CROSS REFERENCE EXAMINEI

United States Patent Office 3,197,341 Patented July 27, 1965

3,197,341

METHOD AND COMPOSITION FOR DESCALING STAINLESS STEELS AND RELATED ALLOYS

Wilfred J. Wallace, Chula Vista, Calif., assignor to Rohr Corporation, a corporation of California

No Drawing. Filed June 19, 1961, Ser. No. 117,780
4 Claims. (Cl. 134—28)

This invention relates generally to the descaling of stainless steels and related alloys and more particularly to a method and composition for chemically descaling heat and corrosion resistant alloys such, for example, as precipitation hardenable stainless steels without producing intergranular attack and etching of the materials treated.

Various chemical solutions have heretofore been used to remove scales from stainless steels and other related alloys. Prior to the removal of heavy scales and oxides, an altering of the condition of the scale is required, this being accomplished, for example, by immersion in hot reducing or oxidizing caustic baths, providing that prevailing heat treat conditions permit such action.

A well known prior art descaling method is the so called sodium-hydride, nitric-hydrofluoric acid process in which descaling after heat treating is accomplished by first immersing the materials to be descaled in a sodium hydride scale conditioning solution for about ten minutes followed by pickling for about two minutes or more in a scale removing solution containing 22% by volume nitric acid and 2% by volume hydrofluoric acid maintained at 130° F. to 150° F.

Other prior art descaling solutions frequently used, following scale conditioning treatment, are sulfuric acid operating at temperatures from 120° F. to 160° F., about 50% hydrochloric acid operating at room temperature, and hydrofluoric-ferric sulfate solutions operating in the neighborhood of 170° F. All of these prior art solutions and processes produce rough pitted surfaces, intergranular attack, loss of metal thickness, and other deleterious surface conditions, unless critical controls are observed and extraordinary precautions taken. Variations in heat concentration, or deviations from critical proportions of any of the constituent materials results in loss of control of their descaling properties and inevitable production of the deleterious surface conditions.

Ferrous alloys as as 17–7PH, PH15–7MO, and super alloys A-286 and AM350 in the annealed and certain heat treated conditions are severely etched, for example, in the nitric-hydrofluoric acid solution operated at 130° F. to 150° F. following scale alteration. The prior art acid descaling processes, moreover, etch the metal underneath the oxide layer, and the descaling operation and function is effected by and predicated upon the undercut scale then falling freely away from the basic materials being treated.

The components constituting the grain boundaries of the stainless steels and related alloys are comprised more or less of ferric carbide and the other constituent carbides of these materials. The prior art scale removing solutions such, for example, as the nitric-hydrofluoric solution dissolve and attack the metal and the carbides with vigor and this results in a very rough surface condition. Dissolving of the carbides causes the metallic grains to become loose and fall away. As the carbides become dissolved and the metallic grains become loose and fall away, primary and incipient notch effects are produced which induce fatigue failures and loss of other physical and mechanical properties. In general, a weakening of the metal results, and complete disintegration may occur.

In accordance with the descaling process of the present invention, oxides and scale on the surface of stainless steels and related super alloys are removed without producing intergranular attack and without undercutting the scale as in the prior art methods, there being little or no etching action involved in the scale removal operation. As in the prior art descaling processes, a suitable scale conditioning solution such as sodium hydride is employed to alter the condition of the scale prior to immersion in the descaling solution when heavy scales and oxides are encountered. In the case of slight oxides, the descaling solution of the present invention may be used with or without first altering the condition of the scale.

The descaling solution of the present invention, unlike those of the prior art, operates as a controlled oxidizing solution which produces a limited reaction only when the oxides or metal is introduced into the solution. This reaction is limited in accordance with the law of mass action which determines initially the amount of oxidizing material formed in the oxidizing solution from the basic constituents of the composition employed to make up the solution. When these controlled oxidizing materials are formed in the initial solution, they do not react with themselves until another material such as the alloy material or the oxides and scale thereon are added to the solution to upset its initial equilibrium or balance. Upon addition of the metal or oxides, or both, a reaction is initiated therewith by the descaling or oxidizing solution and active secondary or auxiliary materials are formed. As this reaction proceeds, less active material and water are formed and gaseous hydrogen is released until the solution again reaches equilibrium whereupon the reaction stops. In order to reactivate the solution or, as otherwise expressed, to keep the solution going, the oxidizing elements must be renewed and this is accomplished by replenishing that constituent of the basic composition which is the most active agent in the production of the oxidizing elements.

