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3,306,740

HIGH-TEMPERATURE CORROSION- RESISTANT ALLOYS

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1 Claim. (Cl. 75—176)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to an improved nickel-chromium base alloy having high resistance to corrosion at elevated temperatures in the presence of combustion products from fuels. More particularly the invention relates to alloys of the nickel-chromium base type having selected alloying elements added to improve their resistance to corrosion when used in ships' boilers and where the alloy is subject to an environment containing compounds of vanadium, sodium, chlorine and sulphur.

It has been found that many alloys are attacked by such compounds as vanadium pentoxide to produce a relative low melting point mixture and thus cause the structure formed of the basic alloy to fail in a high temperature environment such as occurs in the fire-box of a ship's boiler.

In the making of the present invention it was decided to produce an alloy which forms a surface layer resistant to fuel oil ash while retaining sufficient ductility to permit the devices made from the alloy to be used without cracking or breaking.

It is an object of this invention to produce an alloy which is protected by a dense adherent coating which is non-slagging, self-healing and which serves as a diffusion barrier. In accomplishing this objective, one approach was to select alloying compounds from those which produce highly refractory oxide such as titanium and aluminum. Another approach was to select large-atom elements, such as the lanthanide metals i.e. misch-metal and yttrium.

In the preparation of these alloys it was found that for the most effective corrosion resistance the ingredients of the alloy must be of high purity and that they must be processed in a manner to maintain this degree of purity. Therefore, the basic ingredient, i.e. a binary alloy of 60% chromium, 40% nickel which ingredients are selected as commercially available high-purity electrolytic chromium and nickel. The additive elements were also selected as high-purity commercially available materials. By way of example, to avoid contamination in the processing, the ingredients were melted in magnesium crucibles and the melt was ladled in magnesium ladles. The melting was accomplished in an argon atmosphere and an argon at-

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mosphere was maintained during the pouring of the melt to the conventional baked-sand molds.

By test it was found that ternary alloys formed by adding to the 60/40 Cr/Ni alloy an alloying ingredient selected from the following table in a small but effective quantity from within the range indicated as percent by weight, produced improved resistance to corrosion from fuel oil-ash in oil fired ship-boilers.

TABLE I.—ADDITIVES TO 60/40 Cr/Ni BASE ALLOY

Periodic Table Group	Elements	Percent by Weight
II.....	Calcium.....	0.04.
15	Magnesium.....	0.1 to >0.5.
III.....	Yttrium.....	0.1 to >1.0.
	Rare Earths ¹	To 1.7.
IV.....	Titanium.....	To 4%.
V.....	Columbium.....	0.04.

¹ Lanthanides, Mischmetal.

The alloys produced from the additives listed in the foregoing table were specifically tested to determine their corrosion resistance to V₂O₅, NaVO₃ and NaSO₄ and showed markedly improved resistance to corrosion when compared with the binary 60/40 Cr/Ni alloy, which itself has been proven to be many times more resistant to the corrosive environment of an oil fired ship's fire box than conventional high temperature stainless steels.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claim the invention may be practiced otherwise than as specifically described.

What is claimed is:

A ternary alloy consisting essentially of about 60% Cr, about 40% Ni and an alloy element selected in an amount from the group consisting of:

Calcium ----- 0.04%.
Magnesium --- 0.1 to about 0.5%.
Yttrium ----- 0.1 to about 1.0%.
Rare earths --- A small but effective amount up to 1.7%.
Titanium ----- A small but effective amount up to 4%.
Columbium --- 0.04%.

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