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COMPOSITION FOR REMOVING SCALE DEPOSITS FROM FERROUS METAL SURFACES

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The invention relates to compositions for removing scale deposits from ferrous metal surfaces. It more particularly concerns an improved composition comprising hydrochloric acid for use in removing scale deposits from iron or steel surfaces.

One of the well-known uses of hydrochloric acid is in treating iron and steel surfaces for the removal of scale deposits such as those comprising the various iron oxides or other foreign matter which is more or less soluble in the acid. Inasmuch as the acid also attacks and dissolves some of the metal underlying the deposits to be removed, a corrosion inhibitor is added to reduce the rate of attack of the acid upon the metal while the scale is being removed. Among the substances known to reduce the corrosion of the metal by hydrochloric acid solutions are the organic nitrogen bases when present therein in comparatively small concentrations, the more effective ones being the aromatic and heterocyclic nitrogen bases. Some of the aldehydes in comparatively small concentrations are also known to reduce to a marked extent the corrosiveness of hydrochloric acid solutions, formaldehyde being probably the most effective. For some purposes, as for example in the descaling of high pressure steam generators with hydrochloric acid solution, where even a small loss of metal is undesirable, these substances either alone or together do not produce all the reduction in corrosiveness of hydrochloric acid solution to be desired, particularly at the elevated temperatures required to produce descaling in a reasonably short time.

We have now discovered that by employing in the hydrochloric acid solution the organic nitrogen-base inhibitor along with the formaldehyde in the presence of a wetting agent, which has little or no inhibiting action in itself, but is capable of promoting the wetting of the ferrous metal surface by the acid solution, a greatly increased corrosion inhibiting effect is obtained which exceeds that obtainable with either the organic nitrogen base or the aldehyde, or both. The invention then consists in the improved scale removing composition hereinafter fully described and particularly pointed out in the claims.

In carrying out the invention, aqueous hydrochloric acid is used in a concentration suitable for decomposing, dissolving, or disintegrating the scale deposits to be removed from the ferrous metal surfaces to which the acid solution is applied. Complete solution of the scale in the acid solution is not always necessary. Some scale deposits contain both acid-soluble and acid-insoluble constituents and usually slough off when attacked by the acid without completely dissolving. A wide range of concentration of HCl may be used in the solution, such as from about 1 to 30 per cent by weight, although other concentrations may be used. Preferred concentrations

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are in the range of 2 to 15 per cent, about 5 to 10 per cent being generally useful. Inasmuch as the higher the acid concentration the more corrosive and difficult the acid is to inhibit, it is generally desirable to use the acid in as low a concentration as will serve to attack and remove the scale in a satisfactory length of time.

In accordance with the invention, we add to the hydrochloric acid solution, which contains a suitable concentration of HCl, formaldehyde and together therewith both an organic nitrogen base and a wetting agent, suitable amounts and illustrative examples of these agents being given below.

As to the formaldehyde, the usual commercial form is an aqueous solution containing about 40 per cent by weight of formaldehyde (HCHO) and such solution may be used conveniently as the source of the formaldehyde. The amount to employ may vary over a wide range. It is desirable to have in the acid solution at least 0.002 per cent by weight of HCHO but concentrations over about 2 per cent by weight do not appear to be more effective than lower concentrations. In terms of per cent by volume of the 40 per cent commercial formaldehyde solution, these amounts are 0.005 to 5.0 per cent of the volume of the acid solution. An amount of the 40 per cent formaldehyde solution which is about 0.05 per cent by volume of the acid solution is generally suitable.

As to the organic nitrogen base, the aromatic and heterocyclic tertiary amines are to be preferred as they do not chemically react with the formaldehyde. The concentration of the organic nitrogen base in the hydrochloric acid solution may vary over a wide range as long as an effective amount is present. Effective amounts to use, when in combination with the other agents aforesaid, are in the order of 0.05 to 2 per cent, a preferred concentration is about 0.1 to 0.2 per cent, these proportions being by weight. Illustrative examples of suitable organic nitrogen bases to employ are shown in Table I in the column headed "Organic Nitrogen Base."

