

UNITED STATES PATENT OFFICE

2,483,075

METHOD OF COPPER COATING IRON PARTICLES

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No Drawing. Application December 15, 1944,
Serial No. 568,397

3 Claims. (Cl. 117-100)

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This invention relates to cupreous-coated iron powder for use in powder metallurgy, and has for its object the provision of certain improvements in the manufacture of cupreous-coated iron powder.

As pointed out in the copending patent application of John L. Overholt, Ser. No. 568,396, filed December 15, 1944, cupreous-coated iron powders have been found to possess certain advantageous properties for powder metallurgical purposes. Thus, objects made of cupreous-coated iron powder, compacted and sintered in accordance with customary practices of powder metallurgy, possess superior tensile strength and hardness in comparison with objects similarly made of uncoated iron powder. In accordance with the disclosure of the aforementioned application, a cupreous coating is imparted to the particles of iron powder by intimately mixing the powder with finely divided or pulverulent oxidized cupreous material capable of reduction by hydrogen to the metallic state, e. g. cuprous oxide, and subjecting the mixture to a temperature of 150 to 600° C. (preferably 450-550° C.) in an atmosphere of hydrogen until reduction is complete, usually 1 to 2 hours. The resulting cupreous-coated iron particles are cooled in an inert atmosphere (preferably hydrogen), milled lightly if necessary, and screened. Copper-coated iron powders with a copper content of about 10% give excellent powder metallurgical results.

I have discovered that the inclusion of a small amount of copper chloride in the mixture of iron powder and oxidized cupreous material materially aids the complete envelopment of the iron particles in a continuous coating of the reduced cupreous material. Based on that discovery, the present invention involves the improvement in the aforementioned method of making cupreous-coated iron powders which comprises including copper chloride, and preferably cuprous chloride, in the mixture of iron powder and cuprous oxide or other oxidized cupreous material. About 1% by weight of the copper chloride, based on the weight of the mixture, gives excellent results, although marked improvement is attained with smaller amounts of copper chloride. The invention further contemplates the manufacture of cupreous-coated iron particles by the inclusion in the mixture with iron powder of copper chloride, and preferably cuprous chloride, as the sole or main source of copper. While either cupric or cuprous chloride may be used in practicing the invention, cuprous chloride is preferred since cupric chloride is too volatile, hygroscopic and usu-

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ally contains water of hydration. The copper chloride should be finely divided or pulverulent and preferably anhydrous.

When iron powder and copper oxide are mixed in a mortar, by tumbling on paper or in a ball mill, and regardless of the type of iron powder or oxide used, microscopical examination shows that the copper oxide does not uniformly coat the surface of the iron powder particles, but that relatively large areas are uncoated and the oxide tends to flocculate. When such imperfectly coated iron particles are reduced by hydrogen, the reduced copper migrates over the surface of the iron particles and more or less completely envelops them in a coating of copper, in spite of the fact that the temperature is too low for appreciable alloying to occur, and that both iron and copper oxide are solids having no appreciable vapor pressure at the contemplated operating temperatures. Frequently, however, the coatings are poor, and many areas of the particles are uncoated. This is particularly so when the iron powder contains an appreciable amount of iron oxide, or when the copper oxide is made by roasting or oxidizing copper (roasted copper oxide). The inclusion of copper chloride (preferably cuprous chloride) in the mixture of iron powder and copper oxide promotes migration of the reduced copper over the surface of the iron particles resulting in more complete and satisfactory cupreous coating thereof.

It is believed that the copper chloride acts as a flux or wetting agent, and so conditions or wets the surface of the iron particles that the reduced copper easily migrates over and completely envelops them. Cuprous chloride melts at about 422° C. and experiments indicate that at temperatures of from 450 to 550° C. the melted cuprous chloride creeps over the surface of the iron particles before being itself reduced by hydrogen. Thus, the cuprous chloride wets the surface of the particles and facilitates their envelopment by the reduced copper. It is also possible that the mutual solubility of cuprous oxide and cuprous chloride, and perhaps of iron oxide and cuprous chloride, aid in spreading the reduced copper over the iron particles. Whatever the explanation, the presence of copper chloride during the hydrogen reduction of the mixed iron powder and copper oxide results in more complete and satisfactory coating of the iron particles by the reduced copper, irrespective of the source and quality of the iron powder or copper oxide or both.

