ABSTRACT: Copper rods which are coated with an oxide scale are descaled and brightened by introducing the rod at a temperature of from 800°F to 1,600°F into a descaling zone which is substantially free of oxygen. While in the descaling zone, the rod is exposed to an atmosphere which contains at least 50 percent by volume of vapors of an organic compound. The organic compound is a lower alkyl monohydroxy alcohol, a lower alkyl polyhydroxy alcohol, a lower alkyl ketone or a mixture of any of these materials. After the reaction in the descaling zone is completed, the rod is quenched in an aqueous coolant without exposure to an oxidizing environment.
DESCALING COPPER RODS

This invention relates to a process for the descaling and brightening of a copper rod to eliminate an oxide scale therefrom, and in particular, to a process for the descaling of a copper rod in which the rod is exposed to vapors of an organic compound at elevated temperatures.

Copper rods from which copper wire is drawn are commonly formed by the hot-rolling of cast copper wire bars. The hot-rolled copper rod is usually circular in cross section and commonly about five-sixteenths inch or three-eighths inch in diameter. Since the hot-rolling operation is normally carried out in the open air, the resulting copper rod is usually covered with an oxide scale, some of which is only loosely adherent to the underlying metal. In order to produce the final copper product, the hot-rolled copper rods are cold-drawn into wire. The presence of the oxide scale on the copper rod during cold-drawing would generally result in defective wire and would cause severe wear problems with respect to the dies used in the cold-drawing operation. Therefore, the oxide scale must be removed before the rod is cold-drawn.

One procedure long used for removing scale from copper rod involves immersing the rod in a dilute sulfuric acid solution. In this procedure, commonly known as pickling, black-cupric oxide scale is readily removed, but the underlying and more firmly adherent cuprous oxide scale may be only partially removed. Another known procedure used to insure thorough removal of the oxide scale involves drawing the rod (usually after pickling) through a shaving die by which a thin shaving of the rod surface is mechanically removed.

Other procedures for removing scale from copper rods have also been developed. One such process that has enjoyed marked success involves exposing the rod to an atmosphere containing a halide vapor or a halogen at a temperature below 700°F., then heating to a dull red heat (e.g., about 1,200°F.), and then cooling to room temperature. This procedure results in the formation of a scale which separates readily and leaves the surface of the rods clean, free of dust and slivers, and free of objectionable pits.

These commercially used descaling procedures have a common disadvantage. All of these processes involve the consumption of a substantial part of the copper rods in the form of a scale loss or scrap. Generally, this loss amounts from about 1 percent to as much as 5 percent of the weight of the rods. In view of this large copper loss, special reclaiming procedures are necessary to recover the metal values of the scale scrap or pickle liquor to make the cleaning process economically feasible. The reclaiming procedure of course increases the cost of the final copper product.

It is known that copper oxide may be readily reduced to metallic copper by heating the oxide in a reducing atmosphere. One successful process for removing the oxide scale from copper rods by heating in a reducing atmosphere is found in our copending application Ser. No. 749,013, filed July 31, 1968 now U.S. Pat. No. 3,546,029. Another successful process involves inductively heating the copper rod to a temperature above 1,100°F. (up to 1,400°F.) and exposing the copper rod to a reducing atmosphere to reduce the oxide scale to metallic copper and is found in our copending application Ser. No. 812,283, filed Apr. 1, 1969.

We have devised an improved process of character described which is performed in an atmosphere containing vapors of an organic compound which atmosphere is substantially free of uncombined oxygen but which may contain substantial amounts of water vapor, and thereby we have overcome the shortcomings and inadequacies of the prior art methods while obtaining excellent descaling and brightening of copper rods.