Various wetting agents, such as the synthetic detergents, may be employed, which are stable and dispersible or soluble in hydrochloric acid solution and capable of promoting the wetting of the ferrous metal surface by the aqueous solution. There may be used as wetting agents various organic sulfonates and sulfates including those of saturated hydrocarbons, higher aliphatic alcohols, as well as aromatics, illustrative examples of which appear in Table II with their corresponding trade names in the column headed "Wetting Agent." Only a small amount of the wetting agent need be employed, as for example from about 0.02 to 0.1 per cent by weight, 0.05 per cent being generally sufficient, although other amounts may be used.

Table I

Test No.	Liters of Acid Solution	Organic Nitrogen Base	Percent by Weight Organic Nitrogen Base	Percent by Volume—40% Formaldehyde	Percent by Weight Wetting Agent ¹	Corrosion Rate lbs./sq.ft./day
1	2					0.739
2	2			0.05		0.345
3	2				0.05	0.745
4	2			0.05	0.50	0.348
5	2	dimethylaniline	0.20			0.483
6	1	do.	0.10	0.05		0.277
7	2	do.	0.20		0.05	0.467
8	2	do.	0.10		0.05	0.525
9	1	do.	0.10	0.05	0.05	0.268
10	2	diethylaniline	0.20			0.455
11	1	do.	0.10	0.05		0.284
12	2	do.	0.20		0.05	0.438
13	2	do.	0.10		0.05	0.490
14	1	do.	0.10	0.05	0.05	0.266
15	2	di-n-butylaniline	0.20			0.237
16	1	do.	0.10	0.05		0.198
17	1	do.	0.20		0.05	0.216
18	1	do.	0.10		0.05	0.272
19	1	do.	0.10	0.05	0.05	0.182
20	2	pyridine	0.20			0.548
21	1	do.	0.10	0.05		0.366
22	2	do.	0.20		0.05	0.523
23	2	do.	0.10		0.05	0.557
24	1	do.	0.10	0.05	0.05	0.349
25	2	alpha-picoline	0.20			0.522
26	1	do.	0.10	0.05		0.325
27	2	do.	0.20		0.05	0.518
28	2	do.	0.10		0.05	0.549
29	1	do.	0.10	0.05	0.05	0.314
30	2	beta-picoline	0.20			0.537
31	1	do.	0.10	0.05		0.324
32	2	do.	0.20		0.05	0.513
33	2	do.	0.10		0.05	0.556
34	1	do.	0.10	0.05	0.05	0.303
35	2	gamma-picoline	0.20			0.528
36	1	do.	0.10	0.05		0.335