More specifically, the descaling solution of the present invention is an aqueous acid solution comprising minor proportions of nitric and sulphuric acids and ferric chloride in which the ferric chloride is in the predominant proportion with respect to the two acids. The acid constituents introduce hydrogen ion concentration and the necessary amount of controlled nitrate oxidizing agent. These basic components as constituents of the composition do not react with each other in the aqueous oxidizing solution nor would these materials separately react with the stainless steel alloy materials or their oxides or surface scale material.

Immersion of the alloy materials to be descaled into the oxidizing solution upsets the balance of the initial solution and initiates a first reaction which produces auxiliary oxidizing agents such as hydrochloric acid and nitrosyl and active oxidizing materials in the form of ferrous nitrates, ferrous chlorides, and ferrous sulfates as well as similar salts of other metals present in the alloys being treated together with the formation of water and release of hydrogen. The solution tends to seek a state of equilibrium, however and, accordingly, the active materials, in turn, form less active materials such, for example, as ferric chloride, ferric sulfate, and ferric nitrate to form more water and release further hydrogen. The equilibrium of the solution is then reestablished and further reaction stops. There is thus provided a controlled oxidizing solution in which the reaction with the scales and oxides is limited and controlled by the amount of nitric acid acting as an oxidizing agent and also as an inhibitor in the solution, and the removal of the oxides and scale only may thus be controlled thereby to present incipient etching of the alloy metals.

On the other hand, the extent of metal removal, as may be desired, may likewise be controlled in accordance with the proportions of nitric acid used in the oxidizing solution, the nitric acid being the most active agent for pro-

ducing the oxidizing elements. By increasing the hydrogen ion concentration with increases of sulfuric and nitric acids in controlled quantities, and by increasing the operating temperature of the solution, the reactive agents become aggressive to dissolve the alloyed metals, thereby to provide controlled etching of the stainless steels, the related alloys, and other metals.

An object of the present invention is to provide a new and improved method and composition for descaling stainless steels and related alloys.

Another object is to provide a descaling process and composition applicable to heat and corrosion resistant stainless steel alloys and having particular application to precipitation hardenable stainless steels.

Another object is to provide a descaling process and composition applicable to the 300, 400, 500 series stainless steels and super alloys in all conditions of heat treatment without producing deleterious surface conditions characteristics of prior art descaling processes and compositions.

Another object is to provide a process and composition for descaling stainless steels which retains all of the advantages of the prior art methods while obviating the deleterious surface conditions resulting from the use of such methods.

Still another object is to provide a new and improved method and composition for descaling stainless steels and related alloys without producing intergranular attack and without appreciably etching the materials such that little or no reduction in the thickness dimension results.

Another object is to provide a descaling process for removing scales and oxides from heat and corrosion resistant stainless steel alloys with or without first altering the condition of the scale depending upon whether the oxides and scale are heavy or light.

Still another object is to provide a new and improved composition which may be used in a process of descaling stainless steels with or without first altering the condition of the scale.

Yet another object is to provide a scale removing composition operable in an aqueous solution as a controlled oxidizing agent to produce limited reaction only with the oxides and metal in accordance with the law of mass action.

A further object is to provide an aqueous descaling solution which will not attack the components of the gain boundary of stainless steels.

Still another object is to provide a method and composition for descaling stainless steels which may be used to advantage with scale inhibiting compounds.

Still other objects, features, and advantages of the present invention will become more clearly apparent from the following detailed description wherein permissible ranges of the constituent composition ingredients are disclosed together with optimum proportions thereof as well as representative examples of descaling operations conducted on different stainless steels and super alloys under various heat-treat conditions and immersion times, metal loss data also being disclosed in order additionally to disclose the extent to which etching accompanies the descaling operations.

