

USE OF HYDROGEN AND PHOSPHORUS FOR MANUFACTURE PISTON SILUMINS

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To number of the most responsible and intense details of the engines largely influencing on plant-performance figures of machines, pistons refer to. Difference of service conditions in such bands of the piston as the bottom door, the skirt, furrows, raggles, etc. stipulates also different requirements to piston materials. So, the bottom door needs high hardness and durability at temperatures 280-300°C, for furrows - a high wearing quality, hardness and durability at temperatures up to 230-260°C, for raggles these requirements include first of all high durability and plasticity at temperatures up to 150-170°C, for the skirt the base requirement - high score-resistance and a low linear expansion coefficient. In linkage with indicated to piston alloys rigid conditions are presented enough: high static and a resistance to chok, including at operating temperatures of the piston; high fatigue resistance, sufficient hardness at normal and heightened temperatures, a high thermal conduction; a low linear expansion coefficient, a small specific gravity, good antifriction properties and a high wearing quality; the satisfactory processing behavior ensuring an opportunity of manufacture of qualitative details at minimum economic expenditures. As performance so different and conflictings objective represent extremely a challenge, at mining alloys, as a rule, make a compromise, taking into account datas of the requirement in a different standard. In this connection for manufacture of pistons of engines both Al alloys based on Al-Si and Al-Cu systems and alloyed irons are used, and recently non-metallic materials have been used [1, 2].

The comparative assaying of the materials used in a domestic and foreign engine building for manufacture of pistons, shows, that to fullesty indicated requirements fit сложное легированные aluminum-silicon alloys [1]. High-silicon alloys which have lower linear expansion coefficient, a heightened hot-resistance and a wearing quality are considered as the most perspective. However alongside with the marked advantages these alloys have some deficiencies, from which low mechan-

ical characteristics are main at routine temperature, the bound with availability in their structure of large chips of primary silicium and not permitting a carry a qualitative flowage of bullions. In this connection major value is gained with mining and a heading of the new more perfect master schedules, permitting to increase a level of these properties. For hypereutectic doped silumins with the contents of silicium of 20 % (weights). And more, items used for reception under the routine plan from wrought alloys (a bullion → a deformable semimanufactured material → the item), the most efficient and, hence, perspective is use of machining of alloys at the stage of molten metal - inoculation. And the base purpose of this machining is fine crushing and a uniform distribution of chips of primary silicium on section of a bullion and, as a corollary, martempering of speed-torque characteristics of alloys.

Authors design makeups piston Al-Si-сплавов for molten and deformable pistons with the contents of silicium up to 22 % and technology of their preparation [3, 4]. The makeup of alloys includes the base alloying elements which are capable considerably to improve physical-mechanical characteristics of silumins, such as Cu, Mg, Mn, and such microaddings as Ti, Zr, Ca and other, rendering the positive action on structure of alloys. In the capacity of modifying machining for fine crushing chips of primary silicium coprocessing by hydrogen and phosphorus utilised. For the first alloy this machining by a mix containing cupric phosphide, iron oxides and a nickel and boric acid as 0,2-0,5 % from weight of mix material [5]. For other alloys - introduction of cupric phosphide with simultaneous hydrogenation a melt the wet asbestos plugs or without it.

Properties of designed and known deformable piston alloys determined after different views of warp in a heat treated condition. For this purpose bullions from alloys cast by the machine of semicontinuous pouring of Payload - 2 in a copper mold of slipping by a diameter of 165 mm. From bullions excised samples for warp by the size

80x80x200 mm. forged bars section 15x15 mm gained a smith forging on a pneumatic hammer with weight of impinging parts 150 kg. The aggregate amount of reduction has made $\epsilon = 94\%$. A malleating conducted at the temperature of 450-480°C with process annealings within 1 hour. For press forming used vertical hydraulic presses force 70 MH. After a heat treatment from forged bars and press formings excised samples for definition of speed-torque characteristics and the dilatometric assaying.

