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PROCESS FOR THE BLUING OF STEEL SURFACESDavid Stefanye, 12005 Gregerscroft Road,
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7 Claims

ABSTRACT OF THE DISCLOSURE

Steel surfaces can be colored to any desired hue between a light violet-blue and a deep blue-black by suspending the part in the effluent vapors obtained by boiling any organic compound selected from the group in which the boiling temperature thereof lies between 305° C. and 360° C., the coloring attained varying from the lighter to the darker hues in accordance with the extent to which the boiling point temperature of the selected organic compound exceeds the minimum.

The invention described herein may be manufactured, used and licensed by or for the Government for governmental purposes without the payment to me of any royalty thereon.

BACKGROUND OF THE INVENTION

This invention relates to the treatment of steel surfaces and is more particularly directed to an improved method for coloring such surfaces to a specific hue.

The exterior surfaces of guns and other ordnance material are generally blued or blackened to prevent the undesirable reflection of light in combat situations and to provide some resistance to corrosion. The required coloring has heretofore been achieved by producing a superficial coating of iron oxides on the exposed surfaces of the steel. However, none of the various methods in current use have been completely satisfactory in all respects. For example, one of these methods consists of treating the steel surfaces with an aqueous solution of the type which will cause rust to form thereon and thereafter removing the rust by brushing to expose the blue or black oxide coating formed therebeneath. Use of this method has generally been limited by such factors as the relatively complex composition required of the aqueous solution, the slowness of the rusting process, the need for extreme care in the brushing process to insure uniform color formation, the inability to obtain a deep color in a single application, and the small number of hues which can be obtained.

Another coloring technique in current use is the exposure of the steel surfaces to oxygen-rich fused salts which can be easily decomposed to provide a rapid release of the oxygen. Such technique is unsatisfactory since it is limited to the production of black or blue-black colors and, more importantly, leaves a chemical residue which is fairly difficult to remove from the steel surfaces. Another undesirable factor in both the rust and the fused salt methods is the necessity for periodic replacement of the oxidizing material.

A third technique for the coloring of steel surfaces consists of heating the metal in an atmosphere containing air or oxygen. A variety of colors ranging from light straw to deep blue-black can be obtained simply by regulating the temperature at which the heating is conducted. This is commonly accomplished by heating the steel for definite time periods in kilns, oven or rotating drums either in air, or in some solid ingredient which will distribute the heat in uniform manner or, if closer control is required, heating the steel in a bath of molten metal maintained at a temperature just above the solidification point. Such temperature is selected to yield the color desired and is obtained by utilizing a metal or composition of metals whose

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melting point corresponds to the selected temperatures. For example, a mixture of 64% of lead and 36% of zinc melts at 220° C. and will impart a straw color to the steel while a mixture of 97% of lead and 3% of tin melts at 316° C. and imparts a dark blue color to steel.

However, despite the variety of colors and hues which can be obtained by the use of molten metal baths, such technique is still not completely satisfactory. For one thing, it is extremely difficult to control the temperature in a precise manner, especially when heating long or large items. Furthermore, the molten metal of the bath tends to adhere to the steel and is extremely difficult to remove once solidification has occurred following the withdrawal of the steel part from the bath. In addition, molten metallic mixtures such as lead and tin form surface oxides during heating which also adhere to the steel and thereby produce an uneven coloring thereon.

Accordingly, it is an object of this invention to provide a method of coloring steel surfaces which will provide superior results over the methods in current use.

It is another object of this invention to provide a method for oxidizing steel surfaces to form a variety of deeply colored coatings thereon which do not require cleaning by subsequent mechanical or chemical treatment.

A further object of the present invention lies in the provision of a method for treating steel surfaces as aforesaid wherein the oxidizing medium is automatically maintained at maximum strength to provide an oxide coating of uniform color.

Another object of this invention is to provide a steel coloring technique as aforesaid wherein the surface to be colored is not subjected to a temperature in excess of that required to attain the desired color hue.