The present invention contemplates a simple, relatively inexpensive, nontoxic and efficient process for descaling and brightening a copper rod having oxide scale on its surface which comprises introducing the rod at a temperature from about 800°F. to about 1,600°F. into a descaling zone which is substantially free of oxygen. The rod is exposed in the zone directly to an atmosphere containing at least 50 percent by volume of vapors of an organic compound. The organic compound is a lower alkyl monohydroxyalcohol, a lower alkyl polyhydroxyalcohol, a lower alkyl ketone or a mixture of any of these materials. The reaction between the oxide scale and the organic vapors is over in a short amount of time. After about a 3-second exposure in the descaling zone, the copper rod is substantially free of the oxide scale. After exposure, the organic compound vapor the rod is quenched without exposure to an oxidizing environment in an aqueous coolant bath to a temperature below that at which any substantial reoxidation of the copper can occur. The bath is in communicating relation with the descaling zone, and as a result the presence of water vapor in the descaling zone is permitted.

In performing the method of the invention, a copper rod with oxide scale on its surface is introduced into a descaling zone comprising, for example, an elongated or tubular chamber. The rod may be passed continuously through the descalcing zone in which the organic vapor atmosphere is maintained. The rod may be heated to the required temperature immediately prior to or even after entering the descaling zone, or it may come directly from a hot-rolling operation. Heating may be by any desired means. For example, it may be accomplished in an externally heated furnace or oven, or it may be by induction heating either within or without the descaling zone, or it may be by retention of the heat of a prior hot-rolling operation. Heating may be accomplished as the rod passes continuously along, or alternatively, a coil of oxidized rod may be heated to the required temperature, and then treated batchwise in the descaling chamber. In any event, the copper rod should be at a temperature of from about 800°F. to about 1,600°F. when it is subjected to reaction in the descaling chamber. The range from 1,100°F. to 1,300°F. is eminently suitable for the reaction.

Following the introduction of the rod into the descaling chamber the heated copper rod is directly exposed to the atmosphere comprising vapors of the organic compound. For this purpose, a lower alkyl monohydroxyalcohol, a polyhydroxyalcohol, a lower alkyl ketone, or a mixture thereof is placed in a suitable vessel within the descaling chamber and heated by some heating source to form within the chamber an atmosphere comprising a substantial proportion of vapors of the organic compound. Evaporation of the organic compounds which are included within the invention are such organic compounds as methyl alcohol, ethyl alcohol, butyl alcohol, isopropyl alcohol, ethylene glycol, methyl ethyl ketone, acetone and cyclohexanone. It is important to note that the atmosphere within the descaling zone should be substantially free of oxygen so as to avoid the formation of any additional oxide scale on the surface of the copper rod, or combustion of the organic vapor. However, the atmosphere may without disadvantage contain a substantial amount of water vapor. The presence of the water vapor in the atmosphere generally results from the descaling chamber being in communicating relation with the quenching bath; and does not interfere with the reducing operation nor does it affect the finish on the copper rod. However, the presence of the water vapor in the atmosphere may also result from using a mixture of the organic compound and water. A mixture of a lower alkyl alcohol with water (25 to 75 percent by volume of alcohol) may be used, for example, an ethyl alcohol-water mixture in the ratio of 1 to 1 to 2.

After the oxide scale has been reduced to metallic copper, the rod is immediately quenched in an aqueous liquid coolant to a temperature below that at which any substantial reoxidation of the copper can occur, e.g., below about 150°F. This is best achieved by positioning the exit end of the descaling chamber below the surface of the aqueous liquid coolant whereby the rod will pass directly from the reducing atmosphere within the chamber into the coolant without intervening exposure to the atmosphere. The coolant is held in a suitable container or trough (which may be open to the atmosphere).
A coolant vessel 19 is positioned adjacent the rod exit end 12 of the descaling chamber and is adapted to contain an aqueous liquid coolant, e.g., water, up to a normal level 20. The rod exit end of the descaling chamber is so positioned that it extends into the coolant vessel to a position below the normal liquid level of the coolant. Thus, the copper rod 17 emerging from the descaling chamber passes directly into the aqueous coolant without coming into contact with the air. The coolant vessel may with advantage be in the form of a relatively long shallow trough 21, equipped with guide rollers 22 for directing the rod 17 into a substantially horizontal path for advancement through the coolant vessel.

