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Microalloy Steels: Energy Saving Prospect at Manufacture of Details of Cars

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Complex researches of mechanical and processing behavior of ATs40H2NMAF and ATs30H3NMAFB microalloy steels are conducted. Possibility of realization of forging heat for heat treatment of forgings is shown. Use such staly for manufacture the heavy-duty of details – elbowed shaft and rods of the engine is recommended.

Key words: Thermal processing, Steel, Deformation, Structure, Hardness.

The most power-intensive processes in a technological route of manufacture of semi-finished products is the stage of heating of preparations under a plastic strain and the subsequent heat treatment of forgings. One of paths of energy saving at this stage of a metalrepartition is realization of residual heat of hot-rolled forgings at their heat treatment. In most cases it is not possible to use this heat that is bound to application staly inclined to an overheat at temperatures of a hot plastic strain. Such undesirable structural state is inherited by the forgings cooled in shop conditions to ambient temperature. For collimating of the favorable structure and properties in such hot-rolled semi-finished products for the subsequent types of their processing they are exposed to annealing, normalization or thermal improvement[1-4]. Thus energy consumption and prime cost of steel products significantly raise.

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Work purpose

Realization of residual forging heat of forgings due to use of microalloy steels.

Work technique

Metallurgical surveys are executed with use of microscopes of “Epitip-2” and “Neofot-2” at increases ×100 - ×1000*. Impurity became nonmetallic inclusions estimated in accordance with GOST 1778-70.

Tests for stretchings and impact elasticity carried out on a tension testing machine of ZD-20 and an oscillating rum engine of PSW-30 according to GOST 1497-61 and GOST 9454-60. Exemplars made of the preparations which are selected from hire in accordance with GOST 7564-73 and took place a heat treatment: training from temperature of 930 °C in oil and annealing at 630 °C. Used TSh-2M and TK-2M devices to hardness test. Fatigue resistance on a bend of elbowed shaft was estimated by a cheek loading by a variable moment of deflection, and on torsion – by a loading of a shatunny neck a variable torque. Tests of rods carried out on a sign-variable cycle of a loading with procreation of hydrodynamics in a slideway of a crank head at pulling stress from 4 to 8 tn and the double amplitude of a cycle from 14 to 24 tn. Workability was estimated by cutting in laboratory

and working conditions on automatic transfer lines when machining forgings of an elbowed shaft and rods.

In a reference state impurity of ATs40H2NMAF steel oxides and sulfides did not exceed 2,5 point, and ATs30H3NMAFB steel – oxides no more than 3 points, sulfides – 2 points and nitrides – 1 point. Mechanical characteristics of thermally processed steel are given in table 2.

In the course of the manufacture of forgings providing induction heating of preparations up to the temperature of 1260±20 °C, a plastic strain and a heat treatment processibilitystaly with nitridvanadiyevy hardening at all stages of processing is established. Both the structure and properties became received as a result of a heat treatment of forgings with the realization of residual forging heat and also which passed an austenization at a temperature of 930±20 °C, training in oil and high annealing are given in table 3.

Machining of preparations of a rod on the automatic transfer line showed high processibility of ATs30H3NMAFB steel on various operations of cutting.

The analysis of workability of preparations of an elbowed shaft showed that an exponential stage of process of cutting are operations of deep drilling. It is established that optimum parameters when drilling forgings are:

- For drills of ø 5,5 mm and ø 5,7 mm – giving of 0,1 mm / about at a speed of 660 rpm
- For drills of ø 8,5 mm and ø 8,7 mm – giving of 0,17 mm / about at a speed of 400 rpm
- For drills of ø9,0 of mm and ø10,0 of mm – giving of 0,15 mm / about at a speed of 360 rpm

The main attention at trial approbation is paid to indexes of office properties of details – their fatigue resistance. Bench tests of elbowed shaft showed that endurance strengths make: on a bend – 1000kg•m, on torsion – 900 kg•m.

Results of fatigue tests of rods that is explained by realization of forging heat at a heat treatment of steel are of interest.

From table 3 it is visible that in steel the sorbitny structure both after traditional heat treatment, and as a result of postdeformation cooling of forgings with compressed air with the subsequent holiday is formed. Insignificant decrease in hardness is observed at details which

Table 1. Chemical composition of the staly

Steel	Content of chemical elements, %									
	C	Si	Cr	Ni	Mn	Mo	V	P	S	Nb
ÀTc40H2NÌÀF	0,37	0,20	2,12	0,72	0,45	0,11	0,11	0,025	0,007	-
ÀTc30H3NÌÀFB	0,31	0,24	2,54	0,74	0,40	0,20	0,07	0,021	0,011	0,03

Table 2. Mechanical characteristics of the staly

Steel	Indexes of properties					
	$\sigma_{Â}$, N/mm^2	$\sigma_{Ò}$, N/mm^2	δ, %	ψ, %	KCU, Dj/sm^2	HB
ÀTc30H3NÌÀFB	1210(1000)	1080(850)	12,5(12)	56(55)	110(100)	334(287)
ÀTc40H2NÌÀF	1110(850)	1030(730)	12,5(12)	54,0(42)	88(80)	321 (255)

Table 3. Properties of ATs30H3NMAFB steel after a heat treatment

Heat treatment mode				Structure	Hardness, HB
T_{aust} °C	Cooling medium	$T_{îtp}$ °C	Cooling medium		
940	Air	650	Air	Sorbite	285
930	Oil	650	Oil	Sorbite	302
930	Air	705	Oil	Sorbite	278
950 (temperature of the end of stamping)	Heavy air (8°Ñ/ñåê)	705	Air	Sorbite	255

heat treatment included realization of forging heat of preparations. Results of bench tests of details showed that fatigue strength[1] Research is executed at the expense of a grant of the Russian Scientific fund, Project N-15-19-10030 of all trial details made on compression 6 tn with a double amplitude of a cycle 24 tn that considerably exceeds similar indicators of serial details. It is also necessary to note that existence of a drobenaklep of a surface of details in addition increases endurance of rods that is confirmed with metalgraphic researches, studying of microhardness of a surface and fatigue tests. Complex researches of technological, mechanical and office properties constructional stalymicroalloyed by vanadium, niobium and nitrogen showed prospects of their application and opportunity to replace a stage of an austenitization became on air training of forgings from temperature of completion of hot plastic deformation of metal.

CONCLUSIONS

1. The high rates of the mechanical properties microalloyed by staly ATs40H2NMAF and ATs30H3NMAFB, received at static and dynamic tests allow to recommend them for production of hard loaded details – cranked shaft and rods of the car.
2. Possibility of training on air of rods from the microalloyed ATs30H3NMAFB steel from temperature of the end of stamping (~ 950 °C) with ensuring high level of its properties after high holiday is established.

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