Technology For The Production Of Workpieces And Metal Powder Products

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ABSTRACT

In our country, the production of spare parts for cars and equipment from metal and non-metal materials, which is developing year by year, is developing in a combined manner. In this article, it is explained how important the production of metal powder products, which are successfully used in the national economy, is important for the machine-building and automobile industry, and that extensive work is being carried out on new models and methods of technological processes.

Keywords: Metal, powder, technology, metallurgy, mixture, alloy, non-ferrous metal, steel, bearings, grinding, metal-ceramic, organic, inorganic, temperature, dispersion

Introduction

Powder metallurgy is understood as a technological process covering the complex production of metal powders and metal-like compounds, semi-finished products and products made from them or their mixtures from the solution of the main components with non-metallic powders [1,2].

The rapid development of powder metallurgy has created the necessary conditions for the development of a wide class of alloys that are used as substitutes for traditional casting and hammering, steel and alloys, and materials with properties that cannot be obtained by other technological processes.

Materials and methods

The advantages of powder metallurgy compared to other methods of production of equipment parts and devices are as follows:

- obtaining products that cannot be produced by other methods (filters, porous bearings, contacts from alloys based on refractory metals, etc.);
- it is possible to save a lot of metals, use waste (for example, shavings, soot, shavings, etc.) to obtain powders, and obtain products without further mechanical processing (bushes, gears, balls, etc.), which significantly reduces the cost of materials and finished products will reduce the cost [3,4].

In addition to the advantages, powder metallurgy has several disadvantages: expensive equipment (economic growth in serial and multi-series production), instability of properties, and difficulties in the production of large-sized and complex-shaped products.

The main technological operations of the production of powder products:

a) preparation of a powder mixture with a given chemical and granulometric composition;
b) forming - moulding (pressing);

v) baking to give the pressed planks the necessary strength and physical-mechanical properties;

d) additional processing depending on the purpose of the products and their requirements (mechanical, thermal, etc.).

Table 1. Methods of obtaining and processing powders

Production of metal powders		
Chemical processes	Physical processes	
Reduction of oxides	Grinding solids	Melt pollination:
Precipitation from alkali and feathers	Mill:	- drop by drop;
Thermal separation	- disc;	- turning;
Electrochemical deposition	- spherical;	- vacuum;
	- putty;	- hit;
	- liquid substance	- ultrasonic;
		- electrodynamic

Metal powders and non-metallic material powders are the main raw materials for the production of powder products. The industry produces metal powders: iron, copper, nickel, chromium, cobalt, tungsten, molybdenum, titanium, etc. There are various methods of obtaining metal powders: mechanical grinding (shards, scraps), metal spraying, recovery of soot or pure oxides, carbonyl, electrolysis and other process methods (Table 1). Powder physical methods can be divided into two large groups, which cover about 95% of all technological processes currently in use: mechanical grinding of solids and methods of spraying solutions [5,6].

Grinding, grinding or polishing can be an independent method of obtaining metal powders and an additional operation for other methods of their production. Jaw, roller and conical disk crushers, as well as sieves, are used for coarse grinding. The coarse grinding product consists of sand particles with a particle size of 1... .10 mm. The final grinding of the material is carried out in ball-rotating, vibrating and planetary centrifugal, sharp-edged hammer and hammer mills. The powder particles have a size of 0.2 to 0.002 mm.

Recovery of metals from their oxides is one of the most common methods of obtaining metal powders. In this method, powders of iron, copper, nickel, tungsten and other metals, as well as powders of steels, and metal alloys - powders of alloyed and corrosion-resistant steels are obtained. Oxide recovery methods are classified depending on the reducing agent and aggregates used, the type of charge and its delivery method to the reducing zone, the pressure of the reducing gases and the temperature of the process [7,8].

The iron powder obtained by the reduction method is divided into the following types according to its chemical composition: PJV1, PJV2, PJVZ, PJV4, and PJV5, where PJ is iron powder, the following numbers are the degree of chemical incompatibility of the powder in terms of compounds.

