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Changes in its Wear Resistance When Alloying Aluminum Alloys with Lithium

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Abstract. The article investigated the hardness of aluminum alloys of grades AK7 and D16 according to wear resistance when applying a lithium fluoride compound as a flux, changes in abrasive wear resistance of samples. The study was conducted in the laboratory of "Foundry technologies" of the Tashkent State Technical University. Based on the results of the experiments, the authors present their conclusions in the article.

Keywords: quartz sand, furnace, wear resistance, corundum sand, aluminum, lithium, abrasive, sand-clay.

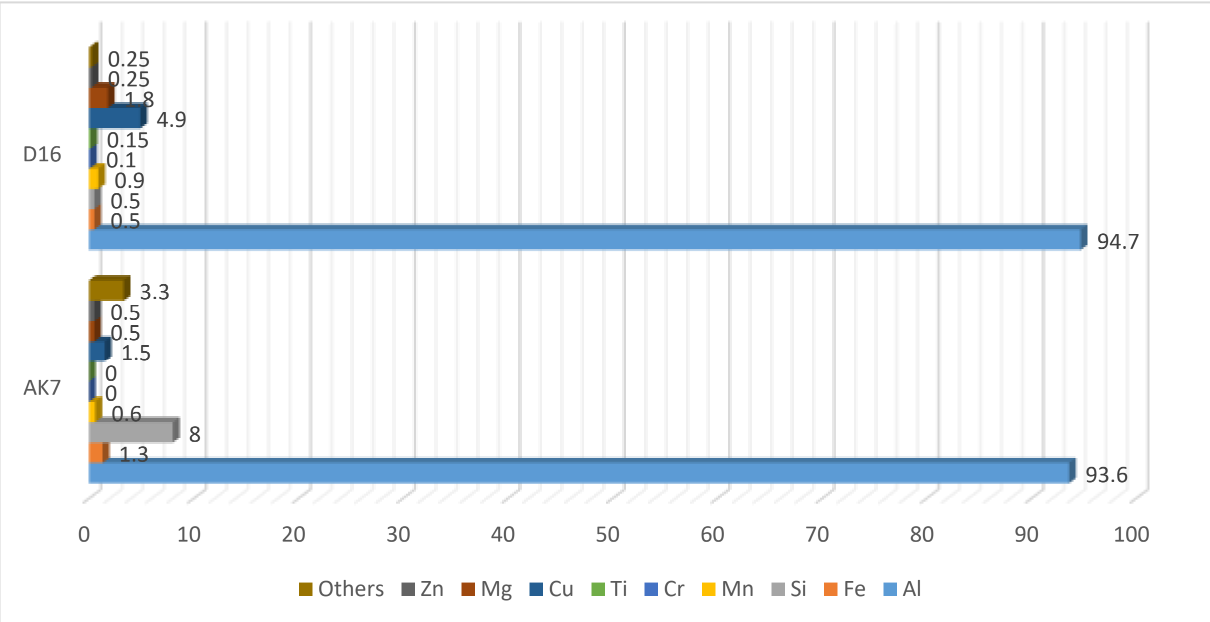
Introduction

Aluminum-lithium alloys are considered one of the promising materials for the fields of mechanical engineering and the aviation industry.An urgent task is to improve the physical, mechanical and operational properties of this group of alloys by strengthening them.This increased interest in alloys is explained by the fact that lithium with a density of 0.54 gr/cm^3 increases the moduls of elasticity of aluminum while reducing the mass of products made from its alloys [1]. The addition of rare metals to aluminum alloys increases their strength, heat resistance, corrosion resistance. In order for parts and mechanisms to work for a long time and reliably, the materials from which they are made must meet the necessary operating conditions. Therefore, it is important to control the permissible values of their basic mechanical properties. Aluminum alloys with other metals and nonmetals (copper, manganese, magnesium, silicon, iron, nickel, titanium, beryllium, etc.) are widely used as structural materials [2-3].Aluminum alloys embody high strength properties of alloying along with good properties of pure aluminum. [4].

Materials

In the experiments, aluminum grades AK7 and D16 were chosen as the object of research.The diagrams below show the chemical composition of the aluminum stamps used in the experiment.

Chemical composition



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The samples were poured into sand-clay molds.The composition of sand-clay forms consists of: 85% quartz sand, 11% bentadine clay, 4% water.In this composition, a molding mixture was prepared and mixed in a mixer until the same mass was obtained.The finished mass was placed in pre-prepared flasks, and the molds for namana were pressed and prepared. Our experiments were carried out by setting the oven to 750 °C.

Experiments

In experiments, lithium fluoride compound was added in an amount of 5%, 10%, 15% compared to the weight of the charge. To plot the dependence graph, a sample was first poured into which lithium fluoride was not added. The samples were separated from the molds, and then the necessary parts were extracted from each sample using a 1M63MF101 lathe for research (Fig.1). The selected samples are shown in Figure 2.

Figure 2. The process of extracting fragments from samples on a lathe.

Fig. 2. Processed samples.