Inside the tube 15, at the rod entrance end 11, is a seal (not shown), which permits the passage of the rod into the chamber but prevents substantial leakage of air into the chamber or of organic vapors out of the chamber. At the rod exit end 12 the seal is provided by the coolant. Thus, aside from the passage of water vapor into the chamber from the coolant vessel there can be no substantial gas or vapor leakage into or out of the descaling chamber.

Located at the bottom of chamber 10 is a vessel 23 which is used to contain the liquid organic compound 24 within the chamber. Immediately below the vessel and outside of the chamber is a burner 25 which is used to heat the organic compound to the proper temperature to that vaporization of the compound can be formed. These vapors fill the chamber and pass through the perforations 16 located in tube 15. Subsequently, the vapors contact the oxide rod 17 and reduce the oxide scale on the surface thereof.

We claim:

1. A method for descaling andbrightening a copper rod having oxide scale on its surface which comprises:
   a. introducing the rod at a temperature from about 800° to 1,600° F. into a descaling zone, said descaling zone being substantially free of oxygen;
   b. exposing the rod in the zone at said temperature directly to an atmosphere containing at least 50 percent by volume of vapors of an organic compound selected from the group consisting of lower alkyl monohydroxy and polyhydroxy alcohols, lower alkyl ketones, and mixtures thereof, to effect substantially complete reduction to metallic copper of the oxide scale thereon;
   c. thereafter quenching said rod without exposure to an oxidizing environment in an aqueous coolant bath to a temperature below that at which any substantial reoxidation of the copper can occur, said bath being in communication with the descaling zone allowing the presence of water vapor in the descaling zone.

2. The method according to claim 1 wherein the rod is at a temperature from about 1,100° to 1,300° F.

3. The method according to claim 1 wherein the descaling zone is an elongated region immediately surrounding the rod and the organic compound is located in a container immediately below the rod.

4. The method according to claim 1 wherein the copper rod is a hot-rolled prior to descaling and is introduced into the descaling zone directly from the rolling operation while still hot.

5. The method according to claim 1 wherein the rod is inductively heated to the descaling temperature.

6. The method according to claim 1 wherein the point at which the rod exits from the descaling zone is submerged below the surface of the liquid coolant.

7. The method according to claim 1 wherein the rod is continuously passed into and through the descaling zone.

8. The method according to claim 1 wherein the copper rod is in the form of a heated coil of oxidized copper and is treated batchwise in the descaling zone.

9. The method according to claim 1 wherein the organic compound is a mixture of a lower alkyl alcohol with water, said mixture containing about 25 percent to 75 percent by volume of alcohol.
10. The method according to claim 1 wherein the organic compound is an alcohol selected from the group consisting of methyl alcohol, ethyl alcohol, butyl alcohol, isopropyl alcohol, and ethylene glycol.

11. The method according to claim 1 wherein the organic compound is a ketone selected from the group consisting of methyl ethyl ketone, acetone and cyclohexanone.

12. A method for descaling and brightening a copper rod produced by a continuous forming operation and having an oxide scale on its surface which comprises:
   a. introducing the rod from the continuous forming operation at a temperature of about 800° to 1,200° F. into a sealed rolling mill system, the atmosphere in said rolling mill system being substantially free of oxygen,
   b. having the rod in the rolling mill system at said temperature in contact with a mixture of a coolant lubricant and an organic compound selected from the group consisting of lower alkyl monohydroxy and polyhydroxy alcohols, lower alkyl ketones and mixtures thereof, to effect substantially complete reduction to metallic copper of oxide scale thereon, and
   c. cooling the rod without exposure to an oxidizing environment to a temperature below that at which any substantial reoxidation of the copper can occur.

13. The method according to claim 12 wherein the coolant lubricant is an oil-water emulsion.

14. The method according to claim 12 wherein the organic compound is selected from the group consisting of methyl alcohol, ethyl alcohol, butyl alcohol, isopropyl alcohol, ethylene glycol, methyl ethyl ketone, acetone and cyclohexanone.

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