The descaling process of the present invention, hereafter referred to as the Sodium Hydride-RW77 process, is applicable to adequately descale the 300, 400, and 500 series stainless steels and also such super alloys as Hastelloy X and René 41, the process being particularly applicable to precipitate hardenable stainless steels such, for example, as 17–7PH which may be adequately descaled in all conditions of heat treatment without producing the deleterious conditions inherent in and evidenced from the use of prior art acid descaling proceses such, for example, as that employing the aforementioned nitric-hydrofluoric acid solution, hereinafter referred to as the Sodium Hydride, Nitric-Hydrofluoric acid process.

AISI 300 series stainless steels, for example, have been adequately descaled by the Sodium Hydride-RW77 process, and the loss in metal thickness from descaling operations has been shown to be approximately one-half of that resulting from descaling by the Sodium Hydride, Nitric-Hydrofluoric acid process. Similarly, comparative etch tests conducted on descaled René 41 material revealed a total loss of 0.0001 inch in thickness after etching for twenty-five minutes in the RW77 solution and 0.002 inch after etching in the Nitric-Hydrofluoric acid solution.

The use of scale inhibiting compound is applicable to the Sodium Hydride-RW77 process of the present invention to enhance the descaling operation. When scale inhibiting compound was used to reduce the thickness of scale formed on 17-7PH material during heat treatment, for example, the amount of metal loss from the chemical descaling operation subsequently applied was substantially reduced.

In descaling these and other stainless steels and related alloys in accordance with the Sodium Hydride-RW77 process, the materials are first immersed in the scale conditioning Sodium Hydride solution, when scale conditioning is required, or this solution may be used optionally whether required or not. The treated materials are then pickled in the RW77 descaling solution operated at ambient temperature of the order of 65° to 110° for an average immersion time of from three to fifteen minutes, followed by a water rinse. Materials so treated evidence a very smooth surface condition and no intergranular attack such as is typical of the surface conditions resulting from the use of the prior art processes. In the use of the process of the present invention, therefore, there are thus eliminated those deleterious surface conditions critical to the physical and mechanical properties of the ferrous or nickel base alloys treated.

The RW77 descaling solution, for use in the foregoing process, may have the following composition in which the proportions of the basic ingredient materials may vary within permissible ranges as follows.

Solution composition, percent by weight:

Ferric chloride—42° Bé.	16.0 to 20.0
Sulphuric acid—66° Bé.	1.0 to 3.5
Nitric acid—42° Bé.	1.2 to 4.0
Water	Balance

The following examples will serve to illustrate the effects of the Sodium Hydride-RW77 (NaH-RW77) process, comparatively with those of the Sodium Hydride, Nitric-Hydrofluoric acid (NaH, NHO_3-HF) process, on the surfaces of various stainless steels and related alloys in various heat-treat conditions. 17–7PH material and AISI 300 series stainless steels, for example, were descaled comparatively in this manner in their annealed, transformed, and precipitation hardened conditions. Similarly, comparative descaling operations were performed on René 41 materials in the solution annealed (1950° F.) and precipitation hardened (1400° F.) conditions. The examples also disclose the effects of unstabilized AISI 304 material annealed at 1950° F. and descaled by the Sodium Hydride-RW77 process, and comparative descaling effects on AISI 321 material descaled by the Sodium Hydride-RW77 process and by the Sodium Hydride, Nitric-Hydrofluoric acid process. The examples further disclose Hastelloy X descaled by the Sodium Hydride-RW77 process after annealing at 2150° F.

All materials disclosed in the following examples were decontaminated, prior to the annealing heat treatment, by vapor degreasing in trichloroethylene and immersing for ten minutes in a solution containing 19% by volume nitric acid maintained at 140° F., this soluiton being used to remove soft metal die pick up from stainless steel. Descaling after heat treating was accomplished by immersing materials for ten minutes in the Sodium Hydride solution maintained at 700° F. This scale conditioning treatment was followed by pickling in the RW77 solution at ambient temperature or in the Nitric-Hydrofluoric solu-

tion containing 22% by volume nitric acid and 2% by volume hydrofluoric acid maintained at 130° F., the immersion time for the RW77 solution being from three to five minutes and, except as otherwise noted in the following examples, being two minutes for the Nitric-Hydrofluoric acid solution. The effectiveness of scale inhibiting compounds was also measured by subjecting two panels from the same sheet of material of each alloy tested to the same heat treating and descaling cycles. Except as noted in the examples, one panel from each group was coated with a scale inhibiting compound known in the trade as Turco 4367.

