W13-35

9901509-1

Description

COMPOSITE METAL POWDER FOR SINTERED BEARING, AND SINTERED OIL-RETAINING BEARING

Technical Field

This invention relates to a composite metal powder for a sintered oil-retaining bearing and a sintered oil-retaining bearing, for example, a bearing used for electric motors which can easily have a low gas permeability at a low cost without lowering the oil content and which has a low and constant friction, so that it has high abrasion resistance, excellent compatibility and high durability.

Background of the Invention

The sintered compact of copper-coated iron powder for a bearing is disclosed in Japanese Patent Publication No. 38019/1980, which proposes the use of an iron powder coated with 30 to 60% of copper. Japanese Patent Laid-Open No. 166303/1991 discloses addition of a foil powder made of the same metal as that of the coating layer or an alloying metal.

Further, Japanese Patent Publication No. 54126/1995 proposes addition of a copper-graphite

composite powder because of the necessity for lowering the gas permeability to improve the characteristics of the sintered oil-retaining bearing. Japanese patent Laid-Open No. 20836/1996 proposes a bearing material of a copper-coated iron powder which has a gas permeability of 30 darcies (30×10^{-11} cm^2) or less while retaining an oil content of 18% by volume or more, and in which an iron powder coated with 30 to 60 wt% of copper is used and is sintered in a zinc atmosphere to adsorb the zinc.

The aforementioned disclosure of Japanese Patent Publication No. 38019/1980 comprises coating of 30% or more of copper and, accordingly, needs to use expensive copper in a large quantity, so that the cost has to rise and the overlying copper layer is too thick to attain a sufficient surfacing effect of the iron particle to incur a disadvantage that the sliding performance as the bearing is deteriorated. Further, in Japanese Patent Laid-Open No. 166303/1991, since the foil powder made of the same metal as that of the coating layer or the alloying metal is added, this incurs disadvantages that the process is complicated and stable characteristics can not be achieved. Especially, since the gas permeability which is required for a bearing material of high performance is

not considered in them, the oil pressure is released from the oil pores in the bearing sliding face even after the compatibility has been attained to invite a disadvantage of difficulty in providing such a sliding state as is offered by fluid lubrication which is ideal for the sintered oil-retaining bearing.

Japanese Patent Publication No. 54126/1995 describes for the suppression of the gas permeability in which the addition of the copper-graphite composite powder inevitably increases the price of the powder and incurs a disadvantage of reducing the strength of the sintered compact. Further, the disclosure of Japanese Patent Laid-Open No. 20836/1996 comprises the use of 30 to 60% of a copper-coated iron powder and includes a step of sintering the powder in the zinc atmosphere to adsorb the zinc, so that it can provide excellent characteristics as such but the quantity of required copper is large and the sintering in the zinc atmosphere is required to increase manhours, which inevitably increases costs.

Disclosure of the Invention

In this invention, investigations have been made for solving the aforementioned problems of the prior art and it has succeeded in achieving a preferable

bearing performance at a relatively low cost by employing a composite alloy powder, in which iron powder is coated with 10 wt% or more and less than 30 wt% of copper, and setting a specific surface area of the composite metal powder to within a predetermined range and a gas permeability of the sintered green compact of the composite metal powder to within a predetermined range to thereby set an oil content in a predetermined state.

According to this invention, the iron powder is coated with 10% or more of copper to cover the surface of the iron powder completely thereby enhancing the corrosion resistance and improving the compatibility with a shaft material or the like. In addition, by making the copper quantity to less than 30%, a low cost is ensured, and the surfacing effect of the coated iron particle is optimized to stabilize the sliding performance as the bearing. The method of coating the iron powder with copper is not particularly specified, but an electroless plating method makes the coating copper layer porous to enlarge the specific surface area and to lower the gas permeability in the powdery state.

By the setting particle size of the aforementioned copper-coated iron powder to 80 meshes

or less, and that of 30% or less of the powder to 350 meshes or less, the copper-coated iron powder can be easily achieved without requiring any special starting powder but by employing the iron powder for usual powder metallurgy, and the mold can be easily operated to obtain products at a low cost without any difficulty in the charge of the mold.

