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ABOUT EUTECTICUM CONSTITUENT OF ECONOMICALLY ALLOYING HIGH-SPEED STEELS

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It is considers the presentation of the formation for eutectic carbides in spa-ringly alloyed fast-cutting steels with additional introduction of niobium and titanium. There are discusses changing of the chemical composition for the matrix and carbide depending on the thermal treatment. It has been established that the performance properties are satisfactory. The experimental steel is recommended as a substitute for classic steel P6M5.

Key words: eutectic carbides, cutting sparingly alloyed steel, heat treatment, titanium, niobium, microstructure

Long time steel P18 was only high-speed steel, used for all instruments and diferent conditions of cutting. From 1940 at the USA developed steel of S6-5-1 (M2), which presently is the basic mark of high-speed steel in the entire developed countries. Approximately in these years at the USSR little alloyed steels type of Р0М3Ф3, Р3М3Ф2, Р3АМ3Ф3 were worked out, which, as a rule, have steel P6M5.

The attempts of improvement of properties for steels, on creation of more economical, were carried out and done by the additional alloying and modification less deficient elements, mostly carbide forming, by nitrogen, rare-earch metals and other. Presently titan and niobium use into all greater attention as substitute of vanadium in high-speed steel.

The last year’s technologies also widely are developed on utilization of high-tungsten wastes of industry for smelting of instrumental steels.

At work used steel of Р3АМ3Ф2 type, which was additionally alloyed by niobium (table. 1).

Samples for research of eutectic carbides in the cast metal cut out from the axial zone of transversal templates, selected from middle on a height part of bars with mass 20 kg. Bars of compositions 1 and 2 preliminary exposed to annealing at a temperature 850 °C, 2 hours, and then to heat treatment: hardening (at a temperature 1210 °C) and tempering (at a temperature 560 °C) on one hour three times. After treatment of steel have secondary hardness and red-hardness at the level of 66 and 60 HRC accordingly, and durability was within the limits of 3400-3500 MPa.

X-ray spectrometry microanalysis was executed on raster electronic microscope REM-106I at next conditions: accelerating voltage – 20 kV, current of probe – 20 nA.

On facts of X-ray spectrometry microanalysis chemical composition of matrix (table. 1) changed depending on passing of the stages of heat treatment of experimental steels. So, steel Р3АМ3Ф2Б1Т (composition No 1) at tempering, content of *W*, *V*, *Cr*, *Nb* in a matrix diminishes, and after hardening its quantity increases. The content of molybdenum goes down with the stages of heat treatment. For steel Р3АМ3Ф2Б1Т1 (composition No 2) there is a decline of content of *W*, *V*, *Cr*, *Mo* after tempering and some increase its after hardening. A content of niobium and titan in a sosoloid, after the complete cycle of heat treatment, is goes down con-siderably.

Table 1 - Chemical composition of investigated steels (mass part)

Mark steel	Method of analysis		*C*	*W*	*Mo*	*V*	*Cr*	*Nb*	*Ti*	*Fe*
Р3АМ3Ф2Б1Т (omposition No 1	Chemical analysis		1,18	3,05	2,82	1,96	4,10	1,26	0,24	ост.
	sosoloid, facts of micro-analys	annealing	-	2,26	1,48	1,08	2,64	0,09	-	90,08
		tempering	-	2,05	1,43	1,09	2,53	0,06	-	90,62
		hardening	-	2,31	1,43	1,12	2,54	0,12	-	89,63
Р3АМ3Ф2Б1Т1 composition No 2	Chemical analysis		1,41	3,05	2,82	1,94	4,05	1,28	1,55	ост.
	sosoloid, facts of micro-analys	annealing	-	2,81	1,62	1,38	1,35	0,08	0,03	90,21
		tempering	-	2,61	1,66	1,10	1,27	0,08	0,02	90,17
		hardening	-	2,62	1,82	1,18	1,59	0,06	0,04	90,71

As is generally known [3], in the cast steel of Р3АМ3Ф2 the carbides of M_6C MC and M_2C type crystallize, which can form eutectic colonies. Such structure is determined by the concentration of vanadium and total content of tungsten and molybdenum. Additional alloying niobium (composition No 1) does not cause the change of type of carbides at cast state.

Introduction of titan (composition No 2) causes the increase of it quantity in carbides MC. The additional alloying by titan results in the origin of carbide of M_6C type and disappearance of M_2C and MC (NbC). Fixed eutectic carbides M6C, to forming of which, properly to suppose, the complex alloying by titan and niobium is promotes, also results in appearance of difficult alloying of titan-niobium carbide MC (($TiNb$)C). Thus, the increase of alloying steel has investigation an increase of content of elements in carbides, and, consequently, and possibility of improvement of steel properties.

After passing of complete cycle of heat treatment character of carbidic phase changes. So, in steel composition No 1 the carbides M_2C disintegrate and the carbides of type of M_6C appear, however here primary carbides of MC type remain unchanging. Such action of phase composition is regularity and practicable. Morphology of carbides is here typical, the carbide TiC has a form of the «chinese hieroglyphs» with the developed surface.

In steel of Р3АМ3Ф2Б1Т1 (composition No 2), after heat treatment, passing of disintegration of carbide M_2C takes place, however the carbide of M_6C type is present and at cast state.

Along with TiC, morphology of which is similar with steel of composition No 1, the «difficult» carbide of ($TiNb$)C type appears. The form of it substantially differs from TiC: it is acquires the outlines of three-, five-, and sometimes hexahedrons. A quantity of niobium in it is at maximal level with the relatively large quantity of titan that can result to the substantial increase of operating properties of material.

The comparative tests of firmness of instrument, made from experimental steels and classic high-speed Р6М5 steel, executed at the different regimes cutting on construction materials insignificant variation of indexes is set.

Thus, economically alloying steel Р3АМ3Ф2Б1Т1, properties of which on some case even exceed the relative values of firmness, it is possible to recommend as substitute Р6М5 steel.

Conclusions. It is discovered, that introduction of niobium (composition No 1) no accompanied the change of type of surplus phases, and however existent carbides are additionally alloyed by titan and niobium. Complex influence of titan and niobium (composition No 2) on high-quality composition of carbides and change of their alloying is educed, that approaches on a eutectic constituent to classic steel Р6М5. The analysis of model tests showed the satisfactory results of firmness of toolpiece. The most close values of index to steel Р6М5 fixed for experimental steel Р3АМ3Ф2Б1Т1, which it is recommended to use as a foregoing substitute for this material.

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