In the tables, the first column indicates generally the nature of the material preparation prior to heat treat and the second column indicates the heat treat condition, prior to descaling. In certain instances this preparation, as indicated, involves, and the material requires, a descaling prior to placing the same in an intermediate heat treat condition. In the case of the 17–7PH material descaled in condition TH1050, for example, the material preparation, in one instance, included descaling following heat treat to condition "T," and in another instance, did not include this intermediate descaling. The indicated loss of thickness, in either case, includes the total loss incurred in the descaling operations, the scale being accumulative where intermediate descaling was not employed. The losses in thickness provide a comparative measure of the relative effectiveness of the indicated descaling solutions as do the comparative descriptions of the surface condition following descaling. The indicated surface condition, i.e., smooth, no intergranular attack, or rough grains exposed etc. were observed from micro-photographs (not shown) prepared from the sample materials tested.

In the examples, the RW77 descaling solution, operated at room temperature, employed the specific composition and proportions of basic constituents as follows.

Solution composition, percent by weight:

Ferric chloride—42° Bé.	17.0
Sulphuric acid—66° Bé.	2.0
Nitric acid—42° Bé.	3.0
Water	Balance

Micro-photographs were not available for the samples of René 41 material tested and, accordingly, the loss of thickness provides the only comparative measure in Table IV. The scale inhibiting compound is designated S.I.C. in the tables for the sake of brevity, thickness measurements are in inches.

EXAMPLE I.—17–7PH

Material Preparation Prior to Heat Treat	Heat Treat Condition	Descale Solution	Loss in Thickness		Surface Condition
			S.I.C.	No S.I.C.	
Decontaminated. S.I.C. applied prior to annealing at 1,950° F.	Annealed at 1,950° F.	NaH-RW77	0.0005	0.0008	Smooth, no intergranular attack.
		NaH, HNO_3-HF	0.0006	0.0012	Rough, accompanied by intergranular attack.
Decontaminated. Descaled by NaH-RW77 in annealed condition. S.I.C. applied prior to 1,400° F. Heat Treat.	"T"	NaH-RW-77	0.0002	0.0004	Smooth, no intergranular attack.
Decontaminated. Descaled by NaH, HNO_3-HF in annealed condition. S.I.C. applied prior to 1,400° F. Heat Treat.	"T"	NaH, HNO_3-HF	0.0007	------	Surface rough, grains exposed due to intergranular attack. Sharp recesses resulting in incipient notch effects.
Decontaminated. Descaled by NaH-RW77 in condition "T." When used, S.I.C. applied prior to 1,050° F. Heat Treat.	TH1050	NaH-RW77	0.0003	0.0004	Smooth, as received condition, no intergranular attack.
Decontaminated. Descaled by NaH-RW77 in annealed condition. Not descaled in condition "T." S.I.C. applied prior to 1,400° F.	TH1050	NaH-RW77	0.0003	0.0009	Do.
Decontaminated. Descaled by NaH, HNO_3-HF in annealed condition. Not descaled in condition "T." When used, S.I.C. applied prior to 1,400° F. Heat Treat.	TH1050	NaH, HNO_3-HF	0.0007	0.0013	Rough, grains exposed due to intergranular attack. Sharp recesses resulting in incipient notch effects by propagating cracks when material stressed.

EXAMPLE II.—AISI 304

Material Preparation Prior to Heat Treat	Heat Treat Condition	Descale Solution	Loss in Thickness		Surface Condition
			S.I.C.	No S.I.C.	
Decontaminated. When used, S.I.C. applied prior to annealing at 1,950° F.	Annealed at 1,950° F.	NaH-RW77	[1] 0.0008	[1] 0.0008	No intergranular attack, no carbide precipitation. Some roughness due to scale formation and slightly amplified by very small amount of etching.

