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Development of Machine-Building Materials and Details of Machines from the Powders received from Waste of Raw Materials in the Industry of Uzbekistan

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Abstract:

Great opportunities for creation of highly effective antifriction materials give methods of powder metallurgy. They allow managing more differentially antifriction properties, integrating in one material the bearing basis of necessary durability and plasticity with different additives playing a role of solid lubricant or the additives activating formation processes of necessary structures of material and secondary structures of the rubbing layers. In the real work, results of researches on creation of ceramic-metal alloys are presented to an iron basis from the powders received from waste of raw materials of the industry of Uzbekistan. Because of researches, the possibility of production of ceramic-metal products of antifriction assignment from powders of local production is shown. Iron powders were received by recovery of hydrogen scale in Bekabad metallurgical factory. Pyrite is withdrawal production in the Almalyk mining and metallurgical factory.
Keywords: *ceramic-metal alloys, antifriction alloy, additive in a pyrite blend, powders from production wastes, tribotechnical tests, technology of receiving a blend and a production of products by the methods of powder metallurgy.*

I. INTRODUCTION

World production of metal powders exceeds 1 million tons now, and products from them 650-750 thousands [1].The method of powder metallurgy allows producing products of given sizes with a high accuracy that in whole or in part excludes need of machining. Remains sometimes only separate operations on finishing the sizes after installation in a node (boring, coaxiality, etc.). The sizes of the sintered detail usually are in limits of the admissions set according to the drawing and easily are led up before more high-class calibration. By means of methods of powder metallurgy, it is possible to get rid, in some cases, a mouth of the difficult machining necessary at traditional technology [2].Thus, application of the sintered products allows reaching the following advantages:

- economy of metal due to obtaining the exact sizes of details of reduction of losses when machining and decrease in production wastes and mass of product by 20-30% at the expense of a time.
- full elimination or considerable reduction of the park metal processing equipment;

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- economy of expensive non-ferrous metals (bearing alloys) as a result of replacement with their less scarce ferrous alloys;
- easy automation and the high culture of processes on production of details by the method of powder metallurgy that allows to improve working conditions of worker. Finally, it is possible to reduce considerably labor input of production and to increase labor productivity;
- utilizing wastes in metallurgical production and other industries for receiving initial powders (iron, copper, nickel, etc.).

The last advantage in this work is used completely since it issues of replacement of import powders of the Russian plant by the local, iron powders received formation scale of Bekabad metallurgical factory are resolved. Besides, as additive material are used pyrite – withdrawal of production of Almalyk mining and metallurgical plant. (AMMP).

Laboratory tests showed on an opportunity and expediency of production of ceramic-metal ferrograhpite antifriction alloys with pyrite additive based on local raw materials. Production of a pilot batch of cermet plain bearings from locally produced powders with a pyrite additive. Bench tests showed that their working capacity is not worse than at the products received from import powder.

II. METHODS

Objects of researches were the products received during the pressing and agglomeration of powders from local raw materials.

Iron powders were received by recovery of iron scale of Bekabadmetallurgical factory. Recovery was carried out among drained hydrogen at 1100-1150°Ctemperature. In quality, it is the gray containing additive used pyrite, which is withdrawal of mountain metallurgical production.

The received powders of iron corresponded to PZhV5, 450 brands. 24 and PJV5.160.28 in accordance with GOST 9849-86-"Powder iron. Specifications". It is entered on 01.05.1990.

For composing,a blend used graphite and pyrite. Graphite was taken element or pencil in accordance with GOST 4404-78“Rules for production of pencil rods. Specifications”. Pyrite was used after crushing to fraction 0.45-0.16mm.

Mixing of powders and preparation of a blend were carried out in conical mixers with additive of gasoline and stearate of zinc. Content of graphite was constant-2%. Content of pyrite was: 0.5;1.0;1.5;2.5;3.0;3.5; 4.0 in percentage. After preparation of a blend samples, necessary for tests, prepared (were pressed) according to the required sizes and a configuration for test pieces on stretching, compression and impact strength.