37	2	do.	0.20		0.05	0.520
38	2	do.	0.10		0.05	0.555
39	1	do.	0.10	0.05	0.05	0.312
40	1	2-n-ampylpyridine	0.20			0.340
41	1	do.	0.10	0.05		0.274
42	1	do.	0.20		0.05	0.337
43	1	do.	0.10		0.05	0.378
44	1	do.	0.10	0.05	0.05	0.260
45	1	4-n-ampylpyridine	0.20			0.334
46	1	do.	0.10	0.05		0.272
47	1	do.	0.20		0.05	0.291
48	1	do.	0.10		0.05	0.353
49	1	do.	0.10	0.05	0.05	0.265
50	1	2-hexylpyridine	0.20			0.257
51	1	do.	0.10	0.05		0.215
52	1	do.	0.20		0.05	0.242
53	1	do.	0.10		0.05	0.273
54	1	do.	0.10	0.05	0.05	0.204
55	2	2,4-lutidine	0.20			0.440
56	1	do.	0.10	0.05		0.304
57	2	do.	0.20		0.05	0.435
58	2	do.	0.10		0.05	0.476
59	1	do.	0.10	0.05	0.05	0.299
60	2	2,6-lutidine	0.20			0.456
61	1	do.	0.10	0.05		0.341
62	2	do.	0.20		0.05	0.451
63	2	do.	0.10		0.05	0.502
64	1	do.	0.10	0.05	0.05	0.326
65	1	2,4,6-collidine	0.20			0.360
66	1	do.	0.10	0.05		0.174
67	1	do.	0.20		0.05	0.331
68	1	do.	0.10		0.05	0.367
69	1	do.	0.10	0.05	0.05	0.153
70	1	quinoline	0.20			0.355
71	1	do.	0.10	0.05		0.166
72	1	do.	0.20		0.05	0.323
73	1	do.	0.10		0.05	0.381
74	1	do.	0.10	0.05	0.05	0.149
75	1	lepidine	0.20			0.335
76	1	do.	0.10	0.05		0.153
77	1	do.	0.20		0.05	0.329
78	1	do.	0.10		0.05	0.377
79	1	do.	0.10	0.05	0.05	0.140
80	1	quinaldine	0.20			0.340
81	1	do.	0.10	0.05		0.176
82	1	do.	0.20		0.05	0.321
83	1	do.	0.10		0.05	0.356
84	1	do.	0.10	0.05	0.05	0.164
85	1	2,7-dimethylquinoline	0.20			0.299
86	1	do.	0.10	0.05		0.146
87	1	do.	0.20		0.05	0.279
88	1	do.	0.10		0.05	0.338
89	1	do.	0.10	0.05	0.05	0.131
90	2	isoquinoline	0.20			0.370
91	1	do.	0.10	0.05		0.257
92	2	do.	0.20		0.05	0.353
93	2	do.	0.10		0.05	0.402
94	1	do.	0.10	0.05	0.05	0.242
95	2	3-methylisoquinoline	0.20			0.386
96	1	do.	0.10	0.05		0.245
97	2	do.	0.20		0.05	0.349
98	2	do.	0.10		0.05	0.397
99	1	do.	0.10	0.05	0.05	0.230
100	2	acridine	0.20			0.575
101	2	do.	0.10	0.05		0.406
102	2	do.	0.20		0.05	0.491
103	2	do.	0.10		0.05	0.537
104	2	do.	0.10	0.05	0.05	0.392

