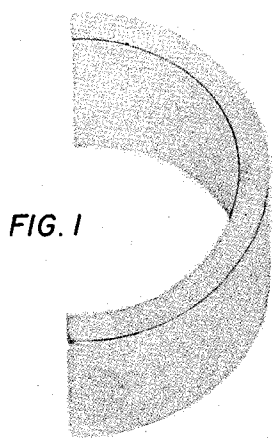


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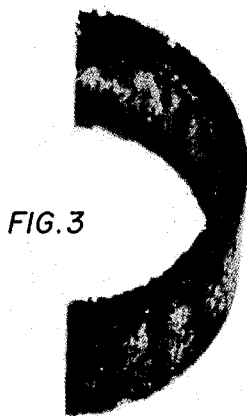
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DESCALANT COMPOSITION AND USE

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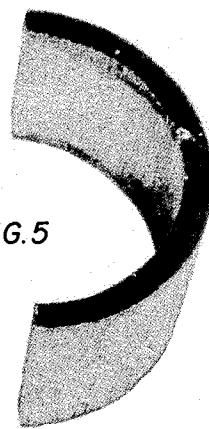
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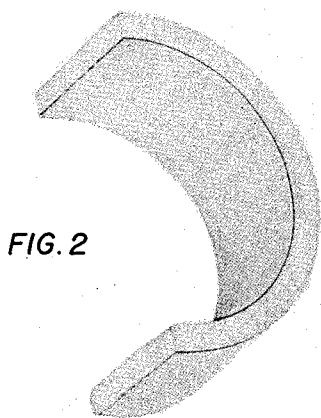
TUBE A



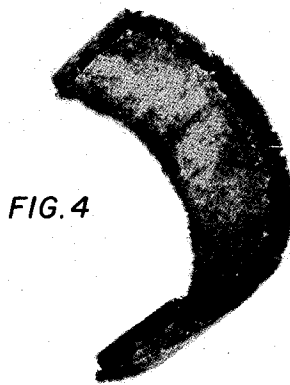
TUBE B



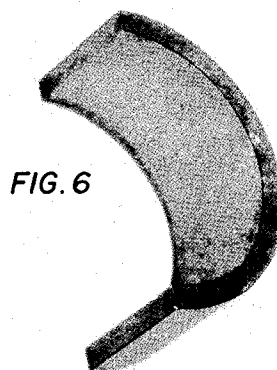
TUBE C



TUBE A



TUBE B



TUBE C

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DESCALANT COMPOSITION AND USE

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2 Claims. (Cl. 252—82)

The present invention relates to a descalant composition and to its use in removing scale deposits from metallic surfaces.

A problem that is common to the use of nearly all heat exchange equipment in conjunction with water is the development of hard, water-insoluble scales on the metallic heat exchange surfaces. The chemical and physical constitution of such scales varies widely, but in all cases the scale deposits seriously reduce the thermal efficiency of the heat exchangers. The problem is one of long standing in the art and to date no completely satisfactory solution has been found.

Theoretically, the complete use of ion-free water should eliminate or substantially reduce the problem, but such an ideal condition cannot be obtained on a practical basis. Thus, the solution to the problem depends largely upon developing inexpensive and efficient methods for removing such scale deposits from metallic surfaces. Physical methods of scale removal such as sand blasting are frequently prohibitively expensive, since in many cases they require disassembly of the heat exchange equipment. For this reason, chemical methods of descaling are widely used.

Throughout the years scores of descalant compositions have been proposed, but the art has generally come to recognize inhibited hydrochloric acid as being the most satisfactory material available on an overall performance basis. While the overall superiority of inhibited hydrochloric acid is conceded, it is equally well recognized that it has a number of serious shortcomings as a descalant. First, hydrochloric acid is a hazardous chemical that should be handled only by trained personnel. Secondly, although recognized as the best all around descalant, the performance of inhibited hydrochloric acid against a number of types of scales is not altogether satisfactory. Thirdly, most efficient inhibitors for hydrochloric acid do not perform satisfactorily above approximately 170° C. and careful temperature control must be maintained during descaling operations. Yet another limitation is that, because of its extremely corrosive nature, special techniques must be employed to prevent corrosion of the metallic surfaces treated, particularly after the main body of the inhibited hydrochloric acid solution has been discharged from the heat exchanger. In commercial practice, after the discharge of the acid, it is customary to maintain the treated surface under a nitrogen atmosphere until it is washed with an alkaline salt such as trisodium phosphate.

It is an object of this invention to provide a descalant composition which has an improved descaling action and which is at the same time less corrosive than the compositions in use.

A further object of this invention is to provide an improved descalant composition that is a dry solid material.

Yet another object of this invention is to provide an improved process for descaling metallic surfaces which does not require close temperature control.

Other objects and advantages of this invention will be

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apparent from the following detailed discussion thereof when read in conjunction with the attached drawing wherein Figures 1 and 2 show different views of tube A which is a segment of a new, steel boiler tube, Figures 3 and 4 show different views of tube B which is a segment of the same steel boiler tube after it has been treated with inhibited hydrochloric acid, and Figures 5 and 6 show different views of tube C which is a segment of the same steel boiler tube after it has been treated with a composition according to the invention hereof.

