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ANALYSIS OF INFLUENCE OF COMPOSITION FOR LOW-ALLOY STEEL ON ITS STRENGTH PROPERTIES AT ENHANCEABLE TEMPERATURES

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Influence of chemical composition for low-alloyed steel at it mechanical properties at workings temperatures to 450 °C is analyzed. Principal reasons for softening steel at heightened temperatures are studied. The basal devices of hardening are considered. It is rotined that complex microalloying by nitrogen, titanium and aluminium provides the high mechanical properties of low-alloyed steel at heightened temperatures (250…450 °C) due to hardening of extent of grains by superfine carbonitrided titanium, and its borders – by nitrided of aluminium.

Keywords: low-alloyed steel, microalloying, nitrogen, titanium, aluminium, thermo-stableness

During the last years there are carried out very intensively development of steels, possessing high resistance to plastic deformation and to destruction at working temperatures to 500-550 °C, and also methods of test of their special characteristics.

The variety of requirements, produced to steels, working at enhanceable temperatures and to heatproof materials, results to development of steels and alloys of different types, answering the concrete conditions of work, mainly certain range of working temperatures and also duration of action of loading and her size.

For work at a temperature 500-550 °C there are used the pearlitic and ferritic-pearlitic steels. Indicated steel used in a power engineer (for making of caldrons, vessels, steam-injections and steam pipelines), and also at chemical and petroleum engineer.

Steady at a room temperature structure of steel in the conditions of high temperatures, from intensification of diffusion processes can test considerable changes, which show up in spheroidizing of pearlite and coagulation of carbidic phase, graphitization, redistribution of elements between a sosoloid (a ferrite) and carbidic phase and, finally, at development of processes for thermal fragility. All transferred phenomena worsen the indexes of durability of steel. It is set that after introduction 0,3-0,6 % chrome in thermostable steel alloyed by a molybdenum, it becomes indisposed for graphitization. These existing the last year’s tendency to explain to apply thermostable steel, containing a chrome and molybdenum.

Redistribution of alloying elements between a ferrit and carbidic phase, looked after in a boiler steel at the protracted influence of temperatures 400-450 °C and higher, results in that a ferrit is some impoverished by carbide-forming elements (a chrome, molybdenum), and carbidic phase, vice versa, is enriched by them, especially by a molybdenum. Thermostable steel of 12MCh brand after normalization contains in carbides 4-8 % molybdenum, and as a result of a 2400 hours self-control at a temperature 500 °C content of molybdenum in the carbidic phase increases to 60

% from his general quantity in steel. Meantime, exactly quantity of molybdenum in a ferrit, but not in a carbidic phase, it is defined positive influence determines on heatstrength of boiler steel. It is possible enriching of carbidic phase by alloying elements as a result of the protracted influence of high temperatures may some to weaken by a decrease in this steel of carbon content and additional alloying it by the most strong carbide-forming elements (in particular, by vanadium).

At alloying a molybdenum and vanadium these elements promote the temperature of recrystallization of ferrite, hamper diffusive processes and promote thermally to the stable work-hardening as a result of formation of superfine carbides.

At even distribution of consolidating particles in the volume of metal, when locomotive dislocation meets with the particle of carbide possibly or cutting of particle or round it by distribution. Thus a process will be realized for flowing of which the least tension is needed.

At the dense location of particles in the process of plastic deformation the line of distribution is bent and Orovan mechanism [1] will be realized.

The problem of explanation of legitimacy for the use of carbonitride mechanism of work-hardening of low-alloy steels, working at a temperature to 450 °C with the use of titanium and aluminium is in-process set, as carbide- and nitridegenerating elements.

Practical application of molybdenum and vanadium for work-hardening steel by their carbides sharply limited to the high cost of these alloying elements, that it is impossible not to take into account at an industrial production the arge-size founding’s. There can the alternative method of increase of strength properties of low-alloy steels, working at high temperatures, be their complex microalloying by nitrogen, titanium and aluminium, which provides high mechanical properties of indicated steels at enhanceable temperatures (250.450 (C) due to work-hardening of volume of grains superfine carbonitride of titanium, and their borders – nitrides of aluminium.

For verification of foregoing positions siliconmanganese 20ГСЛ steel applied for founding’s of the responsible setting was chosen, working in a range temperatures from 250 to 450 °C [2]. Experienced-industrial testing of technology of complex microalloying for 20ГСЛ steel executed in the conditions of AS «Armaprom» on the electric-arc steel-smelting furnace ESF-3 on operating technological instruction with changes, touching the additive of microalloying elements (nitrogen, titanium and aluminium).

Research of mechanical properties of the experienced metal in the interval of temperatures 250-450 °C with step 50 °C, executed in the certificated laboratory of SP the «Research pipe institute» on the break machine of P-5 in accordance with state standardi 9551-84 and 9651-84.

The got results testify that even at the maximally assumed temperature of exploitation (450 °C) the microalloying 20ГСЛ steel has a level of limit of fluidity, which on 170-200 MPA a higher required for base steel at a temperature 400 °C. Can be marked, that the regulated decrease of this index for standard 20ГСЛ steel from a room temperature to 400 °C almost 40 % rel. makes., while at the microalloying steel actually it a decrease in the investigational interval of temperatures does not exceed 20-25 % rel., that testifies to stability of her properties in the conditions of thermal influences.

Conclusions. As a result of analysis of influence for chemical composition of low-alloy steels on their mechanical properties at enhanceable temperatures positive influence of the microalloying system is educed on the base of nitrogen, titanium and aluminium. It is set that at the maximally assumed temperature of exploitation (450 °C) the microalloying 20ГСЛ steel has a level of limit of fluidity, exceeding on 170-200 MPa the required value for base steel at a temperature 400 °C, that testifies to stability of it properties in the conditions of thermal influences.

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