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METHOD FOR THE PRODUCTION OF IRON
POWDER FROM SPONGE IRON

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Coated welding electrodes consist of a core wire and a surrounding coating which assists slag formation during welding. During the last 20 years, iron powder has become increasingly used in the coating with the objective of increasing the electrode yield. The term yield means the weight of welding material deposited as percentage of the weight of melted core wire. By mixing iron powder into the electrode coating, electrodes were soon produced with yields over 100%, normally 115–120%. These however, are now considered as low-yield electrodes in comparison with the more recently developed high-yield electrodes with yields around 175–220%.

Iron powder for welding electrodes must meet demands for low price with high purity. In particular, low contents of sulphur and phosphorus, low carbon content and at the same time low content of residual oxygen are required. Dry-reduced iron powder, normally produced by crushing and milling of highly reduced sponge iron has, from the beginning, been very suitable for this purpose.

For high-yield electrodes, however, other properties become dominant which have previously caused difficulties when using dry-reduced iron powder, particularly with maintenance of a minimal coating thickness on electrodes with yields of 170% or more. These demands refer mainly to grain size and apparent density.

Normal dry-reduced iron powder has an apparent density of 2.3–2.5 g./cm.³, but this has in recent years been increased by a cold-working technique to 2.7–2.9 g./cm.³. This apparent density is, however, still too low to make possible the production of high-yield electrodes with minimal coating thickness, even though such powder could be used for production of electrodes with yields up to 180%.

Previously marketed dry-reduced iron powders have been characterized by a very irregular grain shape, in which the grain shows a multitude of spikes and corners and with both open and closed pores. The amount of fine grains in such powder, moreover, is usually very high. Consequently an electrode coating material with the high content of such powder necessary for high-yield electrodes, has so much internal friction that it is practically impossible to extrude it as a coating around a core wire without the use of an excessive amount of liquid, primarily water-glass, which is used both as binder and lubricant in electrode production. Such a coating can also easily have too high electrical conductivity.

This invention concerns a new dry-reduced iron powder, in which the difficulties described above can be entirely eliminated. This powder has the characteristic that it consists of grains with rounded configuration, with such a reduced content of both open and closed pores that with a maximum grain size of 35 mesh U.S. Standard (equivalent to 0.50 mm.), the powder has an apparent density of 3.3–3.8 g./cm.³.

Certain applications demand a very low content of fine grains in the powder, while others require a higher fines content. These requirements can obviously be satisfied by sieving out the unwanted grain fractions. From the viewpoint of technical production it is, however, simpler to sieve out a greater amount of the fines, i.e. 30% of the powder by weight, and thereafter remix a suitable amount of the separated fines to meet differing requirements.

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The invention also includes a method for producing this powder. Powder has previously been produced by crushing and milling of sponge iron and then sieving of the powder obtained. Attempts have also been made to increase the apparent density of the powder by cold-working and repeated milling, with a final heat treatment in protective atmosphere to remove the cold-working effects, particularly the increase of hardness caused by cold-working.

The production method according to the invention has generally the same working cycle as is described above, but is distinguished from it by the characteristic feature that between the cold-working operations and the final milling an annealing operation is performed in non-oxidizing atmosphere at a temperature of 750–1200° C. for between 15 minutes and 4 hours, with the objective of achieving a limited sintering of the material, a shorter time demanding naturally a higher temperature. If the cold-working is done by rolling the material into strip, or by pressing into large briquets, it may be advisable to disintegrate or crush the material to small pieces before annealing.

It is also possible to mix in alloying elements such as Ni, Mo, Mn or Si in the iron powder before the cold working operation, and in this case the annealing should be performed within the temperature range of over appr. 1000° C., while for pure sponge iron powder the most suitable temperature range is 800–1000° C.

In certain cases a soft annealing can be performed after milling to the final sieve analysis, e.g. with the objective of increasing the compressibility of the powder.

The invention will be described in more detail below as an example of the production of a 35 mesh (U.S. Standard) powder, i.e. a powder with maximum grain size of 0.50 mm.

