ACADEMICIA

ISSN: 2249-7137 Vol. 11, Issue 8, August 2021 Impact Factor: SJIF 2021 = 7.492

ACADEMICIA
An International Multidisciplinary Research Journal
(Double Blind Refereed & Peer Reviewed Journal)

DOI: 10.5958/2249-7137.2021.01857.7

ALUMINUM-BASED COMPOSITION MATERIALS FOR PROCESSING ALUMINUM SCRAP

Usmonov J.M*; Shakirov Sh.M*; Ubaydullayev M.M*; Parmonov S.T*

*Tashkent State Technical University
UZBEKISTAN

ABSTRACT

The article deals with the construction of a mill for the production of aluminum-based structural powder composite materials, its processing process, the effect of the process on the granulometric composition of the powder, the composition of the powder from the mechanical properties of the powder obtained from the mill. The results of the study are presented below. A mill design was developed to extract aluminum powder from scrap. The main working body of the mill consists of two disks, the working surface of the disks is coated with a solid alloy of tungsten carbide cobalt.

KEYWORDS: *Aluminum Alloy, Primary Aluminum, Secondary Aluminum, Cast Aluminum, Rolled Aluminum, Processing, Powder Metallurgy, Construction Materials, Powder Composite Materials, Granulometric Composition, Particle Size, Particle Shape, Mechanical, Operational, Technological Properties, General, Technological Parameters, Technology Residual Porosity, Microstructure, Aluminum, Silicon, Mill, Number Of Revolutions.*

INTRODUCTION

Today, aluminum is one of the leading materials used in the national economy. Because aluminum has a number of advantages over other (steel and cast iron) construction materials in terms of operational and technological properties. Currently, 65% of aluminum-based parts are made of secondary aluminum [1]. At the same time, the use of secondary aluminum in the production of parts from aluminum consumes 95% less energy than the production of primary aluminum and causes less damage to the environment.

According to the statistics conducted by the specialists of the Department of Materials Science of Tashkent State Technical University, the total average amount of aluminum waste generated in various sectors of the country in 2018 amounted to 20 thousand tons [2]. At the same time, a significant share of aluminum-based waste falls mainly on the machine-building and automotive industries. Because in these industries, most large-sized parts are produced from aluminum alloys, and small-sized parts from mechanical rolled aluminum. In this case, the aluminum waste (scrap) formed as a result of mechanical processing is 30-40% of the material in the case of castings, and 60 ... 65% of the material in the case of rolled products [3].

An average of 30 ... 35% of aluminum mass (in the form of slag) is lost during the re-melting process of aluminum-based waste, especially aluminum scrap and household waste (aluminum cans, lids, foils, etc.) from mechanical processing [4]. This will further increase the demand for primary aluminum production, thereby increasing energy costs and a number of environmental issues (emissions).

To prevent the development of aluminum-based parts production by reducing the amount of secondary aluminum, increasing energy consumption and harming the environment: it is necessary to use technologies that do not require recycling of aluminum waste, save energy and materials and increase production efficiency. One of the technologies that fully meets such requirements is powder metallurgy [5].

Analysis of the literature on the production of parts of different sizes and shapes by powder metallurgy shows that powder metallurgy reduces material consumption by 2 ... 3 times, energy consumption by 2 ... 2.5 times compared to the production of parts by traditional technologies, and however, it has the potential to increase the productivity of parts production by 1.5 ... 2.5 times. In addition, powder metallurgy has the ability to obtain materials that are traditional in their properties and structure, or materials that have a completely new special complex properties [3].

Production of parts in powder metallurgy methods consists of three main stages: production of powders of metals and alloys; preparation of press briquettes in the form of details by concentrating the powder in press molds; detall press briquettes include heating and, in rare cases, additional processing if necessary [5].

RESEARCH OBJECT AND METHODS

For the production of aluminum powder at GM Uzbekistan was used shavings from mechanical processing of aluminum ingots brand ADS-12, the chemical composition of which is given in Table 1 and the mechanical properties of the casting material are given in Table 2.

A mill design was developed to extract aluminum powder from scrap. The main working body of the mill consists of two disks, the working surface of the disks is coated with a solid alloy of tungsten carbide cobalt. The granulometric composition of the aluminum powder obtained by the mill was studied by sifting the powder in VP-30T laboratory sieves, and the shape and size of the particles were studied by magnifying the powder sections 100 ... 600 times under a metallographic microscope "NEOPHOT-2".