Tests were carried out according to GOST 25698-83-"Powder products. Methods of determination of hardness"; GOST18227 - Materials powder. Test methods on stretching; GOST 9495-75- "Materials powder. Methods of determination of impact strength”. For definition of antifriction characteristics prepared special samples in the form of plugs with an outer and inside diameter of 30 and 20 mm. Samples in the form of plugs put on trials for radial compression in accordance with GOST 26529-85-"Materials powder. A test method on radial compression". In compliance strength at radial compression decided on this state standard specification

$$G_{p.см}=\frac{p_{\max}(D-a}{L\times a^2} \quad (1)$$

$P_{\max}$ - maximum rupture load;
D- external diameter of the plug;
a- plug wall thickness;
L- length of a cylindrical part of the plug.

The pressed samples were exposed to agglomeration. For this purpose, pressings packed into containers from stainless steel then were covered with an asbestos leaf. On an asbestos leaf pig-iron shaving about 40 mm thick was filled, the container was closed by a cover, and details were coated with refractory clay. Sintering was carried out at a temperature of 1100 °C within 2 hours. After sintering containers cooled on air.

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The received samples put on hardness tests, durability according to the above-stated standards.

Density and porosity defined according to GOST 18398-73- "powder metallurgy. Methods of determination of density and durability". Oil content in the impregnated powder products was determined by a weight method in accordance with GOST 24903-81.

From each lot of products not less, than on 3 samples prepared micro sections and carried out the metallographic analysis on microscopes of МИМ-6M and Neophot-21. Researches were conducted after etching of micro sections 4% HNO3 solution ethyl alcohol according to GOST 901-78 at increases in 100 and 300 times.

III. RESULTS OF RESEARCHES

As initial materials used the iron powders received by recovery of iron scale of Bekabad metallurgical factory. Recovery was made by heating of scale in the atmosphere of hydrogen. Recovered powder underwent additional grinding then carried out sifting on sets for obtaining required particle size distribution. The technical composition of the prepared powders corresponded to GOST 9849-86.The prepared powders mixed up and quality of a sulfur-containing component added pyrite of production of Almalyk mining metallurgical plant the particle sizes of 0.1-0.071 mm.

From initial materials, the blend prepared by mixing of iron powders, graphite elementary ГЭ-3 brand and pyrite was prepared. The main received alloys was selected the structure corresponding to ЖГр2 alloy grade. Pressing of products was carried out on the K0628 press submachine gun with a productivity of 15 samples a minute. Sintering was carried out in stainless steel containers with filling parts with cast-iron shavings at a temperature of 1100 0C for 2 hours.The received products and samples were put on mechanical tests, metallographic researches and also other types of tests according to ТУ 23.1.324-83 distributed to products from powder materials on an iron basis of brands Ж intended for production of products antifriction constructional assignments.

Results of tests are given on the figure 1. Density of the received products was a little overestimated, and anoil absorption is a little underestimated. Hardness has a little higher values. Introduction to a pyrite blend from 0.5 to 1.5% leads to some decrease in density and growth of anoil absorption [3]. It is followed by some decrease in hardness and durability, however atcontentpyrite up to 1% all properties meet specification requirements 231.324-83.

The microstructure of alloy represents a ferrite-perlite basis in which sections of inclusions of graphite and sulfides (fig. 2) are visible[4].

