is transported by means of a Koroseal (polyvinyl chloride) line to a holding tank in the boiler room where a wetting agent, Kreelon, was added. The diluted solution now contained 10% by weight H_2O_2 and 0.1% by weight Kreelon.

The dilute solution of the present invention was applied to the superheater surface through a fan spray nozzle at the end of a six-foot length of ¼ inch stain-

less steel tubing. In order to permit freer access by the peroxide solution, the deposits, which were loosened by the peroxide solution, were periodically jetted off with water. The superheater was alternately sprayed with peroxide solution and washed with a jet of water for a period of about 70 hours, with the time of spraying of the peroxide solution accounting for 24 hours. A short period of water jetting after the last peroxide solution spraying ended the cleaning operation.

Examination of the superheater surfaces after treatment indicated that there was an almost complete removal of deposits. A small percentage (approximately 2–3%) of deposit remained but this could readily be washed off.

It was also found that the chrome baffle walls usually forming part of the superheater structure were somewhat corroded following the treatment. Such attack on the chrome baffle wall may be minimized by the application of aluminum pigmented vinyl paint to such surfaces, which have been previously cleaned by brushing and air jetting.

We claim:

A process for removing vanadium-containing deposits from heat transfer surfaces of steam-producing boilers which comprises alternately spraying said surfaces with a composition consisting essentially of an aqueous solution of 10% by weight hydrogen peroxide and 0.1% by weight of an alkylarylsulfonate wetting agent and contacting said surfaces with a high velocity jet of water.

References Cited in the file of this patent

UNITED STATES PATENTS

2,371,545	Riggs et al.	Mar. 13, 1945
2,567,835	Alquist et al.	Sept. 11, 1951
2,882,237	Mahoney	Apr. 14, 1959