[1] 8 minutes.

EXAMPLE III.—AISI 321

Material Preparation Prior to Heat Treat	Heat Treat Condition	Descale Solution	Loss in Thickness		Surface Condition
			S.I.C.	No S.I.C.	
Decontaminated. When used, S.I.C. applied prior to annealing at 1,950° F.	Annealed at 1,950° F.	NaH, HNO_3-HF	[1] 0.0006	[1] 0.0006	Rough, due to severe etching and pitting. Incipient notch effects.

[1] 3-10 minutes.

EXAMPLE IV.—RENÉ 41

Material Preparation Prior to Heat Treat	Heat Treat Condition	Descale Solution	Loss in Thickness
Decontaminated. No scale inhibiting compound.	Solution annealed condition	{NaH-RW77	0.0002
		{NaH, HNO_3-HF	0.0002
Decontaminated. Descaled by NaH-RW77 in solution annealed condition.	Precipitation hardened condition	NaH-RW77	0.0002
Decontaminated. Descaled by NaH, HNO_3-HF in solution annealed condition.	do	NaH, HNO_3-HF	0.0002

EXAMPLE V.—HASTELLOY X

Material Preparation Prior to Heat Treat	Heat Treat Condition	Descale Solution	Loss in Thickness		Surface Condition
			S.I.C.	No S.I.C.	
Decontaminated. Where used, material coated with S.I.C. applied prior to annealing at 2,150° F.	Annealed at 2,150° F.	NaH-RW77	[1] 0.0003	0.0001	Smooth, no intergranular attack, as received condition.

[1] 45 minutes.

The amount of loss in material thickness resulting from the descaling operations as heretofore described was determined by immersing the descaled material for twenty-five minutes in their respective RW77 and HNO_3-HF descaling solution, an average of five micrometer readings on an area of 1.75 by 1.75 inches being taken at five minute intervals, as indicated in the following table:

Loss in material-thickness (inches)

Material and Condition	Pickle Solution	Immersion Time (Minutes)				
		5	10	15	20	25
17-7PH (TH1050)	{RW77	0.0007	0.0011	0.0013	0.0015	0.0017
	{HNO_3-HF	0.0010	0.0013	0.0015	0.0016	0.0017
304 (Annealed)	{RW77	0.0003	0.0004	0.0007	0.0009	0.0011
	{HNO_3-HF	0.0004	0.0006	0.0009	0.0012	0.0015
321 (Annealed)	{RW77	0.0001	0.0001	0.0002	0.0002	0.0003
	{HNO_3-HF	0.0001	0.0001	0.0002	0.0003	0.0004
René 41 (Precipitation Hardened).	{RW77	0	0	(1)	(1)	0.0001
	{HNO_3-HF	0	(1)	0.0001	0.0001	0.0002
Hastelloy X (Annealed)	{RW77	0.0002	0.0002	0.0002	0.0003	0.0003
	{HNO_3-HF	0.0002	0.0003	0.0004	0.0004	0.0005

[1] Negligible.

The theory of operation of the NaH-RW77 descaling process of the present invention, while not fully understood, may be explained, at least in part, in terms of representative reactions.

Sodium hydride scale conditioning operation

In the scale conditioning operation, the Sodium Hydride solution reduces the metallic oxides to base metals or to the lower oxides of other of the alloyed metals treated, as represented in the following equations:

Metal oxides	Reduction products
$3NaH+Fe_2O_3 \rightarrow$	$3NaOH+2Fe$
$4NaH+Fe_3O_4 \rightarrow$	$4NaOH+3Fe$
$NaH+FeO \rightarrow$	$NaOH+Fe$
$NaH+NiO \rightarrow$	$NaOH+Ni$
$2NaH+Cr_2O_3 \rightarrow$	$2NaOH+2CrO$
$2NaH+CrO_3 \rightarrow$	$2NaOH+CrO$
$2NaH+WO_3 \rightarrow$	$2NaOH+WO_2$

Metal oxides such as those of Fe, Ni, Ag, Cu, and Co are reduced to the basic metal. Oxides such as those of Cr, Mo, Wo, and V form acid radicals of their lower oxides and do not reduce to the base metal. It is these lower oxides that need further treatment for removal which is accomplished in the RW77 descaling solution.

