INFLUENCE OF HEATING TEMPERATURE ON THE RELAXATION CAST IRON DURABILITY

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The higher :*the heating temperature, the more completely the residual stresses are relieved and the lower the relaxation resistance and the more probable the process of eutectoid cementite graphitization will be.*

Keywords*: stresses, relaxation, cast iron*

Heating temperature has a significant influence on the effect of residual stress reduction, mechanical properties, structural state and, consequently, relaxation resistance of cast iron. The higher the heating temperature of the casting, the more completely residual stresses are reduced and the more likely it is that the relaxation resistance will decrease and the eutectic cementite will grafit.

Numerous studies have established the onset of graphitization of cast iron at prolonged aging at aging temperatures below the critical point A_c. Thus, depending on the chemical composition and structure, graphitization temperature was found to be 893-1073 K. Similar results were reported by P.N. Aksenov. Thomas and Mühler examined samples heated to temperatures ranging from 573 to 1223 K, followed by an exposure time of 15 to 710 hours. The onset of perlite decomposition was determined by dilatometric measurements. At the heating temperature of 573 K and the dwell time of 250 hours, no deformation was detected in the samples. Insignificant deformation was detected at 623 K and the exposure time of 250 hours. At 723 K and the exposure time of 15 hours, the expansion of the samples was also insignificant. The extension of the dwell time to 710 h resulted in an expansion of $2.2x10^{-3}$ mm per 1 m of the sample length. The complete decomposition of perlite was observed in samples heated to 823 K and incubated at this temperature for 207 h. Similar results were obtained by S.A. Rosenfeld.

A number of works on unalloyed gray cast irons show that the decomposition of eutectoid perlite begins at about 623 K and ends at 773 K proceeds extremely slowly. Thus, according to these studies, the decomposition of eutectoid perlite occurs at temperatures of 623-773 K with exposure over 200 hours. A further increase in temperature to 873 K lowers the iron hardness by about 10% at dwell times of more than 4 hours. The alloying of gray cast iron with Cr, V, Ce and Ti moves the graphitization initiation temperature upward. Therefore, the appreciable decrease in hardness by the graphitization process is be expected for the actually applied regimes at temperatures above 823-873 K for ferrite-pearlitecal cast irons, and above 873-973 K for alloyed irons.

Numerous studies have shown a significant effect of annealing temperature on the reduction of residual stresses.

An initial decrease in the basic stresses at 423 K was found. Increasing the aging temperature to 773-823 K sharply accelerates this process. The beginning of reduction of residual stresses in researches of S.A.Rosenfeld corresponds to temperature 723 K. Increasing the annealing temperature to 873 K leaves the value of residual stresses at 40 % of the initial value. Aksenov, Kritskaya, Tsing et al. found intensive reduction of residual stresses at 723-823 K for cast iron of various chemical compositions. A lower annealing temperature corresponds to higher C+Si content in cast iron. N.I. Klochnev and G.S. Strizhenov found intensive ageing at 773 K. Similar work by other researchers has shown that at 673-873 K plastic deformation occurs in cast iron, which enables intensive reduction of residual stresses. Bourges showed the effect of alloying elements on the temperature of intense aging of cast iron during annealing. He found a marked decrease in residual stresses in common grey cast iron.

The analysis of the data obtained from the annealing of grey cast iron at temperatures of 573 K and from 723 and 823 K in alloyed cast iron. According to his data annealing at temperatures up to 873 K reduces residual stresses to 80% in gray cast iron and to 40% and 20% in alloyed cast iron accordingly to the composition of the studied cast irons. In the same work, it shown that increasing the annealing temperature from 813 K to 838 K, 866 K and 893 K reduces the residual stresses in comparison with the initial state at 500 minute curing by 50 %, 64 %, 70 %, 90 %, respectively. The analysis of annealing modes applied by some foreign companies and the subsequent static treatment shows that the most common heating temperature is 773-823 K. As a result of ENIMS studies and plant experience, an annealing temperature of 823K is also recommended for SC21-40 grade cast iron without significant decrease in hardness.

In a number of works there are other recommendations for annealing temperatures. Thus, one Swiss company performs artificial aging at 513 K and obtains highly accurate automatic machines, recommended by G.N. Grishchenko, obtained satisfactory results in aging at 573 K. It is believed that at lower temperatures from the increased relaxation of stresses in the subsequent annealing is to be expected. This is confirmed, in particular, by the work of I.K. Kontorovich, which found a lack of subsequent relaxation only after annealing at 873 K. This assertion is not without controversy. From the viewpoint of this work, such relaxation is neutralized by increasing the relaxation resistance during aging of cast iron at low temperatures.

The subsequent warpage is influenced not only by the annealing temperature, but also by the design features of the parts. Thus, at the same annealing temperature (823 K) and the same initial state, low rigid structures are prone to increased warpage after annealing. It follows that selection of annealing temperature must be determined not only by iron grade, but also by rigidity, design features and initial stress state of castings.

LITERATURE:

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