Sponge iron produced by the Höganas method, i.e. by reduction of iron ore concentrate with coke in a ceramic container at a temperature below melting temperature, is crushed if necessary to a suitable size for a compressive cold-working, e.g. rolling to a more or less continuous strip, pressing to briquets or forging, and then compressively cold worked. The cold worked material is then annealed at a temperature between 750 and 1000° C. for a time between 15 minutes and 4 hours to achieve the required sintering, and then the sintered material is crushed and milled to the desired grain size. After milling the powder can if required be given a conventional soft-annealing in protective atmosphere, normally hydrogen.

Iron powder produced by this new method has a proportionately lower content of fine grains in comparison with previously available dry-reduced iron powder, but even so it is for certain purposes desirable to further reduce the amount of fine grains. This is done by sieving. The sieving can be performed in such a way that only the unwanted fine grains are sieved out in each separate case. From the production point of view it is, however, preferable to arrange the sieving operation for separating of a chosen percentage of the powder weight, e.g. 25–35%, and thereafter remix the desired amount of the separated powder.

Example

Powder with the specification 35/120 mesh, i.e. with grains which during manufacture have passed through a 35 mesh sieve, but will not pass through a 120 mesh sieve.

Precrushed sponge iron is milled in a disintegrator with a 3 mm. sieve. The milled material is then rolled into strip and again disintegrated into pieces of 20 mm. maximum size, of which about 50% lies between 0.5 and 20 mm. The material so obtained is annealed in an electrically heated belt furnace, being held at 975° C. for 20 minutes in a hydrogen atmosphere. A partial sintering

of the material is thereby obtained. After cooling to room temperature, the material is milled in 2 stages in disintegrators with 2 mm. and 1 mm. sieves respectively. After milling, the material is sieved on sieving machines with 35 and 120 mesh sieve cloths. The oversize grains which remain upon the 35 mesh sieve are returned to the disintegrators.

The final product consists therefore of a 35/120 mesh powder (the coarse fraction) and a 120 mesh powder (the fine fraction). The coarse fraction forms about 70% of the weight of the original material, with an apparent density of 3.5 g./cm.³. The fine fraction has an apparent density of 2.8 g./cm.³.

The importance of the annealing operation after the compressive coldworking lies in the fact that with the same working cycle, but without the annealing, at least 70-75% of the powder by weight must be sieved away to obtain the equivalent sieve analysis for the coarse fraction of the powder in the above example, and even then the apparent density is no higher than 2.9 g./cm.³.

According to the invention it is also, of course, possible to produce finer grained powder by continued milling, with correspondingly high apparent density, e.g. powder with maximum grain size of 40, 45, 50, 60 or 70 mesh (U.S. Standard).

The new powder is especially suitable for coated electrodes but can also with advantage be used for certain powder metallurgical purposes, e.g. for production of poleshoes, for which a final annealing at 700-900° C. (recrystallization annealing) has been shown to give the powder a remarkably good compressibility.

What is claimed is:

1. A method for the production of iron powder from sponge iron, comprising subjecting the sponge iron to a compacting cold-working treatment, annealing the cold-worked sponge iron in a protective atmosphere at a temperature of 750-1200° C. for a time between 15 minutes and 4 hours, crushing and milling the annealed sponge iron to form an iron powder, and sieving said iron powder to remove finer iron powder in an amount sufficient to produce a coarser fraction having an apparent density of at least 3.3 g./cm.³.

2. A method as claimed in claim 1, characterized in sieving the iron powder to remove, as fines, 25-35 percent by weight of the powder, and re-adding such a quantity of said fines to the coarser fraction as to give said coarser fraction an apparent density of 3.3-3.8 g./cm.³.

References Cited by the Examiner

UNITED STATES PATENTS

2,735,757	2/56	Zapf	75-5
2,902,357	9/59	Crooks et al.	75-5

OTHER REFERENCES

Powder Metallurgy, Selected Government Research Reports, vol. 9, published by His Majesty's Stationery Office, London, 1951, pp. 37-38 and 80-81.

DAVID L. RECK, *Primary Examiner*.