RW77 descaling operation

As aforementioned, the RW77 descaling solution operates on the theory and principle of being a controlled oxidizing solution which is in balance and equilibrium in the absence of any metals, oxides and scale in the solution. The basic constituents, namely, the ferric chloride, and the nitric and sulphuric acids, in accordance with the law of mass action as determined by their relative proportions, in solution produce oxidizing materials such as hydrochloric acid (HCl) and nitrosyl (NOCl), but the reaction is reversible and thus the basic constituents per se do not react with each other and, accordingly, the solution is in equilibrium, as suggested by the following representative equations:

$$3FeCl_3+3H_2SO_4+3HNO_2 \rightleftarrows Fe_2(SO_4)_3+9HCl+Fe(NO_3)_3$$

$$FeCl_3+3HCl+5HNO_3 \rightleftarrows Fe(NO_3)_3+2NOCl+2Cl_2+4H_2O$$

When the articles to be treated are added to the solution, the law of mass action, as aforenoted, determines the amount of auxiliary materials which are formed as a result of the reaction of the solution with the materials added thereto. When the materials to be treated are added to the solution, the same is no longer in balance and the equilibrium is upset. This initiates the reaction between the solution and the oxides or scales to be removed. The descaling action takes place in two steps. In the first step the acid soluble lower oxides on the surface of the materials treated are dissolved in the solution to form

low valence salts of the treated alloyed metals, and a reducing reaction also takes place in which ferric chloride is reduced to the lower valent ferrous chloride and the auxiliary oxidizing materials aforementioned are formed, as suggested in the following reaction involving the removal of an oxide of chromium. In the second step an oxidizing operation is involved in which the ferrous chloride and other low valence salts are oxidized to form less active higher valence material to thus restore the solution to balance an equilibrium. As otherwise expressed, the RW77 descaling operation involves two steps:

(1) A reducing step in which introduction of scale material initially dissolves the oxides and unbalances the solution resulting in the formation of intermediate materials of controlled amount, and

(2) An oxidizing step in which oxidation of the intermediately formed materials restores the equilibium of the solution.

REDUCING STEP

[No etching]

$$2Fe(NO_3)_3 + Fe_2(SO_4)_3 + 2NOCl + 6HCl + 7CrO \longrightarrow$$
$$2FeCl_2 + Fe(NO_3)_2 + FeSO_4 + 2CrCl_2 + 3Cr(NO_3)_2 + 2CrSO_4 + 3H_2O$$

[Slight etching]

$$2Fe(NO_3)_3 + Fe_2(SO_4)_3 + 4HCl + 4Cr \longrightarrow$$
$$FeCl_2 + 2FeSO_4 + Fe(NO_3)_2 + CrCl_2 + CrSO_4 + 2Cr(NO_3)_2 + 2H$$

OXIDIZING STEP

[Chlorides]

Bi-valent		Tri-valent
$2FeCl_2 + Cl_2$	$\longrightarrow$	$2FeCl_3$
$2CrCl_2 + Cl_2$	$\longrightarrow$	$2CrCl_3$

[Sulphates]

Bi-valent		Tri-valent
$2FeSO_4 + H_2SO_4$	$\leftrightarrows$	$Fe_2(SO_4)_3 + 2H$
$2CrSO_4 + H_2SO_4$	$\leftrightarrows$	$Cr_2(SO_4)_3 + 2H$

[Nitrates]

Bi-valent		Tri-valent
$Fe(NO_3)_2 + HNO_3$	$\leftrightarrows$	$Fe(NO_3)_3 + H$
$Cr(NO_3)_2 + HNO_3$	$\leftrightarrows$	$Cr(NO_3)_3 + H$