Characteristics of the main industrial methods of powder production are presented in Table 2.

Table 2. Description of the main methods of obtaining metal powder

Recovery with hydrogen, carbon monoxide and their mixtures	*$MeO + H_2$^ ^ $Me + H_2O$ MeO + SO ^ ^Me +SO2 Grinding, classification and incineration of recovered particles*	*Fe, W, Ni, Re, Mo, Sa, Cu, alloyed alloys and steels*	*Soot, ore concentrate, coal inclusions*

Metal-ceramic restoration with sodium, magnesium	MeO + [TV] ^ ^ [TV]O + Me	Ti, Zr, Ta, Hf, Cr, Nb	Oxides, complex fluorides (Ta, Nb, Zr)
Dusting liquid metal with air or gas	Dispersion of molten metal flow under gas pressure of 0.4...1.5 MPa. Drying and recovery of powder ashes	Iron, high-speed and corrosion-resistant steel, non-ferrous metal alloys	Synthetic cast iron, given the metal composition
Electrolysis of aqueous solutions	Metal powder deposits from aqueous solutions of salts during direct current conduction	Fe, Ni, So, W, Mo, Cu, Cr, Fe-Ni, Fe- Ni-Mo, Ni-Cu, Ag	Sulfate salts and other solutions
Molten salt electrolysis	Metal powder deposits in molten salt solutions at a temperature of 700...800 °C	Ta, Nb, Al, Zr, Th,	Oxide mixtures with complex fluorite
Grinded in mills, sifted, and mixed	Crushed by pounding and rubbing	Fe, Al, bronze	Struzhka

The presence of a large number of recovered substances predetermines the possibility of obtaining metal powders by various methods. Oxidized ores and rolling soot are used as raw materials in the production of iron powder by recovery. Copper, nickel, and cobalt powders are obtained from oxides by recovery and electrolysis of aqueous solutions.

Production of nickel, copper, and cobalt powders by reducing their water-soluble compounds with pressurized hydrogen is a common method. This process is often referred to as autoclave recovery.

The chemical properties of metal powders depend on the composition of the main metal or the main components that make up the alloy powder, the composition of impurities, various mechanical impurities and gases. In technical classifications for powders, supplying enterprises usually indicate the composition of the main metal and impurities, so sometimes it is necessary to determine the complete chemical composition. In this case, the properties of the components are determined by chemical and spectral analysis [9,10].

Descriptions of the physical properties of the powders include the shape and size of the powder particles, the distribution of the particle granules, the size of the specific surface of the particles, the psychometric density, and the state of the crystalline structure of the powdered metal (Table 3).

Depending on the method of obtaining the powder, the shape of the particles is spherical (carbonyl and dusted), drop-shaped (dusted), edge-shaped (regenerated), dendritic (electrolytic), plate-shaped and fragmented (powders obtained as a result of grinding in a vortex and ball mills, vibrating mills, fibrous and petaloid (in breaking down liquid metals).

Table 3. Physico-technological properties of naturally-alloyed metal powders

Powder	Burr form	Surface, m2/g	Likno metric pressure, g/cm3	Sparse density, g/cm3	Density, g/cm3, at MPa pressure			Powder particle size, µm
					200	400	700	
PPL-18 XSND (Steel Soot Recovery)	Gravel, not straight	0.29	7.43	4.35	5.1	5.7	6.3	3...5

PPL-PKP (derived from the Ore-Critsa-Powder scheme)	Uneven, sometimes gravelly	0.5	7.6	1.9	4.9	5.8	6.5	10...15
PLL-PV-PPX (recovery of chlorides)	It wasn't right	0.4	7.2	2.0	4.6	5.3	5.8	10...15
PVLJ-X (iron cakes, nickel production)	It wasn't right	0.4	7.5	2.6	4.6	5.6	6.5	10...15
PPL-15GS (steel soot recovery)	Rude, Incorrect	0.26	7.5	2.18	4.8	5.6	6.3	40...125
PVLJ-OV (iron cakes, nickel production)	Rude, Incorrect	0.43	7.35	2.7	3.9	4.3	4.7	10...250
PJPZ (solution pollination)	Spherical	-	-	2.65	-	-	6.9	76

The shape of the powder particles has a great influence on their mass density and compressibility, as well as on the uniformity of density, strength and compaction.