A new descalant composition and a method of descaling metallic surfaces therewith have been discovered.

The composition consists essentially of 60% by weight of sodium xylene sulfonate, 30% by weight of sodium acid sulfate, 6% by weight of tartaric acid and 4% by weight of a nonionic wetting agent consisting of a co-generic mixture of conjugated polyoxypropylene-polyoxyethylene compounds containing in their structure oxypropylene groups, oxyethylene groups and an organic radical derived from an organic compound containing a plurality of reactive hydrogen atoms, the compounds being characterized in that all of the oxypropylene groups are present in polyoxypropylene chains that are attached to the organic radical at the site of a reactive hydrogen atom to thereby constitute a polyoxypropylene polymer, the oxyethylene groups are attached to the polyoxypropylene polymer in polyoxyethylene chains, the average molecular weight of the polyoxypropylene polymers in the mixture is at least 900 as determined by hydroxyl number, and the oxyethylene groups present constitute 20-90% by weight of the mixture.

The composition is used by mixing the same with water and applying the resulting solution to the metallic surfaces to be descaled. Preferably about twenty weight percent aqueous solutions of the compositions are used.

The composition of the present invention has a number of marked advantages and superiorities over inhibited hydrochloric acid and other descalant compositions in use. The first and perhaps foremost advantage is that in aqueous solution it will remove marine boiler scale more rapidly and efficiently than the descalant compositions available to the art. Of nearly equal importance is the fact that aqueous solutions of the composition of this invention are relatively non-corrosive towards the mild steel that is widely used in the manufacture of boiler tubes. For this reason descaling operations can be performed at temperatures at least up to the boiling point of water. This is of particular advantage where it is desired to descale boilers in situ, since the descaling temperature can be easily maintained and controlled by simply circulating atmospheric pressure steam through the boiler. A further advantage of the present invention is that after the descalant solution is discharged no special after-treatments are required to neutralize the residual solution to prevent corrosion of the metallic surfaces. The fact that temperature control is not critical and that the descaling solution is non-corrosive makes possible a simplified descaling process that does not require specially trained personnel in its operation. This is of particular advantage in marine installations where a ship's captain may have his regular engine crew descale the boilers on the high seas if necessary rather than to wait until the ship puts into port and have the descaling carried out by special descaling contractors.

The following examples are set forth to more clearly illustrate the principle and practice of this invention to those skilled in the art.

EXAMPLE 1

A composition was prepared which consisted of 60.5% by weight of sodium xylene sulfonate, 30.0% by weight

of sodium acid sulfate, 6.0% by weight of tartaric acid and 3.5% by weight of a nonionic wetting agent consisting of a cogeneric mixture of conjugated polyoxypropylene-polyoxyethylene compounds containing in their structure oxypropylene groups, oxyethylene groups and an organic radical derived from an organic compound containing a plurality of reactive hydrogen atoms, the compounds being characterized in that all of the oxypropylene groups are present in polyoxypropylene chains that are attached to the organic radical at the site of a reactive hydrogen atom to thereby constitute a polyoxypropylene polymer, the oxyethylene groups are attached to the polyoxypropylene polymer in polyoxyethylene chains, the average molecular weight of the polyoxypropylene polymers in the mixture is at least 900 as determined by hydroxyl number, and the oxyethylene groups present constitute 20-90% by weight of the mixture.

A 20% by weight aqueous solution of the foregoing composition was made and placed in an 8-ounce French Square bottle to within one inch of the lip thereof. An approximately 1 square inch, dry-sawn segment of a mild steel, boiler tube taken from a marine boiler, which tube had a relatively heavy scale deposit thereon, was placed in the bottle and soaked in the solution for 4 hours at 170° F. At the end of this time the segment was removed and rinsed with deionized water.

It was observed that all of the scale had been removed from the segment.

As earlier noted, an outstanding feature of the composition of the present invention is that aqueous solutions thereof are appreciably less corrosive to steel than inhibited hydrochloric acid which is currently the most widely used descalant. This effect is illustrated quantitatively in Example 2.

EXAMPLE 2

Part A

Two segments of new mild steel marine boiler tubes were sand blasted to present roughened clean surfaces. These segments were subjected to an accelerated corrosion test at 170° F. by soaking the segments for 4 hour cycles in (1) a 16.5% solution of the composition of Example 1 and (2) a 10% solution of inhibited hydrochloric acid. At the end of each cycle the samples were rinsed in deionized water, dried and weighed. The cumulative weight losses of the samples, expressed as pounds per square foot of surface per hour, at the end of each of 12 descaling cycles are set forth in Table I.

