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PICKLING SOLVENT

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This invention relates to the solvent cleaning of metal articles to remove oxide scale, and is particularly directed to an improved "pickling" solvent having properties adapted for preferential removing of oxide scale or rust from iron or steel surfaces without substantial injury to the underlying metal.

Pickling solvents such as dilute sulfuric acid have long been used for loosening and removing rust or oxide scales from metal surfaces. One of the chief disadvantages of such acid treatment of metal surfaces for rust removal is that the metal itself is attacked and dissolved, sometimes in much greater proportions by weight than the oxide scale. Whenever the metal is attacked by the acid, hydrogen is liberated which in turn develops an acid fog and a corrosive atmosphere in the neighborhood of the pickling operation. Various inhibitor chemicals have been used in pickling operations to reduce the attack of the acid on the clean metal. The presence of inhibitors in the pickling solution has some retarding effect on the solvent action of the acid or the oxide scales, thus limiting the amount of inhibitor which can be employed without unduly prolonging the time required for completing the pickling operation.

A primary object of the present invention is to provide a metal pickling solvent which is adapted for rapid preferential loosening and removal of rust and oxide scale from metal objects without substantial corrosive attack on the metal itself. Another object of the invention is to provide a metal pickling solvent which is safe to use and which does not develop substantial liberation of hydrogen and acid fog during the pickling operation. Further objects are to provide a pickling solvent which is comparatively efficient and economical, and which is water soluble so that it can be made up in dilute aqueous solutions, and readily removed from metal surfaces by simple water-washing as the last step in a metal cleaning operation.

The metal pickling solvent which forms the subject of the present invention comprises a dilute aqueous solution of orthophosphoric acid, an alkali metal bisulfate, and an alkali metal acid phosphate. The preferred pickling solvent also contains a small amount of a mineral oil sulfonate wetting agent, the primary function of which is to improve the wetting and scale loosening properties of the solvent.

The orthophosphoric acid component of the pickling solvent acts in dilute aqueous solution as a preferential solvent for ferrous metal oxide scales and rust in the presence of the underlying metal. In this respect the orthophosphoric acid acts differently than sulfuric acid or other strong acids, which strong acids, even in dilute aqueous solutions, attack the clean metal. The solvent efficiency of the dilute orthophosphoric acid component of the present pickling solvent for metal oxide scales or rust is greatly increased by incorporating in the solvent a substantial proportion of an alkali metal acid sulfate such as potassium bisulfate. Any tendency of such acid sulfate component of the solvent to reduce the preferential solvent action of the solvent for rust in the presence of free metal, is counterbalanced by incorporating in the solvent an alkali metal acid phosphate such as primary sodium phosphate in amounts sufficient to inhibit any tendency of the acid sulfate component to attack free metal. The mineral oil sulfonate component of the preferred reagent has some corrosion inhibiting properties, but is used primarily as a surface tension-lowering reagent to increase the wetting properties of the solvent.

The preferred method of using the pickling solvent for cleaning the surface of a metal part to remove a coating of rust or oxide scale, is to immerse the metal part in a bath of the solvent at a moderate temperature in the range between 70° F. and approximately 120° F. Within a short treating period of approximately fifteen minutes, the preferred reagent effectively loosens and removes heavy deposits of rust from iron and steel surfaces. The wetting properties of the preferred solvent are such that it readily penetrates and loosens oxide scales without substantial corrosive action on the underlying metal. After the pickling solvent has loosened and removed the oxide scale, the metal article may be removed from the bath and rinsed with water to completely remove the solvent remaining on the surface of the cleaned metal; such water wash being effective because the solvent is readily soluble in water and is therefore removed by a water wash. In cases where the metal cleaning operation is not to be shortly followed by application of paint or other protective material to the cleaned surface, it has been found that substantial protection is afforded by allowing a film of the solvent to remain on the surface after removal from the bath. In this case, the water washing step is replaced by a step in which excess solvent is wiped off of the surface after it is removed from the bath. Instead of the bath treatment, it may be more convenient in some cases to apply the pickling solvent to the metal surface by spraying or brush-

ing, allowing the thus applied solvent to remain on the metal surface for a few minutes before removing it by wiping or rinsing.