RW77 descaling solution

The RW77 descaling solution initially includes a polyvalent metal chloride capable of being reduced to the lower bi-valent chloride by the initial reaction of the solution with the materials to be treated therein. For this purpose, a chloride of at least one of the metal constituents of the stainless steel alloy being treated is used, this preferably being ferric chloride as hereinbefore specified. The descaling solution also includes at least one of a group of acids for introducing the essential amount of hydrogen ion concentration, this being one of the functions of the nitric and sulphuric acids. The sulphuric acid in the solution also serves as a reducing agent in the reduction of the ferric chloride to ferrous chloride and in the forming of the hydrochloric acid. The nitric acid also serves as an oxidizing agent in the production of the nitrosyl and nitrates in the reaction with the hydrochloric acid. The nitric acid further serves as an inhibiting agent in relation to the activity of the sulphuric acid in that it tends to oxidize the materials in the manner of the well known use of nitric acid as a passivating agent in the creating or forming of an inert surface condition on certain metals such as stainless steels. As an inhibitor, the nitric acid operates to control the activity of the descaling operation so that the intermediately formed materials are used in the oxidizing process at about the rate in which they are formed in the initial reaction.

The RW77 descale composition may be compounded and sold as a concentrate, preferably in the optimum proportions as heretofore disclosed. In use, the concentrate is added to water to make up the ultimate solution. When an increased rate of descaling is desired, nitric acid is added to the solution. The nitric acid in controlled excess of that required for normal descaling operation operates as an inhibitor to prevent attack of the bare metal. An increase in the sulphuric acid will increase the activity or reactive capacity of the solution.

The novel principles of this invention transcend the scope of the invention as suggested by the embodiments, examples and equations hereinbefore disclosed to provide an understanding of the invention, and the same may be embodied in other forms or carried out in other ways without departing from the spirit or essential characteristics of the invention. The invention as hereinbefore disclosed therefore is to be considered as in all respects illustrative and not restrictive, the scope of the invention being indicated by the appended claims, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Having described my invention, what I claim as new and useful and desire to secure by Letters Patent is:

1. The method of descaling stainless steel metals and related alloys thereof comprising treating said metals for from 3 to 15 minutes in an aqueous solution maintained at a temperature of from 65 to 110° F., said solution consisting essentially of from 16.0 to 20.0% by weight 42° Bé. ferric chloride, from 1.0 to 3.5% by weight 66° Bé. sulphuric acid, from 1.2 to 4.0% by weight 42° Bé. nitric acid, and the remainder water.

2. The process of descaling stainless steel metals and related alloys thereof comprising the steps of immersing said metals for about 10 minutes in a sodium hydride scale solution maintained at a temperature of 700° F., and subsequently immersing said metals for from 3 to 15 minutes in an aqueous solution maintained at a temperature of from 65 to 110° F., said solution consisting essentially of from 16.0 to 20.0% by weight 42° Bé ferric chloride, from 1.0 to 3.5% by weight 66° Bé. sulphuric acid, from 1.2 to 4.0% by weight 42° Bé. nitric acid and the remainder water.

3. An aqueous solution for descaling stainless steel metals and related alloys thereof, said solution consisting essentially of from 16.0 to 20.0% by weight of 42° Bé. ferric chloride, from 1.0 to 3.5% by weight of sulphuric acid, from 1.2 to 4.0% by weight 42° Bé. nitric acid and the remainder water.

4. The aqueous solution of claim 3 wherein said solution consists essentially of 17.0% by weight of ferric chloride, 2.0% by weight sulphuric acid, 3.0% by weight nitric acid, and the remainder water.

References Cited by the Examiner

UNITED STATES PATENTS

2,172,171	9/39	Meyer et al.	252—101 X
2,295,204	9/42	Dockray	134—28
2,353,019	7/44	Dyer	134—3 X
2,605,775	8/52	Kientz	134—3
2,762,728	9/56	Hahn	134—3
2,940,837	6/60	Acker et al.	134—41 X

MORRIS O. WOLK, *Primary Examiner.*

CHARLES A. WILLMUTH, DONALL H. SYLVESTER, *Examiners.*