TABLE 1 CHEMICAL COMPOSITION OF ADS-12 BRAND ALUMINUM MATERIAL

Elements, % max									
Si	Fe	Cu	Mn	Mg	Ti	Zn	Ni	Sn	Pb
12	1,3	3,5	0,5	0,3	0,3	1,0	0,5	0,2	0,2

TABLE 2 MECHANICAL PROPERTIES OF ADS-12 GRADE ALUMINUM MATERIAL

Characteristics	Value
Strength limit in elongation, MPa	165
Hardness on Brinell	85
Relative elongation before interruption, %	2,5

To prepare research samples from ADS-12 brand aluminum powder, the press briquettes of the samples were first obtained by pressing the powders in press molds at different pressures, and then they were heated in a vacuum oven at different temperatures and times.

The total porosity of the prepared test specimens is determined by hydrostatic method in accordance with the requirements of GOST 25281-82 (ST SEV 2287-80), tensile strength in UIM-50 machine, hardness in Brinel method in TSh-2M device and microstructure of slits made of them in NEOPHOT-2 metallographic microscope.

RESULTS AND DISCUSSION

The shape of the aluminum powder, powder particles and particle obtained from the ADS-12 brand aluminum scrap using a mill is shown in Figure 1.

a b c

Figure 1. Aluminum powder from ADS-12 brand aluminum scrap: a - general appearance; b - particles (x250); c - particle shape (x650)

According to the results of studies on the production of aluminum powder using a mill, it was found that the granulometric composition of aluminum powder is formed depending on the number of revolutions of the rotating disk on the axis of the mill. The formation of the granulometric composition of aluminum powder depending on the number of revolutions of the rotating disk of the mill is shown graphically in Figure 2.

As the number of revolutions of the mill disk increased from 40 to 120, it was observed that the size of the particles that make up the bulk of the aluminum powder decreased from 80 μm to 22 μm. Research has shown that as the number of revolutions of a mill disk exceeds 120, the aluminum powder particles begin to partially oxidize.

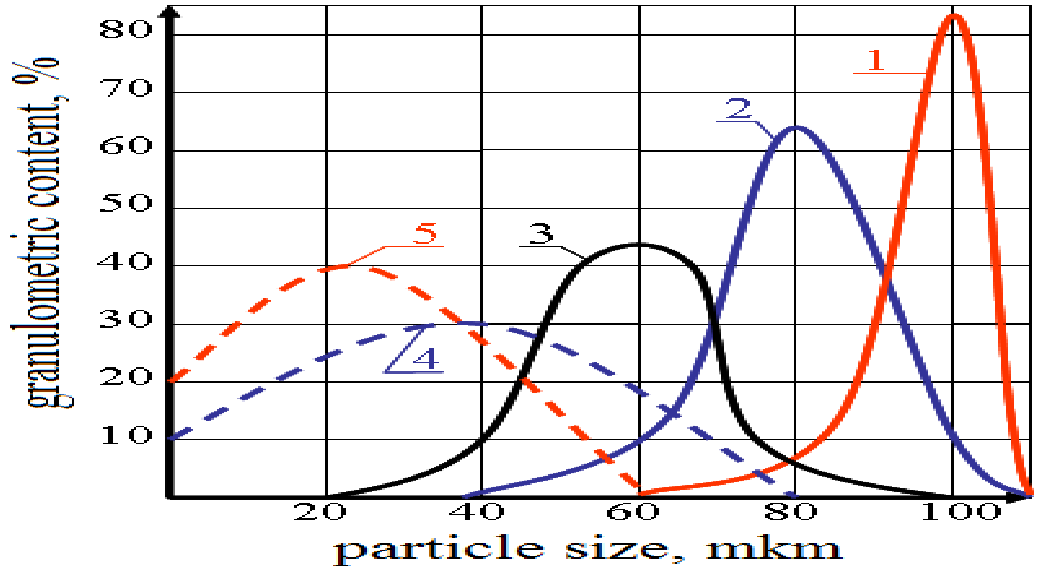

Figure 2. Formation of granulometric composition of aluminum powder depending on the number of revolutions of the mill disk:

1 - 40 months / min; 2 - 60 months / min; 3 - 80 ayl / min; 4 - 100 ayl / min; 5 - 120 ayl / min

In order to assess the suitability of the powder obtained for the production of aluminum-based composite material, powders with a particle size of 80, 60, 40, 20 and 10 μm were selected from the powder obtained at each turn of the mill disk and the samples were pressed in presses at pressures of 80-100 MPa. briquettes were prepared (Fig. 3).