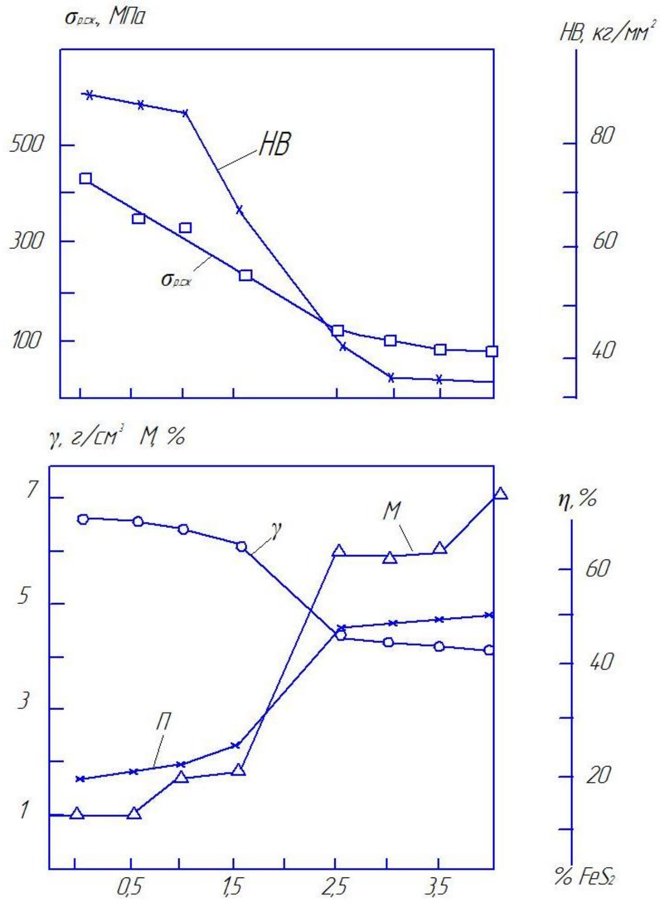
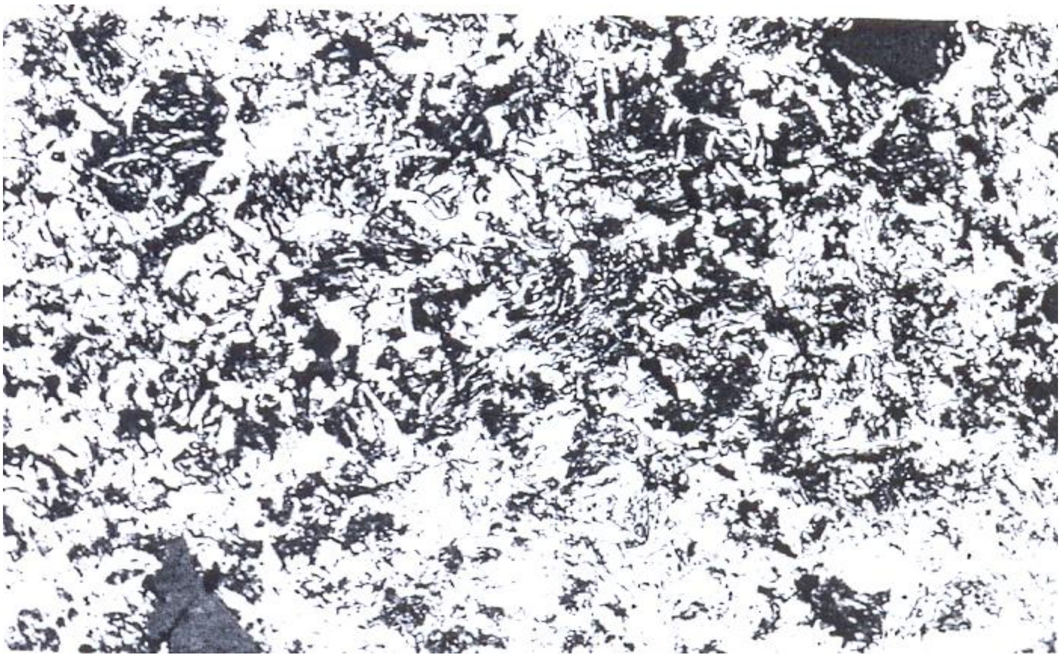
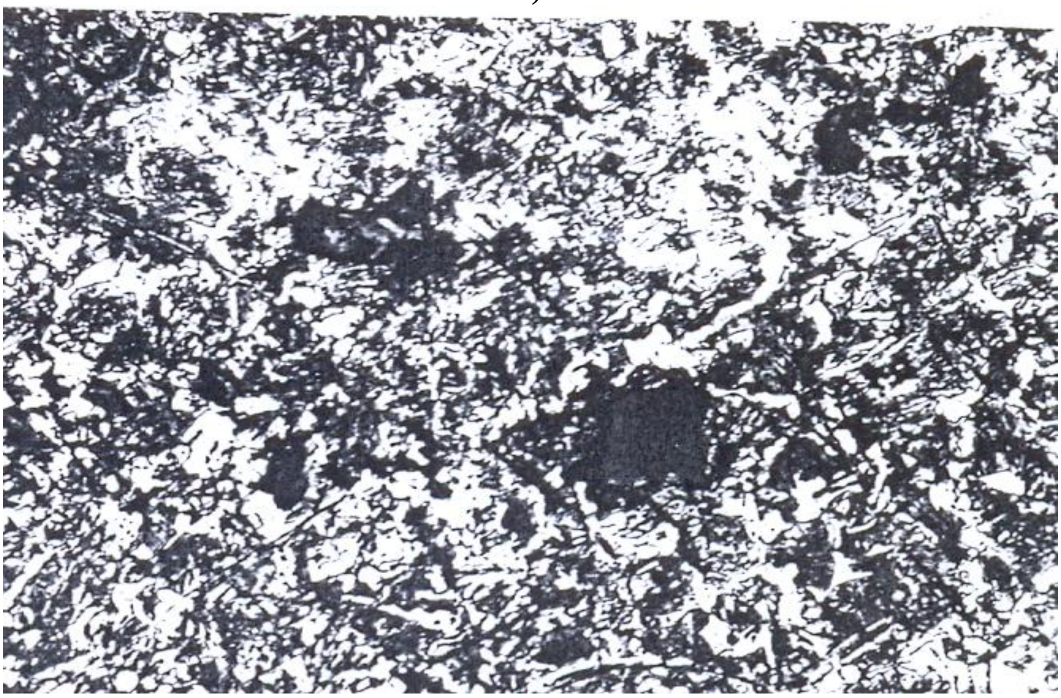


