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ALUMINUM ALLOYS SELECTION FOR BEARINGS OF MACHINE-BUILDING PARTS

Abstract. Aluminium-based alloys are classified by production technology, hardening level after thermal treatment and service properties. Aluminium alloys produced by powder metallurgy methods are of a particular interest. They possess high strength, corrosion resistance and temperature strength. Aluminium-based sintered materials are used instead of heavy metal alloys. Strength properties and processing characteristics of aluminium-based materials change considerably after thermal treatment.

Keywords: Aluminium alloys; duralumin; malleable; high strength; sintered; foundry; silumins, magnalins; recrystallization; non-hardenable deformable alloys.

Aluminium is a silvery white metal with face-centered cubic lattice. Its typical properties are small density (2700 kg/m^3), high electrical conductivity (σ = 3.4·107 cm/m) and plasticity. Aluminium has good weldability, is well processed by pressure but is badly processed by cutting and is characterized by high molding shrinkage. Aluminium oxidizes easily in the air forming thick oxide film Al_2O_3 which ensures its high corrosion resistance. Mechanical properties of aluminium are relatively low and depend on material purity.

Depending on the constant impurity content (Fe, Si, Cu, Zn, Ti), aluminium can be of super purity A 999 (0,001% of impurities), of high purity A 995, A 99, A 97, A 95 (0.005...0.5% of impurities) or low purity A 85, A 8, A 7, A 5, A 0 (0.15...1.0% of impurities). Impurities influence considerably on electrical and processing properties of aluminium, its corrosion resistance.

Aluminium alloys are widely used in mechanical engineering. Aluminium is alloyed with copper, magnesium, silicon, manganese, zinc, sometimes with lithium, nickel, titanium, beryllium, and tin. Most alloying elements produce solid solutions and intermetallic phases in combination with aluminium: $CuAl_2$, Al_2CuMg, Al_3Mg and others.

Aluminium-based alloys are classified by production technology, hardening level after thermal treatment and service properties.

Nowadays alpha-numeric marking is used for aluminium alloys (Table 1).

Marking helps to identify treatment method of half-finished and end products which influence mechanical, chemical and other properties.

Table 1. Alpha-numeric marking of aluminium alloy types

Classification principle	Alloy	
	name	marking
By chemical composition	-	AMg, AMs
By alloy purpose	Duralumin	D1, D16
By technological purpose	Malleable	AK6, AK8
By properties	High strength	B95, B96
	Sintered	SAP, SAC,
	Foundry	AL2

By production method of half-finished materials and products By half-finished material type	Fibers form	Am5P

According to the characteristic of hardening after thermal treatment aluminium alloys are classified into hardenable (quenching at 435 - 545℃), which are naturally (at 20℃) or artificially aged (at 75 - 225℃, 48 hours) and non-hardenable.

Aluminium (Al) is one of the most widely used materials in mechanical and electrical engineering. Its world production exceeds 15 billion tons per year. Aluminium in the form of compounds is abundant in nature; it's the leader among metals and the third among all elements. The main advantages of aluminium as engineering material are its high specific strength, electrical and heat conduction, and corrosion resistance. Aluminium is alloyed in order to increase its mechanical properties and processibility.

Aluminium-based alloys such as duralumins, silumins, magnalins and others obtained by casting methods as well as materials obtained by powder metallurgy methods are widely used as constructional materials in aircraft construction, shipbuilding, and mechanical engineering.

Iron and silicon are the main impurities of aluminium. Iron conditions the decrease of both electrical conductivity and plasticity and certain increase of strength. Silicon as well as copper, magnesium, zinc, manganese, nickel and chromium are considered the main additives which strengthen aluminium.

Because of low strength, aluminium is usually used for production of nonload carrying parts and structural elements with heat conduction, corrosion resistance and low weight being the main operating properties.

Some aluminium alloys are effective bearing materials (Table 1). The alloy ACM is the most widely used. It is close to lead bronze by its antifriction properties but excels it in corrosion resistance and manufacturability (Figure 1).

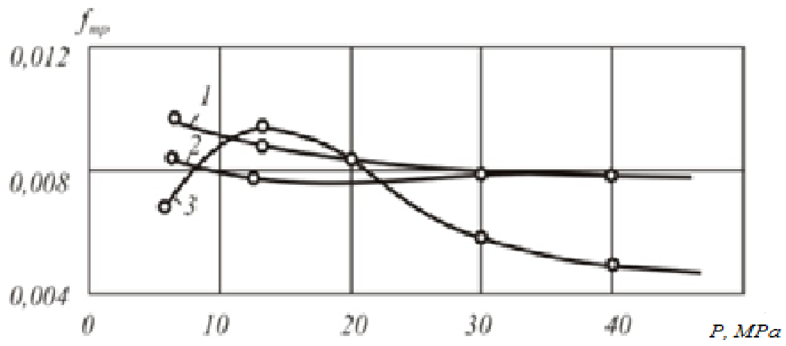

Figure 1. Coefficient of friction *f* in pairs steel-aluminium alloy at dry friction depending on unit load *p*. Alloys: 1 – ASM, 2 – ASMC, 3 – ACC-6-5

Alloys for forging and pressing possess high plasticity; they can be well processed by casting and have no cracks after hot working. Such materials are represented by the alloys of the brands AK6, AK8 and the alloys A1–Cu–Mg with silicon additives.

Forging and pressing are performed at 450...475℃. The alloys are used in the production of semi-loaded components of an irregular shape (AK6) and loaded pressed parts subject to quenching and ageing.

Non-hardenable by thermal treatment deformable alloys include the alloys A1–Mn, A1–Mg.

They are notable for high plasticity, corrosion resistance and good weldability. The alloys of this group are used annealed, cold-worked and semi-cold-worked (cold working is hardening and fortification of materials in the process of fabrication).

Conclusion. In order to eliminate dendritic segregation of deformable alloys it is common to carry out homogenizing annealing of ingots at 450...520℃ for 4...40 hours followed by cooling in the open air or in a furnace.

Deformed half-finished products are subject to recrystallization annealing at 350...500℃ for 0.5...2 hours. This operation helps to remove cold hardening and obtain fine-grained metal structure.

Non-hardenable alloys are used in the production of containers for liquids, pipes, ship constructions, carriage parts. Non-hardenable deformable alloys are mainly represented by the alloys AMs, AMg2, AMg5.

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