¹ Saturated hydrocarbon sodium sulfonate with an average 10 carbon chain, known in the trade as "Petrowet R."

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Table II

Row No.	Wetting Agent		Percent by Volume of 40% Formaldehyde	Corrosion Rate lbs./sq. ft./day ¹					
				2,4,6-Collidine		Quinaldine		Isoquinoline	
	Name	Weight Percent		Weight Percent	Rate	Weight Percent	Rate	Weight Percent	Rate
1		0.05			0.765		0.765		0.765
2	Sodium benzene sulfonate	0.05		0.10	0.347	0.10	0.293	0.10	0.382
3	"Oronite 6"	0.05	6.05		0.307		0.307		0.307
4		0.05	0.05	0.10	0.120	0.10	0.111	0.10	0.135
5		0.05			0.714		0.714		0.714
6	Sodium isopropyl naphthalene sulfonate	0.05		0.10	0.348	0.10	0.228	0.10	0.388
7	"Aerosol OS"	0.05	0.05	0.10	0.347		0.347		0.347
8		0.05	0.05	0.10	0.159	0.10	0.098	0.10	0.221
9		0.05			0.709		0.709		0.709
10	Long chain alcohol sulfate	0.05		0.10	0.349	0.10	0.306	0.10	0.337
11	"Merpol B"	0.05	0.05		0.341		0.341		0.341
12		0.05	0.05	0.10	0.122	0.10	0.138	0.10	0.137
13		0.05			0.772		0.772		0.772
14	Sodium sulfate ester of 2-ethyl hexanol-1	0.05		0.10	0.321	0.10	0.337	0.10	0.388
15	"Tergitol OS"	0.05	0.05	0.10	0.357		0.357		0.357
16		0.05	0.05	0.10	0.114	0.10	0.091	0.10	0.133
17		0.05			0.699		0.699		0.699
18	Sulfated hydroxy stearic acid	0.05		0.10	0.320	0.10	0.237	0.10	0.313
19	"Nopco 2031"	0.05	0.05		0.288		0.288		0.288
20		0.05	0.05	0.10	0.120	0.10	0.096	0.10	0.149
21		0.05			0.702		0.702		0.702
22	Sodium dodecyl benzene sulfonate	0.05		0.10	0.323	0.10	0.242	0.10	0.311
23	"Santomerse #1"	0.05	0.05		0.337		0.337		0.337
24		0.05	0.05	0.10	0.139	0.10	0.096	0.10	0.136
25		0.05			0.750		0.750		0.750
26	Sodium monobutylphenylphenol monosulfonate	0.05		0.10	0.375	0.10	0.284	0.10	0.359
27	"Areskap 100"	0.05	0.05		0.429		0.429		0.429
28		0.05	0.05	0.10	0.142	0.10	0.076	0.10	0.151
29		0.05			0.725		0.725		0.725
30	Sodium monobutyl biphenyl monosulfonate	0.05		0.10	0.342	0.10	0.216	0.10	0.344
31	"Aresket 300"	0.05	0.05		0.362		0.362		0.362
32		0.05	0.05	0.10	0.114	0.10	0.083	0.10	0.129
33		0.05			0.714		0.714		0.714
34	Sodium tetrahydronaphthalene sulfonate	0.05		0.10	0.332	0.10	0.310	0.10	0.397
35	"Alakanol SS"	0.05	0.05		0.381		0.381		0.381
36		0.05	0.05	0.10	0.118	0.10	0.100	0.10	0.155
37		0.05			0.705		0.705		0.705
38	Sodium xylene sulfonate	0.05		0.10	0.316	0.10	0.331	0.10	0.356
39	"Naxionate Q"	0.05	0.05		0.379		0.379		0.379
40		0.05	0.05	0.10	0.137	0.10	0.173	0.10	0.133
41		0.05			0.709		0.709		0.709
42	Sodium diisobutyl sulfosuccinate	0.05		0.10	0.373	0.10	0.355	0.10	0.389
43	"Aerosol IB"	0.05	0.05		0.391		0.391		0.391
44		0.05	0.05	0.10	0.110	0.10	0.092	0.10	0.127
45		0.05			0.711		0.711		0.711
46	Sodium diamyl sulfosuccinate	0.05		0.10	0.361	0.10	0.371	0.10	0.395
47	"Aerosol AY"	0.05	0.05		0.390		0.390		0.390
48		0.05	0.05	0.10	0.107	0.10	0.093	0.10	0.131
49		0.05			0.732		0.732		0.732
50	Sodium dihexyl sulfosuccinate	0.05		0.10	0.355	0.10	0.371	0.10	0.402
51	"Aerosol MA"	0.05	0.05		0.378		0.378		0.378
52		0.05	0.05	0.10	0.101	0.10	0.098	0.10	0.135
53		0.05			0.763		0.763		0.763
54	Sodium dioctyl sulfosuccinate	0.05		0.10	0.315	0.10	0.289	0.10	0.385
55	"Aerosol OT"	0.05	0.05		0.337		0.337		0.337
56		0.05	0.05	0.10	0.113	0.10	0.100	0.10	0.131
57		0.05					0.730		
58		0.05				0.20	0.271		
59	Sodium lauryl sulfate	0.05				0.10	0.302		
60	"Duponal WA"	0.05	0.05				0.347		
61		0.05	0.05				0.100		
62		0.05			0.713		0.713		0.713
63	Sulfated aliphatic alcohol (8 to 10 carbon atom chain)	0.05	0.05		0.350	0.10	0.094		0.350
64	"Petrowet WN"	0.05	0.05	0.10	0.121		0.350	0.10	0.162
65		0.05				0.10	0.318		

¹ 1 liter of 2.5% HCl was used for each test unless the corrosion rate exceeded 0.393 lbs./sq.ft./day where 2 liters was used.