Fig. 1. Dependence of hardness of HB, durability on radial compression σr.t, density of , porosity P, oil absorption of M of porous antifriction alloy on the basis of iron from contents in a pyrite blend

At contents, more than 2% of pyrite sharply increase in a blend porosity that is necessary to connect with gas generation at decomposition of FeS2 in the course of agglomeration. Growth of porosity leads to decrease in density and increase in an oil absorption. Strength properties and hardness sharply decrease.



a)



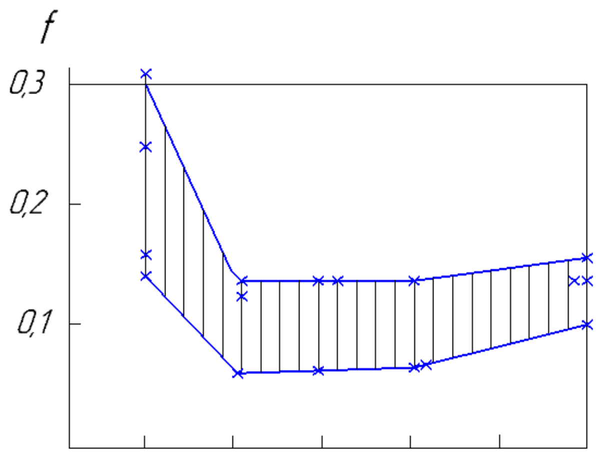
b)

Fig. 2. Microstructures of ferrographite ceramic-metal alloys with additive in a pyrite blend

For carrying out tribotechnical tests plugs were manufactured. The received plugs had the sizes: outer diameter is 32 mm, internal – 20 mm, height is 10 mm. Plugson outer diameter were ground to diameter of 30+0.05 mm. Tribotechnical tests were carried out by the machine MI-1M at a sliding friction without additional lubricant.The plug was installed on the lower live spindle of the test machine. A counter body were the axle boxes made of steel 45 and thermally processed on the hardness of HRC 52 – 54. Speed of the lower spindle of machine 500 RPM that gives the sliding speed at outer diameter of the plug of 30 mm – 0.78 m/s (47.1 m/min). The normal load on an axle box made 50 kilogauss (or 490 N). As the axle box had the area of friction of 2 cm2, specific pressure was 245 N/sm2.