The aforementioned composite metal powder has a specific surface area set to 450 cm^2/g or more by the sub-sieve sizing method to lower the gas permeability as the composite metal powder, and is molded and sintered while keeping its characteristics, to provide a bearing having high oil content and strength but low gas permeability. The specific surface area has an upper limit of 750 cm^2/g by sub-sieve sizing method to improve the chargeability of the green compact into the mold to thereby facilitate molding at compacting.

Further, by setting the gas permeability of the sintered green compact to 3×10^{-11} cm^2 or more, the oil feed amount during bearing action is properly retained and, by setting the same to 30×10^{-11} cm^2 or less, moreover, unreasonable release of the oil pressure is blocked to ensure a preferable oil feed to the shaft surface and the accompanying bearing action.

A proper durability as the bearing material is

ensured by setting the oil content to 15% by volume or more, and the strength of the bearing material is ensured to optimize the durability by setting the same to 28% by volume or less. Further in this invention, it is possible to add a solid lubricant or a low-melting metal such as tin.

According to this invention, moreover, the sintering can be facilitated, and the compatibility during bearing action can be properly improved by adding 0.1 to 2 wt% of tin and/or lead as the low-melting metal.

According to the invention, coefficient of friction during sliding movement of the bearing is further reduced to lower the temperature rise during a long-time bearing action by adding one kind or two kinds or more of graphite, molybdenum disulfide and boron nitride as the solid lubricant.

Best Mode for Carrying Out the Invention

(Example 1)

Specific modes for carrying out the invention will be described together with comparative examples. First of all, the iron powder, as used by the present inventors, has a copper coating amount of 20 wt%, a particle size of - 80 meshes and a specific surface

area of 573 cm^2/g, which was molded in both example and comparative examples into a cylindrical green compact having an internal diameter of 6 mm, and external diameter of 12 mm and a height of 4 mm, and was sintered in an ammonia decomposed gas at 1,000°C for 30 min.

The thus obtained sintered compact was subjected to an ordinary sizing treatment and an oil immersing treatment to provide bearings each having an oil content of 20% by volume and subjected to a bearing test under the following conditions:

Shaft Material: S45C Green material

Load: 0.81 N/cm^2, 1.63 N/cm^2 and 3.26 N/cm^2;

Sliding Speed: 52.9 m/min;

Impregnation Oil: Mineral oil 32 cst

The comparative examples for the above-described example of the invention are as show below.

Comparative Example 1:

Iron powder coated with 20 wt% Cu having a particle size of - 100 meshes, a specific area of 295 cm^2/g was employed to produce a bearing sample under conditions similar to those of Example 1 and was subjected to a bearing test under the same conditions.

Comparative Example 2:

Reduced iron powder of - 100 meshes and

electrolytic copper powder of - 150 mesh were mixed at a weight ratio of 8:2, which were employed to produce a bearing sample under conditions similar to those of the example and subjected to a bearing test under the same conditions as those of the example.

The results of the bearing tests, as made on the materials of the example and the comparative examples in terms of abrasion loss and temperature rise of the bearings (difference from room temperature) are as shown in the following Table 1, the results of measurement show the average value for respective three samples, and it can be sufficiently confirmed that materials of the examples of this invention had smaller temperature rises and were superior in abrasion resistance and in sliding characteristics compared with those of Comparative Examples 1 and 2.