TABLE I

Descaling Cycles	Cumulative Wt. Loss lbs./ft. ² /hr. inhibited hydrochloric acid control ¹	Cumulative Wt. loss lbs./ft. ² /hr., Composition (Ex. 1)
0	0	0
1	9.6×10 ⁻³	10.2×10 ⁻³
2	13.9×10 ⁻³	11.8×10 ⁻³
3	22.3×10 ⁻³	18.8×10 ⁻³
4	31.8×10 ⁻³	28.0×10 ⁻³
5	43.5×10 ⁻³	38.7×10 ⁻³
6	54.7×10 ⁻³	48.2×10 ⁻³
7	72.8×10 ⁻³	57.9×10 ⁻³
8	87.9×10 ⁻³	67.5×10 ⁻³
9	100×10 ⁻³	79.5×10 ⁻³
10	120×10 ⁻³	88.8×10 ⁻³
11	132×10 ⁻³	95.2×10 ⁻³
12	143×10 ⁻³	100×10 ⁻³

¹ 10% solution, inhibitor conforming to Navy specification MIL-1-17433 (ships).

In the attached drawing tube A is a segment of the boiler tube as it appeared before the test, tube B is the tube that was subjected to 12 descaling cycles in the inhibited hydrochloric acid and tube C is the tube that was subjected to 12 descaling cycles in the solution of the Example 1 position. The superiority of the compositions

of the present invention with regard to lack of corrosion properties is obvious.

Part B

The mild corrosive action of the aqueous solution of the Example 1 composition indicated in Table I above can be reduced substantially by adding sufficient NaOH to the solution to increase the pH to 2.0. The quantitative data illustrating this effect (to be compared with the data of Table I) are set forth in Table II.

TABLE II

Descaling Cycles	Cumulative Wt. Loss lbs./ft. ² /hr. pH adjusted to 2.0
0	0
1	3.7×10 ⁻³
2	5.4×10 ⁻³
3	6.8×10 ⁻³
4	9.1×10 ⁻³
5	10.7×10 ⁻³
6	13.1×10 ⁻³
7	15.2×10 ⁻³
8	17.2×10 ⁻³
9	20.6×10 ⁻³
10	24.6×10 ⁻³
11	27.4×10 ⁻³
12	29.3×10 ⁻³

Increasing the pH of the aqueous solution of Example 1 to 2 has little or no deleterious effect on its descaling activity.

EXAMPLE 3

Part A

Mild steel boiler tubes can be descaled in aqueous solutions of the composition of the present invention at temperatures up to 212° F. To measure this effect quantitatively, clean, sand blasted samples of boiler tube were placed in 16.5% by weight solutions of the Example 1 composition heated to 212° F. and then allowed to cool to room temperature. The total test cycle required four hours. The weight loss per descaling cycle was recorded and is set forth in Table III.

TABLE III

Descaling Cycles	Cumulative Wt. Loss lbs./ft. ² /hr. Composition of Example 1
0	0
1	5.4×10 ⁻³
2	6.8×10 ⁻³
3	11.9×10 ⁻³
4	18.6×10 ⁻³
5	22.0×10 ⁻³
6	25.6×10 ⁻³
7	29.4×10 ⁻³

In comparing the data of Table III with Table I it will be noted that at the end of seven cycles the weight loss in the present example was less than in Example 2, Part A, which was run at 170° F.

Part B

One inch square segments of boiler tube were completely descaled when subjected to one descaling cycle as described in Part A above.

Part C

Part B was repeated except the boiler tube chips were heated to 253° F. and maintained at this temperature for four hours. All of the scale was removed and there was no evidence of corrosion on the metal.

In addition to the four essential components of the descalant composition, other components may sometimes optionally be included within the formulation. Although it has been noted herein that the present descalant is in aqueous solution materially less corrosive than inhibited hydrochloric acid, the corrosion effect of the descalant composition can be reduced further by the use of

well-known corrosion inhibitors such as mercaptobenzothiazole. The inclusion of such corrosion inhibitors in the formulation sometimes has a beneficial effect upon the descaling action of the composition, particularly where the scale to be removed contains appreciable quantities of iron salts.

What is claimed is:

1. A descalant composition consisting essentially of (1) 60% by weight of sodium xylene sulfonate, (2) 30% by weight of sodium acid sulfate, (3) 6% by weight of tartaric acid and (4) 4% by weight of a cogeneric mixture of conjugated polyoxypropylene-polyoxyethylene compounds containing in their structure oxypropylene groups, oxyethylene groups and an organic radical derived from an organic compound containing a plurality of reactive hydrogen atoms, the compounds being characterized in that all of the oxypropylene groups are present in polyoxypropylene chains that are attached to the organic radical at the site of a reactive hydrogen atom to thereby constitute a polyoxypropylene polymer, the oxyethylene groups are attached to the polyoxypropylene polymer in polyoxyethylene chains, the average molecular weight of the polyoxypropylene polymers in the mixture is at least 900 as determined by hydroxyl number, and the oxyethylene groups present constitute 20-90% by weight of the mixture.

2. The method of removing water deposited-inorganic scales from metallic surfaces in high pressure marine

boiler tubes, which comprises contacting the scaled metallic surface with an aqueous solution of the composition of claim 1.

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