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PRODUCTION OF SINTERED METAL PRODUCTS

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ABSTRACT OF THE DISCLOSURE

Process for production of sintered metal products containing nickel and carbon comprises compacting and sintering special powder mixture containing nickel-coated graphite particles.

The present invention relates to powder metallurgy and more particularly to the production of sintered alloys which contain both carbon and nickel.

The production of alloy steel components by sintering powder compacts is becoming of increasing importance, largely because a finished component can be made without working steps and with very little machining; in addition excellent control can be exercised over the composition. However, a common disadvantage of the resultant products is inadequate ductility.

Heretofore, for production of sintered metal compacts, nickel and carbon have been introduced into the compacts to be sintered as nickel powder and graphite powder.

It has now been discovered that sintered steel products having desirable useful characteristics can be produced by a new powder metallurgical process.

It is an object of the present invention to provide a process for production of sintered alloy products containing nickel and carbon.

Other objects and advantages will become apparent from the following description.

Generally speaking, the present invention contemplates a powder metallurgical process for production of sintered steel products containing nickel and carbon comprising providing a special mixture of powder particles which contains the carbon in the form of metal-coated graphite particles, mixed with other powder particles for the alloy, and then compacting and sintering the powder mixture to convert the powder mixture to an alloyed condition. The metal on the graphite is most advantageously nickel. It is found that the ductility of the sintered product is most surprisingly increased.

The reason why the ductility of the steel is improved by the invention is not certain, but it is possible that the coated graphite flows more readily when the powder compact is made. Again, there may be improvement in the alloy structure by diffusion during the sintering step. There is some support for this theory in the fact that the improvement in ductility is greater when the sintering temperature is high.

Nickel-coated graphite can be produced in various ways.

for example by decomposing nickel carbonyl onto a fluidised mass for graphite particles, by the electrodeposition of nickel onto graphite particles, or by hydrometallurgical precipitation techniques. The particle size of the graphite may vary considerably, for example between 4 and 100 microns. The weight of the coating also varies, both in accordance with the method of coating and the particle size of the graphite. In general the nickel amounts to from 50 to 70% by weight of the coated particles.

Iron-coated graphite can be produced by similar methods.

Graphite powder as commercially produced by different manufacturers varies somewhat in particle size and shape, with the result that the metal-coated powder also varies. The strength and ductility of sintered steels of identical chemical composition vary in accordance with the particular coated powder used, but improvement in the ductility of appropriately sintered steels is always obtained by replacing uncoated graphite by similar graphite with a metal coating.

When, as is much preferred, the graphite is coated with nickel, the coatings will not normally introduce as much nickel into the steel as is required, and the remainder is introduced as nickel powder.

The invention is particularly useful in the production of steels containing from 0.5 to 7% nickel and from 0.3 to 1% carbon, with or without copper up to 5%, manganese up to 4% and molybdenum up to 1%, the balance being iron except for unavoidable impurities.

For the purpose of giving those skilled in the art a better understanding and appreciation of the advantages of the invention the following illustrative examples are given of processes according to the invention and also, for comparison, of other processes not in accordance with the invention.

The table below gives details of four steels according to the invention (Steels 1 to 4) together with those of three comparative steels (A, B and C). The aim in each case was to make a 5% nickel steel containing 0.55 carbon, the balance (except for very small quantities of impurities) being iron. All the compacts were made by mixing the powders for 1 hour in a double-cone mixer and then pressing the mixtures at room temperature. The nickel powder was carbonyl-nickel powder from 4 to 7 microns in size. The powder, which formed the balance of each mixture, was Hogenas HC iron powder less than 150 microns in size. The graphite was that sold as Acheson G 10 and was all less than 50 microns in size. The nickel-coated graphite was made by the decomposition of nickel carbonyl onto G10 graphite, containing 56% nickel, 41% carbon and 3% ash, and was less than 50 microns in size. The iron-coated graphite was made by the decomposition of iron carbonyl onto G10 graphite, contained 60% iron, 37% carbon and 3% ash, and was also less than 50 microns in size.

The compacts of Steels 1, 2, 4 A and B, were all made under a pressure of 54 hectobars and then sintered for 1 hour at 1300° C. in argon. Those of Steels 3 and C were made under a pressure of 77 hectobars and then sintered for 1 hour at 1120° C. in cracked ammonia. These are two conventional manufacturing processes.

TABLE

Steel	Ni-powder, percent	Graphite, percent	Ni-coated graphite, percent	Fe-coated graphite, percent	UTS, hecto-bars	Elongation, percent
1	4.45		1.1		50.0	8.8
A	5.0	0.55			50.0	5.3
2	4.25		1.30		56.0	14.5
B	5.0	0.55			57.4	9.5
3	4.25		1.30		50.4	5.0
C	5.0	0.55			46.6	4.2
4	5.0			1.35	56.2	12.0

It will be seen that when the sintering was effected at 1300° C., the ductility of the steel made with nickel-coated graphite increased materially, as shown by the elongations of the comparative Steels 1 and A, and 2 and B, respectively; and when the steel was made with iron-coated graphite the increase was still material but not so large, as shown by a comparison of Steels 4 and B. When the compacts were sintered at 1120° C., there was again increase in ductility, as shown by comparison of steels 3 and C, but not so large as when the sintering temperature was higher. It is therefore desirable to effect the sintering in the temperature range of 1200 to 1350° C.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understod that modifications and variations may be resorted to without departing from the scope of the invention as those skilled in the art will readily understand. Such modifications and variations may be considered within the purview and scope of the invention and appended claims.

We claim:

1. A process for production of a sintered steel product characterized by the chemical composition of a preselected steel alloy comprising providing a powder mixture comprising metal powder particles consisting of metals in the preselected steel composition and also comprising metal-coated graphite particles selected from the group consisting of nickel-coated graphite particles and iron-coated graphite particles and compacting and sintering said powder mixture to convert the powder mixture to an alloyed condition.

2. A process as set forth in claim 1 wherein the metal-coated graphite particles are nickel-coated graphite particles.

3. A process as set forth in claim 1 wherein the powder mixture contains nickel particles in addition to the nickel-coated graphite particles.

4. A process as set forth in claim 1 wherein the metal powder mixture contains 0.5% to 7% nickel, 0.3% to 1% carbon, up to 5% copper, up to 4% manganese and up to 1% molybdenum, with the balance essentially iron.

5. A process as set forth in claim 1 wherein the sintering is effected in the temperature range of 1200° C. to 1350° C.

6. A process as set forth in claim 1 wherein the metal-coated graphite particles are nickel-coated graphite particles and wherein the sintering is effected in the temperature range of 1200° C. to 1350° C.

7. A process as set forth in claim 1 wherein the powder mixture comprises 0.5% to 7% nickel, 0.3% to 1% carbon, up to 5% copper, up to 4% manganese and up to 1% molybdenum with the balance essentially iron, the metal particles are of metals selected from the group consisting of nickel, copper, manganese, molybdenum and iron, the particle size of the graphite in the metal-coated graphite particles is 4 microns to 100 microns, the metal coatings on the graphite particles are nickel and the nickel coatings amount to 50% to 70% by weight of the coated particles and wherein the sintering is effected at 1200° C. to 1350° C.

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