The preferred pickling solvent of the present invention is a clear aqueous solution which may be prepared substantially as follows:

A paddle mixer is charged with about 95 parts by weight of water or from 80 to 100 parts by weight of water, about 7–10 parts by weight of 85% orthophosphoric acid, about 3 to 5 parts by weight of potassium or sodium bisulfate, about 5 to 7 parts by weight of acid sodium phosphate, and about 0.1–.5 part by weight of a mineral oil sulfonate of the type produced by neutralizing with an alkaline reagent the acid reaction product produced by treating a petroleum fraction with concentrated sulfuric acid in the manner employed in the production of petroleum white oils. The orthophosphoric acid is preferably first admixed with the water, after which the other components of the reagent are added gradually with constant stirring until a clear solution is obtained. This mixing operation should be carried out at a low temperature not substantially above atmospheric.

The proportions of the various components in the preferred reagent may be modified to some extent without seriously interfering with the effectiveness of the solvent. However, the specific solvent composition found most practical comprises about 95 parts by weight of water, about 8 parts by weight of orthophosphoric acid, about 4 parts potassium bisulfate, about 6 parts acid sodium phosphate, and between 0.1 and 0.2 part mineral oil sulfonate solution of 1.15 gravity. The relative proportions of phosphoric acid and acid sulfate components should not be substantially varied without a corresponding variation in the proportion of acid phosphate inhibitor.

The "pickling" solvent herein described is not only an effective reagent for rapidly loosening and dissolving rust and oxide coatings preferentially without substantial corrosive attack on the metal surfaces underlying such coatings, but also possesses the property of conditioning or protecting the clean metal to prevent further formation of rust.

The invention having been thus described, what is claimed as new is:

1. A composition for removing rust and oxide scale from metal objects, comprising a dilute aqueous solution formed by mixing from seven to ten parts by weight of concentrated orthophosphoric acid, from three to five parts by weight of an alkali metal bisulfate, from five to seven parts by weight of an alkali metal acid phosphate, from 0.1 to 0.5 part by weight of a mineral oil sulfonate, and from eighty to one hundred parts by weight of water.

2. In a process for loosening and removing rust and oxide scale from metal objects, the steps comprising immersing the metal objects, to be cleaned for a few minutes in a pickling solvent bath made by mixing together from eighty to one hundred parts by weight of water, from seven to ten parts by weight of orthophosphoric acid, from three to five parts by weight of an alkali metal bisulfate, from five to seven parts by weight of an alkali metal acid phosphate, the bath being at a temperature not substantially exceeding 120° F., and thereafter removing the cleaned metal object from the bath and rinsing it with water.

3. A composition for removing rust and oxide scale from metal objects, comprising a dilute aqueous solution formed by mixing from seven parts to ten parts by weight of concentrated orthophosphoric acid, from three to five parts by weight of an alkali metal bisulfate, from five to seven parts by weight of an alkali metal acid phosphate, and from eighty to one hundred parts by weight of water.

4. A composition for removing rust and oxide scale from metal objects, comprising a dilute aqueous solution formed by mixing about 95 parts by weight of water, about 8 parts by weight of orthophosphoric acid, about 4 parts by weight of potassium bisulfate, and about 6 parts by weight of acid sodium phosphate.

5. In a process for loosening and removing rust and oxide scale from metal objects, the steps comprising applying to the metal parts to be cleaned a pickling solvent made by mixing together from 80 to 100 parts by weight of water, from 7 to 10 parts by weight of orthophosphoric acid, from 3 to 5 parts by weight of an alkali metal bisulfate, and from 5 to 7 parts by weight of an alkali metal acid phosphate, permitting the pickling solvent to act on the rust and scale on the metal objects being cleaned and thereafter rinsing the pickling solvent from the metal objects.

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