The invention is particularly applicable to iron powders containing an appreciable amount of

iron oxide. Thus, a poorly reduced, low temperature iron powder was mixed with electrolytic cuprous oxide (11.8% Cu_2O based on the mixture), and reduced with hydrogen to obtain a copper-coated iron powder containing about 10% copper. The iron particles were not completely coated, and many had substantial uncoated surface areas. The addition of 1% cuprous chloride to a similar mixture containing 11.8% cuprous oxide, followed by hydrogen reduction under similar conditions, resulted in excellently coated iron particles with all surface areas covered.

The invention is also of particular advantage where the copper oxide or other oxidized cupreous material is made by roasting or oxidizing copper. Thus, finely ball milled, roasted copper oxide (cuprous oxide) was elutriated with water to obtain a product of about 2 microns average particle size. A dispersing agent (sodium hexametaphosphate) was added in order to obtain good size fractionation. The sized suspension was then flocculated, by the addition of a little sulphuric acid, to aid filtration. The resulting pulverulent cuprous oxide was mixed with a high grade iron powder, and the mixture subjected to hydrogen reduction to produce a copper-coated iron powder. The iron particles were not completely covered with the copper coating, and there were many uncoated areas. The substitution of electrolytic copper oxide for the roasted copper oxide resulted in somewhat better coated iron particles. Repetition of these experiments with the addition of 1% by weight of cuprous chloride to the mixtures of iron powder and cuprous oxide (11.8% by weight in each instance) resulted in greatly improved coatings, of good appearance and color and with few uncoated areas.

The use of hydrochloric acid instead of sulphuric acid as the flocculating agent during the filtration of ball-milled, roasted copper oxide results in the retention of some chloride (presumably cuprous chloride) by the copper oxide, and this is a suitable means for incorporating in the cuprous oxide some, if not all, of the copper chloride contemplated for the practice of the invention. Roasted copper oxide must be ball milled and elutriated to obtain the desired fine particle size for cupreous coating. Similarly, electrolytic cuprous oxide may, and usually does, contain some chlorine, presumably as cuprous chloride. Thus, chlorine contents of from 0.6% to as much as 1.5% have been found, by analysis, in various lots of commercial electrolytic cuprous oxide. Such amounts of chlorine (as cuprous chloride) contribute beneficially to the quality of the cupreous coating, and this provides

another means for incorporating in cuprous oxide all or part of the desired cuprous chloride for the practice of the invention.

The cupreous coating on the particles of iron powder may be copper itself or it may be an alloy of copper such, for example, as bronze. Thus, in imparting a tin bronze coating to iron particles, the iron powder is mixed with pulverulent cuprous oxide and stannic oxide, and in accordance with the invention about 1% by weight of cuprous chloride is included in the mixture.

I claim:

1. In the method of coating with copper particles of iron powder suitable for use in powder metallurgy by subjecting an intimate mixture of iron powder and a finely divided oxide of copper in the form of a coating of the copper oxide on the particles of iron powder to a reducing treatment with hydrogen, the improvement which comprises including about 1% by weight of copper chloride in the mixture of iron powder and copper oxide.

2. In the method of imparting a cupreous coating to particles of iron powder suitable for use in powder metallurgy in which the iron powder is intimately mixed with finely divided cuprous oxide to produce a coating of the cuprous oxide on the particles of iron powder and the mixture is subjected to a temperature of from 450 to 550° C. in an atmosphere of hydrogen, the improvement which comprises including about 1% by weight of cuprous chloride in the mixture of iron powder and cuprous oxide.

3. The method of coating with copper particles of iron powder suitable for use in powder metallurgy which comprises intimately mixing the iron powder with finely divided cuprous oxide and about 1% by weight of cuprous chloride to produce a coating of the oxide and chloride on the particles of iron powder, subjecting the mixture to a temperature of from 450 to 550° C. in an atmosphere of hydrogen in the course of which iron particles are coated with reduced copper, and cooling the copper-coated iron particles in an inert atmosphere.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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1,919,806	Schulz	July 25, 1933