Depending on the particle size, powders are divided into ultra-fine powders with a particle size of less than 0.5 μm; very small (OM designation) with a size of 0.5 to 10 microns; small (M) - from 10 to 40 microns; medium (C) - from 40 to 150 microns and large (K) - from 150 microns and above.

Powder density, compaction pressure, baking shrinkage or shrinkage, and mechanical properties of finished products depend on the particle size of the powders, along with other properties. The finer the powders, the more pressure is required during pressing to achieve a certain density of compacts, and the resulting workpieces are stronger and ripen at lower temperatures.

The next important physical characteristic of powders is the specific surface of the particles, which is understood as the total area, the surfaces of all particles taken in a unit of volume or mass. The specific surface area depends on the particle size and shape.

Technological properties include mass density, fluidity and compressibility of powders. The mass density of powders is a volumetric characteristic, which is the mass of a freely filled powder volume. Bulk density represents the packing ability of powder particles and depends on the density of the powder metal, the actual filling of the powder with a certain volume, dispersion, particle shape and specific surface area.

The fluidity of powders describes the speed at which the powder passes through a hole of a certain diameter. The fluidity of the powders is an important property, because the speed and uniformity of filling the mould depend on it, which is especially important in automatic pressing. The main factors affecting the fluidity of powders are friction and the adhesion of particles to each other (internal friction). Compressibility is the ability of the powder to form a briquette of a certain shape with a minimum permissible density under the influence of a given pressure. Compression is determined by two technological properties: compressibility and formability. Compression is the dependence of briquette density on the value of pressing pressure. Compression characteristic is a compression diagram constructed in "density - compression pressure" coordinates.

Formability is the ability of the powder to maintain a given shape at certain density values. The formability of the powder is characterized by a density range limited by the minimum and maximum density values, in which the compact is not damaged after removal from the mould

Brief description of powder materials

The preparation of powders for pressing is a crucial step in the production of powder products because the quality of the mixture is reflected in the properties of the finished product. The preparation of the mixture is related to the standardization of powders with a certain chemical and granulometric composition, followed by mixing. Characteristics of materials used in powder metallurgy are presented in Table 4.

Table 4. Description of materials used in powder metallurgy

Material	*Powder density, 103 kg/m3*	*Compact material density, 103 kg/m3*	*Poisson's ratio, d*
Aluminum	1.0...1.7	2.5...2.7	0.36
Iron	1.8...3.0	7.8...7.85	0.28
Copper	1.5....2.5	6.8...7.2	0.35
Lead	3.2...3.8	7.3	0.33
Zinc	5.4...5.7	11.3...11.4	0.44

Mixing is carried out in mixers, among which mixers with an inclined axis during rotation and cone mixers are the most widely used. Both powders of different components and powders of the same component from different dispersions or methods of preparation are subject to mixing. Liquid (mineral oil, alcohol, gasoline, distilled water, glycerin) is sometimes added to the mixture to improve the mixing of powder components. In this regard, mixing is divided into "dry" (without adding liquid) and "wet". Depending on the mixing and the characteristics of the components, it can vary from a few minutes to several hours.

To improve the compaction and granulation of powders during the mixing process, plasticizing additives (paraffin organic liquid, wax, rubber, comfort, etc. solutions in organic liquids) are added to the mixer, they create added strength when pressed and reduce their content, wall mi press moulds and particles friction between themselves (external friction) and facilitate their fusion during granulation. In addition to additives that improve the pressing process, additives that form certain properties can also be added.