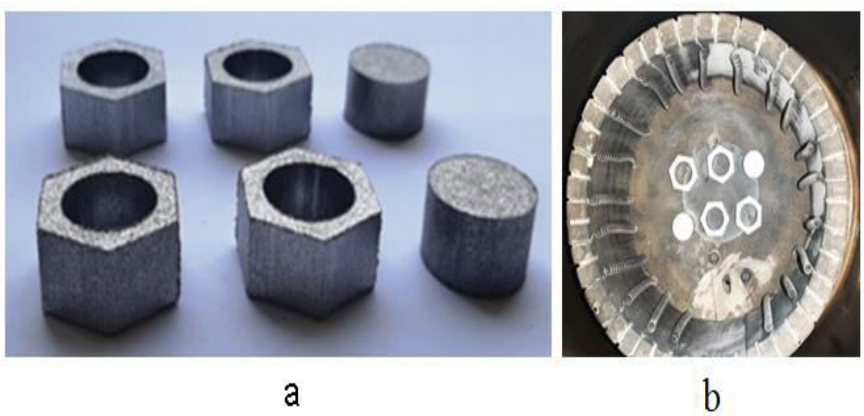

Figure 3. Research samples made of aluminum powder: a - press briquettes; b are samples placed in a vacuum furnace

Press briquettes were heated in a vacuum at a temperature of 520… 540 ^{o}C for 1 hour. During the heating process, the temperature of the vacuum furnace was raised to 520 ^{o}C for 30 min, then the samples were kept at this temperature for 60 min. After the oven temperature had cooled to room temperature, samples were taken from it.

In order to assess the strength of materials obtained from aluminum powder from ADS-12 shavings, the heated samples were tested for elongation on a UIM-50 machine. The results obtained from the elongation test of the samples are shown graphically in Figure 4.

According to the results, the tensile strength of aluminum samples with an average particle size of 80 µm was 5.5 times smaller than the tensile strength of ADS-12 material obtained by casting, and amounted to 30 MPa, however, the tensile strength of a powder sample with an average particle size of 10, 20 and 40 µm was almost equal to the tensile strength of the ADS-12 material obtained by casting.

The relative elongation and hardness of the samples were higher than that of the cast analogue in accordance with the powder-based materials.

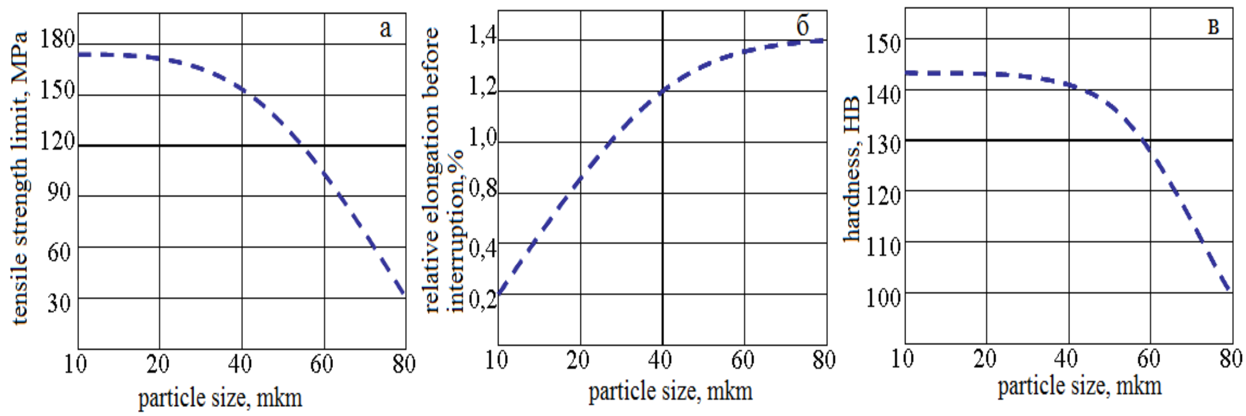

Figure 4. Depending on the particle size of the samples: a is the tensile strength limit; b is the relative elongation; c is the change in hardness

The fact that the tensile strength of specimens made from powders with an average particle size of 60 and 80 µm is smaller than that of the cast analogue is related to the amount of porosity in them [5]. According to the results of the analysis of the total porosity of the samples, the graph of the change in porosity depending on the particle size of the powder used in the preparation of the samples is shown in Figure 5.

