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2,825,658

METHOD OF CHROMIZING

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The present invention relates to chromizing of low carbon steel usually of the order of AISI 1010, but permissibly having a nominal carbon content up to and including 0.35 percent carbon.

A purpose of the invention is to obtain a more smooth chromized surface on low carbon steel, with a minimum of etching and other defects.

A further purpose is to accelerate the diffusion of chromium into low carbon steel.

A further purpose is to minimize the sintering of the chromizing compound to the surface of low carbon steel during chromizing.

A further purpose is to employ from 0.06 to 0.26 and preferably about 0.1 percent by weight of ammonium bromide calculated on the chromium content of the source of chromium in chromizing low carbon steel.

A further purpose is to use between 25 and 85 percent by weight of finely divided inert bodying material based on the chromium content of the source of chromium in the chromizing compound.

A further purpose is to mix one volume of the fresh chromizing compound with from 2.5 to 3.5 volumes of expended compound for chromizing.

Further purposes appear in the specification and in the claims.

In the prior art, extensive use has been made of chromium diffusion into low carbon steel. As explained, for example, in Samuel U. S. Patent 2,536,774, chromizing may be carried out using a source of chromium and a bodying agent such as raw kaolin, along with an ammonium halide as a catalyst. The results obtained, however, are marred by the fact that the surface is considerably etched under the treatment, frequently producing discoloration, and the resultant finish is in general considerably rougher than the finish of the steel before treatment. For some service this result is not objectionable, and the advantages of chromizing from the standpoint of corrosion resistance and resistance to corrosion at elevated temperature have justified the use of chromizing.

There are, however, many applications in which the refinement of surface finish on the chromized surface is important and chromizing cannot be used unless it produces reliable surfaces of fine finish. To cite a few examples, there are surfaces which for hydraulic reasons should have a fine finish in connection with the flow of liquids or access at gases at high temperatures. There are also many machinery surfaces in which refinement of finish is important.

I have discovered that chromizing can be carried on consistently without the damage to the surface due to etching and discoloration and roughness of finish, while at the same time slightly improving the speed of diffusion. This renders the process applicable to parts which otherwise would not be consistently satisfactory in service as chromized by prior practices.

In accordance with the invention, the process is carried out using a chromizing compound which is in contact with or immediately adjacent to the low carbon steel

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being chromized at a temperature of 1650 to 1950° F., and preferably at 1750° F. and in normal course for a time of at least three hours, usually in excess of five hours, and most desirably about eighteen hours.

The chromizing compound itself consists of a source of chromium in finely divided form, a catalyst and desirably an inert finely divided bodying agent.

I find that exceptionally good results are obtained with ammonium bromide as a catalyst, with less damage to the work, if the catalyst concentration is kept exceedingly low, basing the quantity of catalyst on the amount of chromium present in the source of chromium, which may be chromium metal, or ferrochrome (preferably at least 65 percent chromium by weight). I find that the quantity of ammonium bromide should be between 0.06 and 0.26 percent by weight and preferably 0.01 percent by weight.

In addition an inert finely divided bodying agent is desirably used. This may be for example calcined clay, calcined kaolin or calcined alumina. The quantity of the inert bodying agent should be 25 to 85 percent of the weight of the chromium present.

The source of chromium and the inert bodying agent as well as the catalyst should be finely divided, preferably through 100 mesh per linear inch.

In a typical case the chromizing composition according to the invention may be as follows:

Material	Range	Preferred
Ammonium Bromide..... grams	15 to 50	25
Ferrochrome (65% chromium by weight)..... pounds	65 to 85	70
Inert Bodying Agent, such as calcined clay, calcined kaolin or calcined alumina..... pounds	15 to 35	30

One suitable procedure for chromizing is to insert the low carbon steel parts to be chromized in a closed box, packing the chromizing compound around the parts. The box is provided with a vent which allows the bromine, hydrogen, ammonia and nitrogen formed by the dissociation of the ammonium bromide to sweep out the air. The vent is suitably closed by a molten slag seal.

The iron which is present as an impurity in the ferrochrome can be ignored in the composition since in any case iron is diffused from the steel to replace the chromium which diffuses into the steel.

Comparative tests were conducted making up identical chromizing compounds as follows:

Compound	Catalyst	Source of Chromium	Inert Bodying Agent
A.....	25 grams ammonium iodide powder.	70 lbs. ferrochrome, 65% chromium through 100 mesh.	30 lbs. calcined kaolin through 100 mesh.
B.....	25 grams ammonium chloride powder.	same.....	same.
C.....	25 grams ammonium bromide powder.	same.....	same.
D.....	25 grams ammonium bifluoride powder.	same.....	same.

Four boxes containing compounds A, B, C, and D packed around AISI 1010 steel parts of identical size were placed side by side in the same furnace at 1750° F. and the chromizing treatment carried on for eighteen hours.

The results were as follows:

Compound	Penetration of Chromium into steel in inches
A—Ammonium Iodide.....	0.0015 to 0.0016
B—Ammonium Chloride.....	0.0015 to 0.0016
C—Ammonium Bromide.....	0.0020 to 0.0019
D—Ammonium Bifluoride.....	0.0016 to 0.0017

The finish obtained on the parts subjected to the different treatments was as follows:

The parts chromized using the ammonium iodide catalyst had a good finish but it was marred by slight sintering of the chromizing compound on the parts.

The parts chromized using ammonium chloride had a good finish, but inferior to those chromized using the iodide. The powder sintered on the surface more seriously than in the case of the iodide.

The parts produced with ammonium bromide had a very good finish, better than that from the iodide. This is the best finish which has been secured thus far in applicant's experience. There was no trace of sintering of the chromizing powder on the parts.

The parts chromized using ammonium bifluoride as a catalyst gave a good finish, about equivalent to that obtained with the iodide, but there was slight sintering of chromizing powder on the parts.

The experiments were repeated and the same results were obtained.

It is evident that the bromide in the concentrations used gave about 5 to 10 percent more penetration in a given time, along with improved surface finish.

The finish obtained with the bromide was the best secured from the standpoint of evenness, complete absence of sintering and freedom from etching of the parts treated.

In making up the actual chromizing mixture in practice, the normal technique is to retain the compound in the box from the last treatment, and add to it one part by volume of new compound to 2.5 to 3.5 parts, preferably about 3 parts by volume of expended compound from previous treatments. This approximately

compensates for the loss of compound and builds up a proper chromizing potential in the new compound.

It will be evident that the invention is particularly advantageous where special refinements of surface are to be obtained, since this much more than compensates for the increased cost of ammonium bromide.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the process shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

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

1. The method of chromizing, which comprises treating steel having a carbon content of 0.35 percent or less with exclusion of air at a temperature of from 1650 to 1950° F. for a time of at least three hours with a source of finely divided chromium and from 0.06 to 0.26 percent on the weight of the chromium of ammonium bromide.

2. The method of claim 1, in which the content of ammonium bromide is 0.1 percent of the quantity of chromium.

3. The method of claim 1, in which the source of chromium is in the presence of from 25 to 85 percent on the weight of the chromium of inert finely divided bodying material.

4. The method of claim 1, in which about one part by volume of fresh chromizing compound according to claim 1 is used with between 2.5 and 3.5 parts by volume of chromizing compound according to claim 1 previously expended.

References Cited in the file of this patent

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