Determination of abrasive wear resistance

To determine the abrasive wear resistance, the PV -7 device was used. The structure of the PV -7 device is shown in Figure 3. The sample (1) is attached to the holder (2) and is corroded by the friction of the polyurethane screw on abrasive particles. The screw (3) is made by winding a polyurethane thread (cord) with a diameter of 6 mm on the shaft. The load on the sample is created by (4) manual and (5) replaceable loads. The abrasive is fed to the contact point (6) by a dispenser, which is a hollow cylinder with a calibrated hole in the center of the cylinder. The dispenser rotates synchronously with the rotation of the screw [5-6]. At each revolution of the new abrasive dispenser, the abrasive is fed in portions into the working cavity of the sample holder.

When the auger rotates, it draws abrasive particles into the gap between itself and the sample, creates it and pulls down the developed abrasive material. The chain is driven by an rd - 09 type motor with a screw

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and a metering gearbox. The sample itself is cut using a metal cutting lathe in the form of a parallelepiped 45 mm long and 35 mm wide. The thickness of the sample is 5-10 mm.

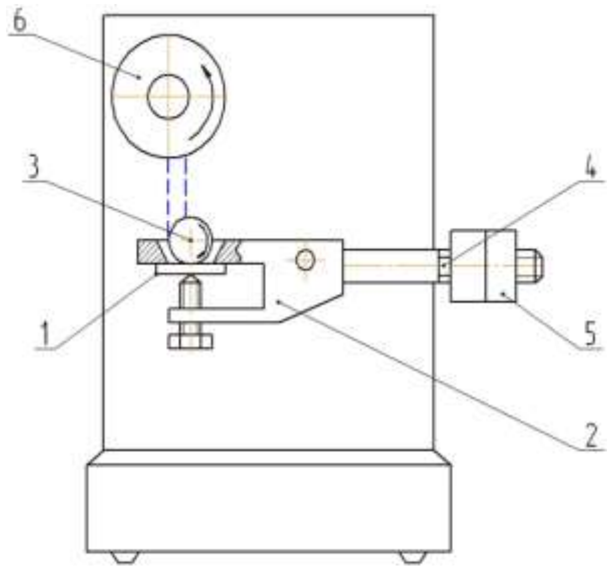

Figure 3. Structure of the PV -7 device: 1 - sample; 2-Holder; 3 - screw; 4 - handle; 5 - switchable loads; 6 -dosing.

Samples were tested on the device at regular intervals. Quartz sand and the mineral corundum (crystalline α-alumina Al_2O_3) were used as an abrasive material [7]. The samples were measured for one to four hours after each hour using their Mass Weights. Competitiveness was calculated based on the decreasing mass. In the first experiments, quartz sand was used as an abrasive material[8]. Table 3 shows the results of determining the abrasiveness of quartz sand.

Table-3.
Results of measurement of abrasive wear resistance of samples (quartz sand)

№	Sample composition	Pre-test mass (grams)	60 minute	120 minute	180 minute
1	AK7	10.209	10.196 (0.013)	10.183 (0.026)	10.166 (0.043)
2	AK7+5% LiF	10.210	10.207 (0.003)	10.203 (0.007)	10.198 (0.012)
3	AK7+10% LiF	10.219	10.217 (0.002)	10.213 (0.006)	10.220 (0.009)
4	AK7+15% LiF	10.220	10.216 (0.006)	10.211 (0.009)	10.202 (0.018)
5	D16	10.196	10.174 (0.022)	10.161 (0.035)	10.148 (0.048)
6	D16+5% LiF	10.201	10.197 (0.004)	10.193 (0.008)	10.189 (0.012)
7	D16+10% LiF	10.198	10.196 (0.002)	10.193 (0.005)	10.188 (0.010)
8	D16+15% LiF	10.202	10.190 (0.012)	10.181 (0.021)	10.169 (0.033)

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In later experiments, corundum mineral sand was used as an abrasive material. In corundum sand, the wear time was less than in quartz sand. Table 4 shows the results of determining the viscosity of corundum mineral sand.

Table-3.
Results of measurement of abrasive wear resistance of samples (corundum mineral sand)

№	Sample composition	Pre-test mass (grams)	30 minute	60 minute	90 minute
1	AK7	10.196	10.172 (0.026)	10.151 (0.045)	10.134 (0.062)
2	AK7+5% LiF	10.534	10.528 (0.006)	10.523 (0.011)	10.520 (0.014)
3	AK7+10% LiF	10.542	10.538 (0.004)	10.535 (0.007)	10.530 (0.012)
4	AK7+15% LiF	10.540	10.530 (0.010)	10.518 (0.022)	10.501 (0.039)
5	D16	10.372	10.341 (0.031)	10.311 (0.061)	10.288 (0.084)
6	D16+5% LiF	10.669	10.658 (0.011)	10.644 (0.025)	10.633 (0.036)
7	D16+10% LiF	10.588	10.580 (0.008)	10.572 (0.016)	10.563 (0.025)
8	D16+15% LiF	10.285	10.262 (0.023)	10.249 (0.046)	10.226 (0.069)

Based on the revealed results, a graph of the dependence of the amount of lithium fluoride on wear resistance was developed (Fig. 4.5.).