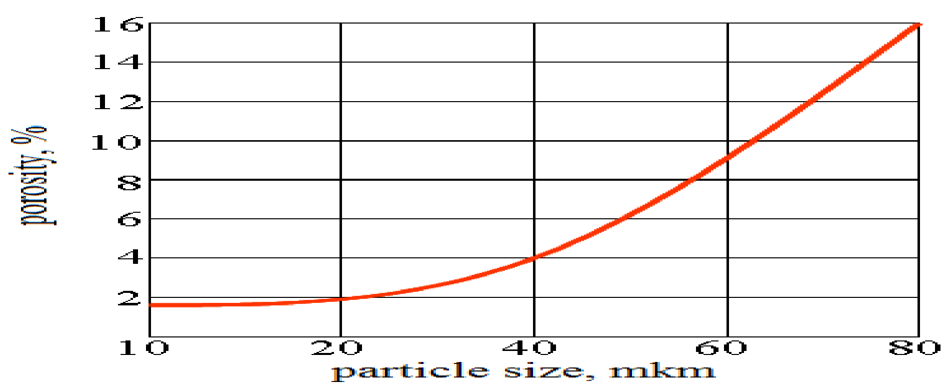

Figure 5. Graph of change of porosity of samples depending on powder particle size

The increase in the porosity of the samples with the increase in the particle size of the powder is related to the technological property of the powder obtained from the shear. The presence of 12%

silicon in the ADS-12 aluminum alloy has a negative effect on the compaction of the powder during the pressing process, but it prevents the oxidation of aluminum when extracting aluminum powder from the shavings.

CONCLUSION

Using a mill consisting of discs coated with tungsten carbide on the working surface, it is possible to obtain a powdery raw material suitable for the production of aluminum-based composite materials from ADS-12 brand aluminum alloy shavings. To do this, the number of revolutions of the mill disk should not be less than 80 and not more than 120.

It is advisable to use a powder with a particle size of 40 to 10 μm to obtain an aluminum alloy-based powder composite material for construction purposes from ADS-12 brand aluminum alloy shavings.

LITERATURE

1. Gopienko V.G., Smagorinskiy M.E., Grigorev A.A., Bellavin A.D. Spechennye materialy iz alyuminievyh poroshkov [Sintered materials from aluminum powders]. - M.: Metallurgiya, 1993.-320 s.

2. Shakirov Sh.M., Karimov Sh.A., Daminov L. Perspektiva pererabotki proizvodstvennyh otxodov // Materialy mejdunarodnogo simpoziuma «Dostijeniya fundamentalnoy nauki i obrazovaniya, innovacionnye tehnologii» [Prospects for processing industrial waste // Materials of the international symposium "Achievements of fundamental science and education, innovative technologies"]. –Komsomolsk-na–Amure. 12-16 maya, 2015. –S. 195-197.

3. Radomyselskiy I.D. i dr. Konstrukcionnye poroshkovye materialy [Structural powder materials] / I.D. Radomyselskiy, G.G. Serdyuk, N.I. SCherban. – K.: Tehnika, 1985. – 152 s., il. – Bibliogr.: s. 148 – 150.

4. Valuev D.V., Gizatulin R.A. Tehnologiya pererabotki metallurgicheskih otxodov: uchebnoe posobie [Metallurgical waste processing technology: a tutorial] / D.V. Valuev; YUrginskii tehnologicheskiy institut. – Tomsk: Izd-vo Tomskii politehnicheskii universitet, 2012. – 196 s.

5. Wittaker D. Production of Structural PM Parts// International Powder Metallurgy Directory & Yearbook. 11th Edition - 2004/2005. – P.31-47.