Table 1.:Friction coefficient to the value of wear of porous ceramic-metal plugs at tests for a sliding friction depending on structure of a blend at preparation of alloys.

Typeof a blend	Wear, mm	Coefficient of friction
Iron	0,28	0,16-0,23
Powder	0,07	0,23-0,36
+ 2% graphite,	0,03	0,13
Withoutpyrite	0,15	0,13
Iron	0,02	0,06
Powder	0,09	0,13
+ 2% graphite	0,01	0,13
+0,5 pyrite	0,01	0,13
Iron powder	0,015	0,05
+ 2% graphite	0,02	0,05
+1 % pyrite	0,01	0,13
	0,015	0,13
Iron	0,02	0,05
Powder	0,02	0,05
+ 2% graphite	0,01	0,13
+1,5% pyrite		
Iron	0,23	0,1-0,16
Powder	0,12	0,16
+ 2% graphite	0,07	0,13
+2,5 pyrite	0,04	0,13



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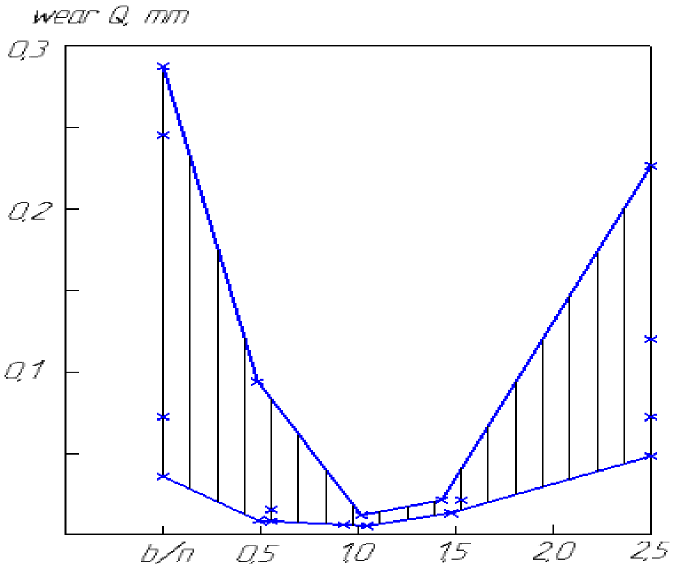

b) % FeS_2

Fig. 3. Change of value of wear (a) of friction coefficient (b) of iron graphite plugs depending on additives in a pyrite blend after impregnation of plugs oil and at a sliding friction without additional lubricant

The friction coefficient was determined by the moment of friction registered by the friction machine. Time of testing was 10000 turns of the lower sample.The value of wear was defined by a linear method of diameter measurement of a sample micrometer in two mutually perpendicular directions both before testing, and after testing.Apparently from the presented results, at a sliding friction of ceramic-metal porous plugs on the steel tempered axle boxes value ofplugs' wear and friction coefficient are not stable: if in alloy, there is no pyrite or its content about 0.5%. At the content in alloy of 1-1.5% of pyrite, the value of wear and friction coefficient accept the minimum values. This fact can be referred entirely to antidromic properties of sulfides at alloys with pyrite additive. Under our condition tests at a sliding friction without supply of additional lubricant at alloy without pyrite additive rather stable operation of plugs is broken quickly enough. It is connected with exhaustion of a possibility of work in the self-oiling mode when the lubricant selected from a time reaches a limit. If in an alloy structure, there are sulfides, then resistance to an edge fin considerably increases, operating time without edge fins considerably increases. Results of tests are given in table 1, fig. 3.At the content in alloy of 2.5% of pyrite, there is its significant loss of strength. In this case,wear value considerably increases due to alloy loss of strength.On the basis of received data alloy with additive of 1% of pyrite was selected and the specification on antifriction porous is made ferrous alloy with additive in a pyrite blend. The technology of receiving products from ceramic-metal alloys in the conditions of large-lot production was developed for this alloy.