Table 1

	Max. Temp. Rise value (°C)			Final Temp. Rise value (°C) and Abrasion Loss					
	0.81 N/mm²	1.63 N/mm²	3.26 N/mm²	0.81 (N/mm²)		1.63 (N/mm²)		3.26 (N/mm²)	
				(°C)	Abrasion loss μ	(°C)	Abrasion loss μ	(°C)	Abrasion loss μ
Example 1	8	9	11	5	0.7	6	1.6	8	1.7
Comp. Example 1	7	10	24	7	2.9	8	2.4	17	2.8
Comp. Example 2	9	8	9	9	1.9	7	3.4	8	3.4
Example 2	12	15	16	8	0.5	10	1.0	11	1.2
Example 3	10	12	18	8	0.7	8	0.9	11	1.0
Example 4	8	8	11	5	1.0	5	1.8	10	2.0
Example 5	7	8	10	6	1.6	6	2.1	8	2.4

For the examples of this invention and Comparative Examples 1 and 2, the oil content, the radial crushing strength constants, the hardness and the gas permeability were measured, respectively, and the results are as shown in the following Table 2, to reveal that the oil content, the strength and the Rockwell hardness were substantially similar. Further, Comparative Example 2 has a somewhat higher gas permeability than those of the examples. In other words, it can be understood that the excellent characteristics of this invention could be achieved by the bearing of the examples because they has both the characteristics of the gas permeability of 30×10^{-11} cm^2 or less and of the copper-coated iron.

Table 2

	Oil content (vol.%)	Radial crushing strength constant (N/cm^2)	Hardness (HRH)	Gas permeability ($\times 10^{-11} cm^2$)
Example 1	21.1	3.45	74	10.0
Comp. Example 1	20.8	3.33	72	51.0
Comp. Example 2	20.0	3.41	71	12.8
Example 2	20.2	4.54	83	20.1
Example 3	21.3	3.92	81	10.3
Example 4	20.3	3.15	71	7.3
Example 5	20.7	2.41	66	3.5

(Example 2)

A sintered compact having the same shape as that of Example 1 was made under the same conditions as those of Example 1 by adding 1.0 wt% of tin powder to the powder of Example 1. The bearing characteristics of the compact are as shown also in Table 1, and the oil content, the strength, the hardness and the gas permeability are as shown also in Table 2.

(Example 3)

A sintered compact having the same shape as that of Example 1 was made at a sintering temperature of 860°C under the same conditions as those of Example 1 by adding 1.8 wt% of tin powder to the powder of Example 1. The bearing characteristics and the oil content of the compact are also as shown in Tables 1

and 2.

(Example 4)

A sintered compact having the same shape as that of Example 1 was made under the same conditions as those of Example 1 by adding 0.5 wt% of graphite powder to the powder of Example 1. Further, the bearing characteristics and the oil content of the compact are also as shown in Tables 1 and 2.

(Example 5)

A sintered compact having the same shape as that of Example 1 was made under the same conditions as those of Example 1 except for changing the sintering temperature to 860°C, and adding 1.0 wt% of graphite powder. The bearing characteristics and the oil content of the compact are as also shown in Tables 1 and 2.

Industrial Applicability

According to the invention, as has been described above, a sintered oil-retaining bearing can be achieved with ease and at a low cost to properly provide a bearing which has a minimal friction and excellent compatibility and which can reduce the gas permeability and abrasion and have an excellent durability, without lowering the oil content.



Claims

1. A composite metal powder for a sintered bearing in which an iron powder is coated with 10 wt% or more and less than 30 wt% of copper; the powder has a size of 80 meshes or less, than 30% thereof has a size of 350 meshes or less; and a specific surface area of the powder is 450 cm^2/g or more and 750 cm^2/g or less by a sub-sieve sizing method.

2. A sintered oil-retaining bearing formed by compacting and sintering the composite metal powder for a sintered bearing as set forth in claim 1 to provide a sintered compact having a gas permeability of 3 to 30 x 10^{-11} cm^2 and an oil content of 15 to 28% by volume.

3. A sintered oil-retaining bearing as set forth in claim 2, in which from 0.1 to 2 wt% of a low-melting metal is added.

4. A sintered oil-retaining bearing as set forth in claim 2, in which from 0.1 to 1 wt% of a solid lubricant is added.

5. A sintered oil-retaining bearing as set forth in claim 3, in which from 0.1 to 1 wt% of a solid lubricant is added.