When pressing into the moulds, the dosage of the mixture is done by weight or volume.

The sample weight of mixture Q is calculated by the formula

$$Q = VY / QK_x K_2$$

where: V is the volume of the finished part, cm^3; uk - density of non-porous powder material, g/cm^3; Q is the relative density of the finished sintered product; K1 is a coefficient that takes into account the loss of powder during pressing (K1 = 1.005 ... 1.01, depending on the accuracy of the production of mould parts), K2 is a coefficient that takes into account the loss of mass during the cooking process due to shrinkage. K2 = 1.01.1.03 combustion of oxides and mixtures (including lubricants, plasticizers, etc.).

Conclusion

Pressing (moulding) of metal powders and their mixtures is an operation in which relatively strong semi-finished products or blanks are obtained from free-flowing powder, having the shape and dimensions of the finished product, taking into account the change in dimensions during cooking; as well as what allowances are made - or with further processing. This consists of filling the charge into the mould, pressing, briefly holding it under pressure and pushing the compacts in the presses. Blanks obtained after pressing, as a rule, have 15...25% porosity and low mechanical properties.

The height of the compact is usually 3.5 times less than the height of the powder poured into the matrix, which leads to deformation anisotropy of the properties of the compacts (mechanical, pore shape and size, conductivity). In order to obtain sufficiently strong workpieces in cold pressing, significant pressures are applied, which can vary up to 600 ... 1000 MPa, depending on the given porosity and properties of the powder mixture.

References

1. Tadjikuziyev, R. M. (2022). Technology of repair of press molds for production of machine parts from steel coils, aluminum alloys. *American Journal Of Applied Science And Technology*, *2*(04), 1-11.
2. Tadjikuziyev, R. M. (2022). Analysis of Pollution of Automobile Engines Operating in the Hot, HighDust Zone of Uzbekistan. *Eurasian Journal of Engineering and Technology*, *7*, 15-19.
3. Mamatqulova, S., & Tadjikuziyev, R. (2020). Метод оцінки рівня кваліфікації ремонтних роботників підприємства автомобільного обслуговування. *Λόγοσ. Мистецтво Наукової Думки*, (10), 41-44.
4. Tadjikuziyev, R. M. (2022). Texnologik payvandlash jixozlari, vosita va uskunalari turlaridan ishlab chiqarish korxonalarida maxsulot ishlab chiqarishda foydalanish tadbiqlari. *Science and Education*, *3*(11), 512-522.
5. Mamatqulova, S. R., Nurmatov, D. X. O., Ergashev, M. I. O., & Moydinov, N. X. O. G. L. (2020). The influence of the qualification of repair workers on the efficiency of technical operation of automobiles. *Science and Education*, *1*(9), 193-197.
6. Tadjikuziyev, R. M., & Mamatqulova, S. R. (2023). Metal kukunli (poroshokli) maxsulotlar texnologiyasi. *Science and Education*, *4*(2), 650-659.
7. Tadjikuziyev, R. M., & Mamatqulova, S. R. (2023). Rezina va nometal qismlarni ishlab chiqarish texnologiyasi. *Science and Education*, *4*(2), 638-649.
8. Mukhiddinov, S. M., & Kabilov, E. E. (2022). The effect of harmful gases emitted from the Samarkand chemical plant on human health. *Journal of Geography and Natural Resources*, *2*(06), 49-53.
9. Jorabayeva, N. A., & Kabilov, E. E. (2022). The role of wastes released from grain production enterprises in the origin of respiratory tract diseases. *Journal of Geography and Natural Resources*, *2*(06), 38-42.
10. Kobilov, E. E., & Tukhtaev, M. K. (2022). Comparative Evaluation of the Results of Treatment of Acute Adhesive Intestinal Obstruction in Children. *Eurasian Medical Research Periodical*, *15*, 1-3.