In the aforementioned Tables I and II, illustrative examples of acid compositions inhibited according to the invention are given. The examples show the effect on the corrosiveness of the hydrochloric acid solution of the conjoint use of an organic nitrogen base, formaldehyde, and a wetting agent in the acid solution in accordance with the invention, in comparison with the effect on the corrosiveness of the acid solution of each agent alone, and combinations of two of the agents without the third agent. In obtaining the corrosion rate data set forth in both tables, sand blasted mild steel test pieces 2.68 inches long, 1 inch wide, and 0.13 inch thick, and substantially all alike as to corrodability, were immersed in separate vessels containing a quantity of the acid solution for 6 hours and the weight loss determined by weighing each test piece before and after the immersion. The acid solution was maintained at 175° F. and contained

2.5 per cent of HCl by weight. The volume of the acid solution was either 1 or 2 liters, as indicated, the volume being such that not more than about 10 per cent of the acid content of the solution was spent in each test. The corrosion rates reported are based upon the loss in weight of the test piece, the area of the test piece (6.32 square inches) exposed to the acid solution, and the duration of the immersion of the test piece in the acid, this test procedure being conventional in the art.

Referring to Table I, test No. 1 employed 2 liters of the hydrochloric acid solution at 175° F. on a mild steel test piece as described, the corrosion rate thereby obtained was 0.739 lb. per square foot per day as shown for test 1 in the last column. As indicated in the Table I, test No. 2 was run in the same manner as No. 1 but with 0.05 per cent by volume of 40 per cent formaldehyde added to the acid as shown for test No.

2 in the 5th column; the resulting corrosion rate was 0.345 pound per square foot per day as shown for test No. 2 in the last column. Test No. 3 was run similarly but with 0.05 per cent by weight of a wetting agent (column 6) consisting of a saturated straight chain hydrocarbon sulfate having an average of 8 to 10 carbon atoms in the chain, instead of formaldehyde; the resulting corrosion rate was 0.745 pound per square foot per day (last column). Test No. 4 was run similarly to the others but the acid contained 0.05 per cent by volume of formaldehyde (column 5) and 0.05 per cent by weight of the wetting agent (column 6); the resulting corrosion rate was 0.348 pound per square foot per day (last column). Test No. 5 was run similarly but the acid contained 0.2 per cent by weight of the organic nitrogen-base dimethyl aniline alone (column 3); the resulting corrosion rate was 0.483 pound per square foot per day (last column). Test No. 6 was run similarly using 1 liter of acid which contained 0.1 per cent by weight of dimethyl aniline (column 4), 0.05 per cent by volume of 40 per cent formaldehyde (column 5) but no wetting agent; the resulting corrosion rate was 0.277 pound per square inch. Test No. 7 was similar to test No. 6 but the acid volume was 2 liters and contained 0.2 per cent by weight of dimethyl aniline, no formaldehyde, and 0.05 weight per cent of wetting agent; the resulting corrosion rate was 0.467 pound per square foot per day. Test No. 8 was similar to test No. 7 except that the acid contained 0.1 weight per cent of the organic nitrogen base instead of 0.2; the resulting corrosion rate was 0.525 pound per square foot per day. Test No. 9 was run similarly to the others and employed 1 liter of acid and it contained all three agents, viz. 0.1 weight per cent of the organic nitrogen base, 0.05 volume per cent of 40 per cent formaldehyde, and 0.05 weight per cent of the wetting agent; the resulting corrosion rate was 0.268 pound per square foot per day. Thus, it will be seen by comparing the corrosion rate figures in the last column of Table I that the acid alone, i. e. test No. 1, is most corrosive. The presence of wetting agent alone, i. e. test No. 3, in the acid has but little effect on the corrosion rate. The formaldehyde alone, i. e. test No. 2, in the acid markedly reduces its corrosiveness, although the presence of the wetting agent along with the aldehyde, i. e. test No. 4, does not materially affect the inhibiting action of the formaldehyde alone as the corrosion rate of test No. 2 is substantially the same as that of test No. 4. The presence of the organic nitrogen base alone, i. e. test No. 5, in the acid, like formaldehyde, markedly reduces the corrosion rate, but the presence of wetting agent along with this organic nitrogen base, i. e. test Nos. 7 and 8, either lowers (test No. 7) or raises (test No. 8) the corrosion rate depending upon the concentration of the base in the acid. But when the wetting agent is present along with both the organic nitrogen base and the formaldehyde in accordance with the invention as in test No. 9, the corrosion rate is reduced below that obtainable with any one of the agents or combinations of them including the combination of the organic nitrogen base and the formaldehyde, i. e. test No. 9, without the wetting agent.

