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INVENTION REPORT - A CHEMICAL COMPOSITION AND PROCESS FOR REMOVING
OXIDE AND SCALE FROM ALUMINUM METALS AND ALUMINUM ALLOYS.

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R. B. Richman and A. P. Larrick

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OXIDE AND SCALE FROM ALUMINUM METALS AND ALUMINUM ALLOYS.

R. B. Richman and A. P. Larrick

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INVENTION REPORTA CHEMICAL COMPOSITION AND PROCESS FOR REMOVING
OXIDE AND SCALE FROM ALUMINUM METAL AND ALUMINUM ALLOYSINTRODUCTION

This report describes a chemical composition and process for removing oxide, film, and/or scale layers from aluminum metal and its alloys.

Most metals, during refining and fabrication, and during actual use, become coated on their surfaces with layers of metal compounds as a result of chemical reaction with materials in the surrounding environment. Metal oxides and nitrides, for example, may form in air; and metal oxides, hydroxides, or hydrides readily form in water environments. Other compounds of the metals form in other environments, or from additives or impurities in the water or air.

In addition to compounds formed by the metals themselves, layers of other material often deposit on the metal surfaces. Materials found in these layers include lubricating compounds, chemical deposits from prior treatments (e.g. oil quenching, painting, decontaminating, etc.), corrosion products from portions of the same or other metal in other parts of the same environmental system, and suspended materials removed from the environment.

Simultaneous deposition of the other materials during formation of the metal compounds frequently occurs during production and/or use of a metal. This formation and deposition is undesirable, because it may change the appearance of the metal surface and may adversely affect the way in which this surface responds to later treatment or use. These layers on the metal surface also affect subsequent measurements of physical or chemical properties of the metal (e.g. electrical or thermal conductivity, corrosion rates, etc).

Removal of these surface layers is sometimes accomplished by mechanical means (such as brushing, sandblasting, etc), or by chemical dissolution. However, both methods frequently result in removal of some of the base metal in addition to that metal which is chemically combined in the surface compounds. A cleaning method which would remove a minimum of base metal would improve the economy of metal processing, and would also improve the accuracy of measurements (such as corrosion rates) which are based upon metal thickness.

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Surface layers of oxide and scale formed at moderate temperatures are often easier to remove than layers formed at high temperatures. Surface layers formed during processing or use at moderate temperatures may be thinner than high-temperature formed layers, and may also be less adherent to the base metal. Many cleaning methods which are effective in removing the lower-temperature formed oxides and scale without excessive removal of base metal are not effective in removing the layers formed at high temperatures. Some methods may be made more effective by modification (such as increasing concentration, or cleaning temperature), but these modified methods often remove excessive amounts of the base metal.

DESCRIPTION

A chemical composition and process have been developed for removing oxide, film, and/or scale layers from aluminum metal and its alloys. This composition and process removes a negligible amount of the base metal during cleaning.

This method involves a composition of:

3% to 25% OrthoPhosphoric Acid (H_3PO_4)
0.5% to 30% Sodium Dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$)
0.5% to 50% Acetic Acid (CH_3COOH)
Remainder Water (H_2O)

The process involves heating of the metal in air to a temperature of 300 to 500°C, quenching in air or in water, and then immersion in the chemical solution at a temperature of 20 to 95°C until clean.

Heating of the metal with subsequent quenching helps to remove the oxide and scale layers by: (1) rapid change of physical dimensions with temperature change ("thermal shock"), and (2) partial or total change of the oxide and film structure (due to recrystallization, dehydration, and/or rehydration).

An example of the use of this composition and process is the removal of corrosion products from aluminum alloys after use in high temperature aqueous systems. A solution containing 10% H_3PO_4 , 20% $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$, 1% CH_3COOH , with the remainder water has been used to clean corrosion samples. The samples are heated to 500°C, quenched in water at near boiling temperature, and then immersed in the solution

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at a temperature of 75°C. The samples are completely clean after 15 to 75 minutes immersion.

CLAIMS

This composition and process is effective in removing oxide and scale layers which have been formed at high temperatures. Many such high-temperature layers are resistant to most cleaning compositions and processes.

This composition and process does not remove significant quantities of the base metal.

This composition and process does not significantly alter the crystal size, crystal structure, or crystal orientation of aluminum metal and its alloys.

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Coolant Systems Development Operation
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