Bullions from the second alloy as against first flooded in a metal mold with refrigeration in water and further under the mentioned above plan gained samples with use of a smith forging with process annealings [4]. For comparison of the received results with known bullions and the deformed samples have been fabricated of alloy AK4 (the GOST 4784 - 97) and AK12Д (technical specifications 48 - 5 - 248 - 85) in simulated condition. Chemical composition and mechanical characteristics of forged pieces and press formings from designed and known alloys after a final heat treatment are given in tables 1 and 2.

It is visible, that designed alloys and expedients of preparation of the piston hypereutectic aluminum-silicon alloys, including inoculation by phosphorus and hydrogen, allow to receive higher mechanical characteristics as contrasted to known. So, after a hardening on a mode: the heating up to 500°C, a stand-up 2 h + 520°C, a stand-up 1 h, refrigeration in cold water and age-hardening at 150°C, with within 10 h, an alloy №1 ensures as contrasted to with known eutectic piston silumin AK12Д in forged a condition pinch of a ultimate strength on 20 %, and in formed - on 5 % at the same values of plasticity (specific elongation), pinch of hardness on 5-10 % (see tab. 2).

Rupture life of an alloy at 300°C for 100 h makes not less than 25 МПа. The medial temperature coefficient of a linear dilatation (α_{20-300}) over the range operating temperatures of pistons 20-300°C is equal $18,5 \cdot 10^{-6} \text{ grad}^{-1}$ that is much lower, than for alloys AK12Д and AK4. The specific gravity of an alloy - $2642\text{-}2650 \text{ kg / m}^3$, that also is less than the values of alloys of system Al-Cu used for manufacture of pistons.

Thus, use for an alloy building hypereutectic Al-Si- piston alloys of phosphorus and hydrogen allows to increase essentially a level of mechanical characteristics of bullions, to lead qualitative hot their flowage and to receive a higher complex of physical-mechanical characteristics of alloys in a strained state after a final heat treatment as contrasted to known alloys of system Al-Si used in an industry and Al-Cu.

References

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Alloy	Ma- keup	The contents of builders, mac. % (Al– the rest)										
		Si	Cu	Mg	Mn	Ti	Ni	Cr	P	H	N	Ca
Designed:	1	18	0,6	0,5	0,8	0,1	---	-	0,01	0,00008	0,2	0,07
№1	2	19	0,8	0,7	0,9	0,2	-	-	0,02	0,00015	0,3	0,08
	3	20	1,0	1,0	1,0	0,3	-	-	0,03	0,00025	0,4	0,09
№2	1	20	0,8	0,8	0,9	0,3	0,1 Zr	0,1 Be	0,01	0,00020	-	-
	2	22	1,2	0,5	0,8	0,15	-	0,05 Be	0,02	0,00020	-	-
№3	3	20	1,0	0,4	0,8	0,1	-	0,3	0,01	0,00008	-	-
	1	21	1,5	0,6	1,0	0,2	0,05 Zr	-	0,02	-	-	-
Known												
AK4	-	1,0	2,0	1,4	0,8	0,1	1,0	1,0 Fe	-	-	-	-
AK12Д	-	11	2,2	1,1	0,7	0,05	1,0	0,1	0,005		-	-

Table 1 - Chemical composition of hypereutectic piston silumins

Table 2 - Mechanical characteristics and a temperature coefficient of a linear dilatation designed and known piston silumins

Alloy	Make-up	Mechanical characteristics					$\alpha \cdot 10^6$ °C ⁻¹
		A forged piece		Press forming			
		σ_B , МПа	δ , %	σ_B , МПа	δ , %	HB, МПа	
De-signed:	1	425	5,5	366	3,3	1140	18,5
№1	2	441	4,8	341	2,9	1210	
	3	448	4,5	340	2,0	1250	
№2	1	407	3,5	-	-	1180	
	2	394	3,0	-	-	1200	
№3	3	404	3,5	294	1,2	1170	
	1	361	2,7	-	-	-	
Known:							
AK4	-	409	3,5	364	4,2	1170	24,0
AK12Д	-	365	4,8	335	2,0	950	22,0