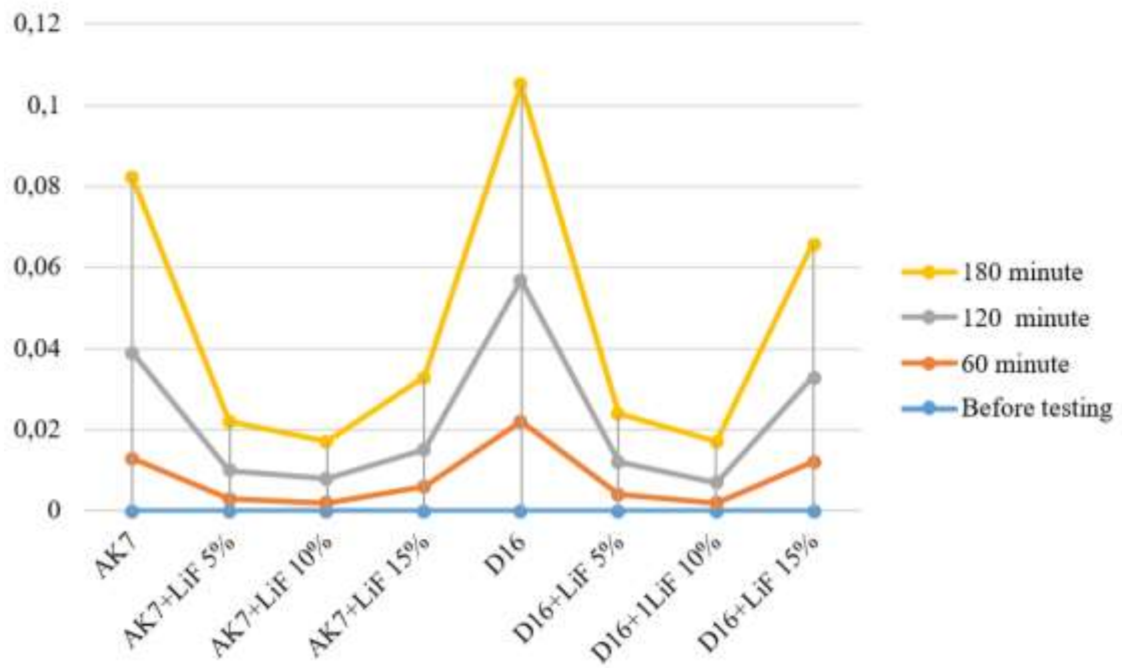

Figure 4: Graph of the dependence of abrasive wear resistance on time (quartz sand)

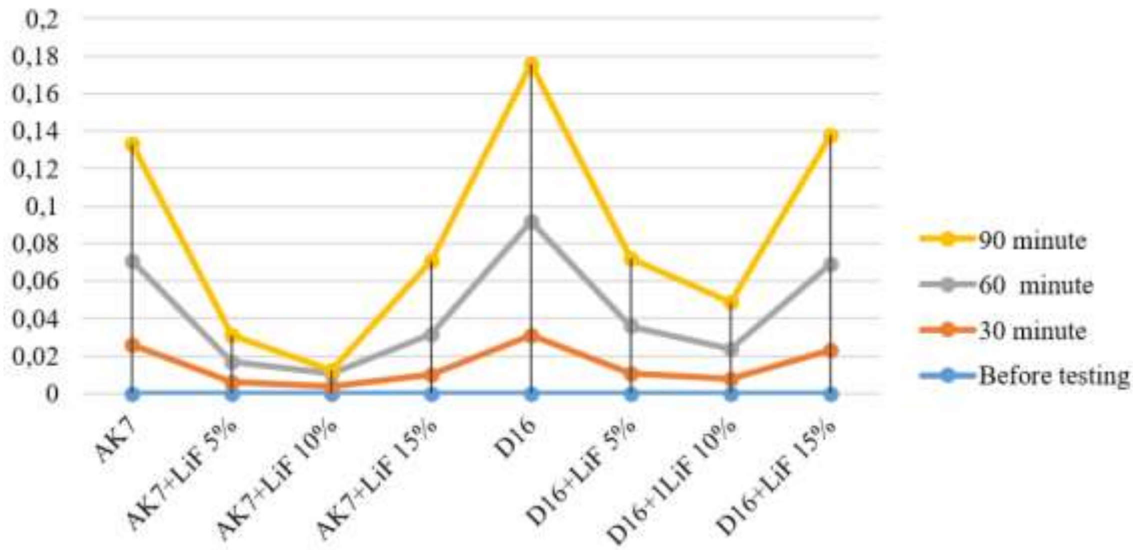

Figure 5. Graph of the dependence of abrasive wear resistance on time (abrasive material corundum sand).

Conclusions

As a result of the conducted studies, the following conclusion can be made about the effect of lithium fluoride compounds on the mechanical properties of the alloy.In the course of research, it was noticed that aluminum alloys, when leached with lithium fluoride, have a significant effect on their wear resistance.The wear resistance of the AK7 and D16 samples was improved from 21% to 32% by adding lithium fluoride to the charge mass in an amount from 5% to 10% units.

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