The effect of other organic nitrogen bases alone, in the presence of formaldehyde, in the presence of a wetting agent, and in the presence of both formaldehyde and a wetting agent, on the rate at which the acid corrodes mild steel is

shown in the remaining tests 10 to 104, inclusive, of Table I. In all of these tests, it will be seen that the combined use of the three agents produces a greater reduction in corrosiveness than can be had from any one alone or any combination of two of them without the third.

The marked cooperative effect of the aforesaid three agents, viz. formaldehyde, the organic nitrogen base and the wetting agent is further illustrated by the data of Table II in which the corrosion rate data was obtained in the same manner as that of Table I. In Table II, the effect of various wetting agents alone, in combination with formaldehyde, and in combination with both formaldehyde and one of the organic nitrogen bases 2,4,6-collidine, quinaldine, and isoquinoline on the corrosiveness of the acid, is shown. In comparing the corrosion rates of Table II, one may refer to Table I for the corrosiveness of the acid alone (test No. 1, 0.739 pound per square foot per day) and for the acid with the organic nitrogen base alone (test No. 65, 2,4,6-collidine 0.360 pound per square foot per day; test No. 80, quinaldine 0.340 pound per square foot per day; test No. 90, isoquinoline 0.370 pound per square foot per day). In each of the "rate" columns of Table II, it will be seen that the corrosion rate reduction produced by the organic nitrogen base and the formaldehyde used together is greatly enhanced by the effect of the wetting agent even though it alone actually may make the acid more corrosive in some cases (e. g. row 1, 13, 25, 53) while in others it has only a slight corrosion reducing effect by itself, if any.

From the foregoing tabulated examples of the invention, it is not to be inferred that the invention is to be limited thereto as the invention contemplates broadly the use of formaldehyde combined with a wetting agent and an aromatic or heterocyclic nitrogen base in various concentrations of hydrochloric acid, the wetting agent being dispersible in the aqueous acid solution and capable of promoting the wetting of ferrous metal by the solution. It will be apparent that any one of the wetting agents may be used with any one of the organic nitrogen bases in formulating the acid composition including the formaldehyde. Also, some of the organic nitrogen bases, as well as certain wetting agents, are superior to others in the combination. The particular choice of the two of the three agents to employ in the acid solution mainly will depend upon the amount of inhibition required as well as the cost of the materials. It has been found that particularly effective combinations are those including as the wetting agent an alkyl aryl sulfonate, such as sodium monobutyl phenyl-phenol sulfonate, sodium monobutyl biphenyl monosulfonate, and sodium isopropyl naphthalene sulfonate. Effective results are also obtained with aliphatic sulfonates as, for example, diisobutyl sulfosuccinate and sodium diamyl sulfosuccinate. Especially effective bases in the combination include 2,4,6-collidine, quinaldine, isoquinoline, quinoline, and 2,7-dimethyl quinoline. Preferred proportions for these agents in these combinations are: 0.05 to 2 per cent for the bases, 0.02 to 0.1 per cent for the wetting agent.

This application is a continuation-in-part of our copending application Serial No. 717,078, filed December 18, 1946, now abandoned.

We claim:

1. A composition for removing scale deposits from ferrous metal surfaces comprising an

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2. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of 2,4,6-collidine from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of a wetting agent dispersible in the solution, said wetting agent being a compound of the group consisting of sulfated and sulfonated organic compounds.

3. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of quinaldine, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of a wetting agent dispersible in the solution, said wetting agent being a compound of the group consisting of sulfated and sulfonated organic compounds.

4. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of isoquinoline, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of a wetting agent dispersible in the solution, said wetting agent being a compound of the group consisting of sulfated and sulfonated organic compounds.

5. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of quinoline, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of a wetting agent dispersible in the solution, said wetting agent being a compound of the group consisting of sulfated and sulfonated organic compounds.

6. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of 2,7-dimethyl quinoline, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of a wetting agent dispersible in the solution, said wetting agent being a compound of the group consisting of sulfated and sulfonated organic compounds.

7. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of an organic nitrogen base selected from the group consisting of the aromatic and heterocyclic nitrogen bases, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of sodium monobutylphenyl-phenol monosulfonate.

8. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of

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HCl, from about 0.05 to 2 per cent of an organic nitrogen base selected from the group consisting of the aromatic and heterocyclic nitrogen bases, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of sodium monobutyl biphenyl monosulfonate.

9. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of an organic nitrogen base selected from the group consisting of the aromatic and heterocyclic nitrogen bases, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of the sodium sulfate ester of 2-ethyl hexanol-1.

10. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing
20 by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of an organic nitrogen base selected ~~from the group consisting of the aromatic and heterocyclic nitrogen bases~~, from about 0.002 to 2 per cent of HCHO, and
25 from about 0.02 to 0.1 per cent of sodium diisobutyl sulfosuccinate.

11. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 1 to 30 per cent of HCl, from about 0.05 to 2 per cent of an organic nitrogen base selected from the group consisting of the aromatic and heterocyclic nitrogen bases, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of diamyl sodium sulfosuccinate.

12. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing
40 by weight from about 2 to 15 per cent HCl, from about 0.05 to 2 per cent of 2,4,6-collidine, from about 0.002 to 2 per cent of HCHO, and from about 0.02 to 0.1 per cent of sodium monobutyl phenyl-phenol monosulfonate.

13. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 2 to 15 per cent of HCl, from about 0.002 to 2 per cent of HCHO, from about 0.05 to 2 per cent of quinaldine, from about 0.02 to 0.1 per cent of sodium monobutyl phenyl-phenol monosulfonate.

14. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 2 to 15 per cent of HCl, from about 0.002 to 2 per cent of HCHO, from about 0.05 to 2 per cent of isoquinoline, from about 0.02 to 0.1 per cent of sodium monobutyl phenyl-phenol monosulfonate.

15. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 2 to 15 per cent of HCl, from about 0.002 to 2 per cent of HCHO, from about 0.05 to 2 per cent of quinaldine, from about 0.02 to 0.1 per cent of sodium monobutyl biphenyl monosulfonate.

16. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 2 to 15 per cent of HCl, from about 0.002 to 2 per cent of HCHO, from about 0.05 to 2 per cent of isoquinoline, from

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about 0.02 to 0.1 per cent of sodium monobutyl biphenyl monosulfonate.

17. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 2 to 15 per cent of HCl, from about 0.002 to 2 per cent of HCHO, from about 0.05 to 2 per cent of quinaldine, from about 0.02 to 0.1 per cent of the sodium sulfate ester of 2-ethyl hexanol-1.

18. A composition for removing scale deposits from ferrous metal surfaces comprising an aqueous solution of hydrochloric acid containing by weight from about 2 to 15 per cent of HCl, from about 0.002 to 2 per cent of HCHO, from about 0.05 to 2 per cent of quinaldine, from about 0.02 to 0.1 per cent of diisobutyl sodium sulfosuccinate.

19. A composition for removing scale deposits from ferrous metal surfaces comprising an

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aqueous solution of hydrochloric acid containing by weight from about 2 to 15 per cent of HCl, from about 0.002 to 2 per cent of HCHO, from about 0.05 to 2 per cent of quinaldine, from about 0.02 to 0.1 per cent of diamyl sodium sulfosuccinate.

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