IV. DISCUSSIONS

Development of trial technology on production of porous antifriction alloy was carried out taking into account production of iron powder. Iron powder is received by recovery of scale in Bekabad metallurgical factory. Recovery of the scale is carried out in electric ovens among drained hydrogen at a temperature of 1000-1100 °C in court shoes from heat resisting steel.After recovery, the received material (pitch) is ground in spherical mills and powder is sifted through a sieve. On particle size, distribution of received iron powder corresponds to GOST 9849-86, but not completely since in some brands there is no small fraction.Chemical composition of powders of localironproduction also differs from data of GOST 9849-86 a bit. It is connected with the fact that the iron scale received from Bekabad metallurgical

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factory can incorporate the accompanying elements which are not in scale of the large plants on production of iron powders.In particular, at scale of Bekabad metallurgical factory there can be elements which are available in the rolled steel. Nonmetallic impurity rather fully are removed by magnetic separation, but the elements, which are a part of solid solution with iron, remain. In particular, when processing technology of receiving porous antifriction alloys used iron powders with the increased silicon content (0.97% against 25%, before seeing GOST 9849-86). In some batches of iron powders the content of sulfides reached 0.25%.When processing technology of receiving products (plugs) from porous antifriction alloy was also established that for achievement of required mechanical properties of a product from iron powders of local production, it is necessary to sinter at a temperature not below 1100 °C. It can be connected with the increased silicon content in a blend and not complete recovery of scale.Control checks of mechanical properties of the sintered products received from preparatory blend ЖГр2ПI at agglomeration around temperatures of 1100 °C showed quite satisfactory results. Determined durability of plugs with the outer diameter of 30 mm and wall of 5 mm thick on radical compression according to, table 2.

Table 2. : Durability on radial compression of the control plugs from ЖГр2ПI alloy received from powders of local production

External diameter, Д, мм	Wall thickness, а, мм	LengthL, мм	Max. destroy. stress, P_{max}, kilogauss	Max. disturbed radial compressed tension $б_{rad.\ ten}$, MPA
30,6	5,4	15,5	625	341
30,6	5,4	15,5	630	344
30,6	5,5 4,5	15,5	620	338
30,6	5,4	15,5	580	320

Researches of a microstructure of the prepared samples showed that the maintenance of a pearlite component reaches not less than 50% that corresponds to ТУ 23.I.324-83.When processing technology of productpreparation of antifriction assignment under production conditions also took a blend with contents pyrite a bit less from more than 1% for the purpose of definition of pyrite'sinfluence on porosity (density) of a product. With increase in pyrite the sizes of sulfides increase in a blend, sulfides are placed mainly on office of a time, and the porosity increases, density (table 3) decreases.

Table 3:The comparative density of the ceramic-metal products received from a blend without additive and with pyrite additive (ЖГр2 и ЖГр2ПI)

Structure of a blend	Density, gr/sm^3
Ferro graphite ЖГр2	6,3 6,48 6,41
Ferro graphite pyrite ЖГр2П1	5,58 5,69 5,60
RequirementsТУ 23.I.324-83	5,7÷6,1

Apparently from the submitted table, density of products without additive of pyrite was overestimated in this connection the oil absorption was at the level of 1.5 ÷1.62% that below the provided level according to ТУ 23.I.324-83. Samples (plugs) manufactured of a blend with pyrite additive had an oil absorption of 2% and more that meets specification requirements ТУ 23.I.324-83.Thus, as a result of pilot works on industrial equipment porous products of antifriction assignment from ЖГр2ПI alloy which in all respects answer with requirements of specifications of ТУ 23.I.324-83 were received.

CONCLUSION

On the basis of the conducted researches it is possible to draw the following conclusions:

1. The iron powders meeting the requirements of the standard can be received by recovery of scale in Bekabad metallurgical factory.
2. Production of iron powders in more stoutly reasonable since their cost are twice lower than import.
3. By production of porous antifriction products as sulfur-containing additive pyrite withdrawal of production can be used in Almalyk mining and metallurgical plant.
4. The sintered antifriction ceramic-metal alloys received from local raw materials both on mechanical, and meet for antifriction properties of requirements of specifications.
5. Optimum structure of a blend by production of ceramic-metal alloys of antifriction assignment is 97% of iron powder, 2% of element or pencil graphite and 1% of pyrite.

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