It has been discovered that the foregoing objects can best be achieved by subjecting the steel surfaces to be colored to the refluxing vapors obtained from the boiling of an organic compound selected from those which possess a boiling point between 305° C. and 360° C. and do not chemically react with the steel surfaces at such temperatures. Since the critical limitation imposed on these organic compounds is the boiling point and not the composition thereof, it is apparent that an extremely large variety of compounds are suitable for use. A representative listing of such compounds would include the following:

Substance:	Boiling point, ° C.
Acetamide	305
4-acetotaluide	307
Acridine	346
Anthracene	354
Benzamide	317
1,2-dinitrobenzene	317
1,3-diphenylbenzene	363
Hexachlorobenzene	326
Benzophenone	306
Benzoquinoline	351
4,4'-dichlorodiphenyl (Arochlor)	360
4-nitrobiphenyl	340
9-fluorenone	342
Chlorotriphenyl methane	310
Benzyl-naphthalene	350
Triphenylmethane	359
2-naphthonitrile	306
2-nathylamine	306
Nitronaphthalene	306
Phenanthrene	340
1,3-diphenoxypropane	338
2-phenylquinoline	363
Tribenzylamine	380
Triphenylamine	365

However, the selection of the most appropriate organic compound to use should also take into consideration the extent to which the flash point, determined on the basis of the well-known open cup procedure, will exceed the boiling point thereof. Inasmuch as the refluxing vapors must be admixed with air in order to provide the iron oxides required to produce the desired coloring, it is essential that the temperature of these vapors be maintained below the flash point thereof to avoid the possibility of burning during the treatment of the steel surface. Obviously, if the bluing process were attempted with an organic compound such as cottonseed oil, for example, which provides little or no separation between the boiling and flash points thereof, it is extremely likely that the refluxing vapors would ignite and burn before the desired coloring was completely attained. Such burning would, of course, consume the admixed air and interfere with the proper formation of the iron oxides which produce the desired coloring of the steel surfaces. Furthermore, while the absorption of heat by the steel part being colored is generally sufficient to prevent the temperature of the refluxing vapors from reaching the flash point thereof, experimentation has shown that the use of organic compounds with a flash point less than 20° C. higher than the boiling point thereof could result in the ignition of the vapors during the physical removal therefrom of the steel part being colored. If such removal was being effected in a normally slow manner, the resulting carbonization of the burning vapors would extend to the steel surface being colored and impart a detrimental deposit thereon. It is therefore apparent that the preferred organic compounds are those which provide a flash point at least 20° C. above the boiling point thereof. Such limitation is particularly important in view of the difficulty of controlling the temperature of the steel part being colored in those instances in which the organic compounds with the highest boiling points are being employed.

In carrying out the process, the organic compound is placed in a suitable container which can be heated to any selected temperature between 300° C. and 400° C. and maintained at the desired temperature for any given period of time up to thirty minutes. Once the boiling point of the selected compound is attained, further heating of the container is stabilized at the temperature which will cause the vapors to rise above the surface of the boiling liquid to a height slightly greater than the maximum dimension of the part to be colored or blued. Such height may be properly controlled by passing a jet of air over the rising vapors at a point just above the part being treated. This air also provides two other functions which contribute to the successful coloring of the part. First, the relatively cool air produces the necessary refluxing or condensation of the vapors which rise from the boiling organic liquid. Secondly, the admixture of the air with the vapors in the vicinity of the metallic part being treated provides the oxygen required to react with the exposed surface and produced the desired hue.

The following two examples are representative of the manner in which the exposed surfaces of carbon steel parts can be provided with permanent preselected coloring varying from violet-blue to a deep blue-black.

EXAMPLE I

A commercial grade of 4,4'-dichlorobiphenyl, commonly identified as Aroclor, is heated at its nominal boiling point of 360° C. at a normal pressure of one atmosphere to produce refluxing vapors. A carbon steel part is suspended by any suitable apparatus within the refluxing vapors without, however, coming into contact with the liquid surface of the boiling medium. A jet of cool air is then passed over the rising vapors at a point just above the suspended part. When thermal equilibrium has been re-established, the carbon steel part reaches the temperature of the surrounding refluxing vapors and begins to change in color from straw to violet to blue usually within

five (5) minutes. As the part remains in the boiling vapors for an additional ten (10) minutes, the blue color first pales to a slight extent and thereafter gradually darkens until a lustrous blue-black gunmetal color is obtained. The specific timing of the color change is, of course, subject to some degree of variation since the greater the boiling temperature of the selected organic compound above the minimum required to produce a specific color, the faster the desired color is reached.

EXAMPLE II

In order to provide a violet-blue coloring on a carbon steel part, the latter is suspended in the refluxing vapors derived from the boiling of alpha nitronaphthalene. The transition from violet to blue is several minutes slower than that achieved in Example I inasmuch as the nitronaphthalene boils at the considerably lower temperature of 306° C. As the part under treatment remains in the refluxing vapors beyond ten (10) minutes, the blue color first pales and then deepens to a violet shade of blue. Even though the part continues to be exposed to the refluxing vapors, no further change in color takes place since that is determined by the temperature to which such part is raised rather than the length of time such temperature is maintained.

Like the various substances currently being utilized to blue or color steel, the organic compounds of the high boiling point type also tend to decompose under prolonged use. However, unlike all other previous procedures, the contents of the coloring bath need not be continuously replenished in order to maintain the desired uniformity of color whenever parts are being treated on a production basis. This desirable feature stems from the fact that the change in color is not being produced by the organic compound but by the refluxing vapors arising therefrom. Consequently, no tars or other non-volatile decomposition products come into contact with the steel surfaces being colored to cause unevenness of color or even unsightly staining. The uniformity of color achieved through the use of refluxing vapors is even more remarkable in comparison to those other procedures which utilize molten baths. In the latter cases, the fused or molten salts in the bath react with the metal under treatment to produce oxides which tend to stick to the treated surfaces and interfere with the uniformity of the coloring.

Another desirable attribute of these high boiling point organic compounds lies in the ability of the refluxing vapors to dissolve the fats and greases normally existing on the surfaces of steel parts. Consequently, the time-consuming and expensive degreasing process normally utilized to clean the surfaces of the steel parts prior to the coloring thereof can be completely eliminated. Furthermore, since a high degree of heat is provided by the refluxing vapors, any traces of the organic compound which may condense on the steel surfaces being treated is rapidly evaporated without introducing any noticeable variation in the intensity and hue of the coloring being produced thereon.

Thus, there is here provided a superior method for coloring and bluing steel surfaces which will provide a variety of uniform hues without the necessity for any time-consuming prior or subsequent treatment of the steel.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A process for forming a colored oxide coating on steel surfaces comprising the step of exposing the surfaces to the effluent vapors of an organic compound in the presence of air until the desired coloring is attained, said compound being selected to be chemically inert to steel and possess a boiling point between 305° C. and 360° C.

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2. A process for coating steel surfaces with colored oxides of desired hue comprising the steps of producing effluent vapors from an organic compound selected to be chemically inert to steel and to possess a boiling point between 305° C. and 360° C., and suspending the steel to be colored within said vapors beneath a flow of cooler air until the desired hue is attained.

3. The process defined in claim 2 wherein the heating of the organic compound is continued to a temperature above the boiling point thereof but below the flash point thereof as determined by the open-cup procedure.

4. The process defined in claim 2 plus the step of passing a jet of air through the vapors above the steel to impart a refluxing action to the vapors.

5. A process for coating steel surfaces with a deep blue-black oxide layer, comprising the steps of heating an organic compound having a boiling point of 360° C. to produce effluent vapors chemically inert to steel, passing a jet of cooler air through the upper portion of said vapors to provide a refluxing action thereto, and suspending the surfaces to be coated within the refluxing vapors until the desired coloring is attained.

6. The process defined in claim 5 wherein the selected organic compound is 4,4'-dichlorobiphenyl.

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7. A process for forming oxide coatings varying from light violet-blue to a deep blue-black on untreated steel surfaces, comprising the steps of selecting an organic compound which will be chemically inert to steel and possess a boiling point between 305° C. and 360° C. selected in accordance with the intensity of the coloring desired, heating said compound to a temperature between the boiling and flash points thereof to produce effluent vapors, passing a jet of cooler air through the upper portion of said vapors to impart a reflux action thereto, and suspending the steel surfaces above said organic compound but within said effluent vapors until the desired color is attained.

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