ABSTRACT

AUSTENITIC STEEL CASTINGS USED IN CONSTRUCTION OF CARBURISING FURNACES. Theoretical and practical aspects of increasing operating life

The study presented here relates some problems of increasing the life on performance of the creep-resistant cast elements used in carburising furnaces, specially of the castings used for preparation and transport of the charge to be carburised.

The study consists of eight chapters and conventionally can be divided into a reference literature part and a research part. In part first, in Chapters 1 to 3, basing on the data given in literature and own research, the creep-resistant elements of carburising furnaces were characterised and classified. The typical alloys used in their manufacture were compared, and the studies carried out so far on the effect of carburising atmosphere and cyclic changes of temperature on changes in the microstructure and properties of austenitic cast steel were reviewed, discussing also the possibilities of increasing the steel resistance to the carburising effect and to thermal fatigue. Some examples were given of novel designs, typically encountered in this group of products. The second and most important part of the dissertation discloses an output of the author's individual and joint researches on some material-related aspects of increasing the performance life of cast elements of the carburising furnaces. In Chapter 4 the objective of the study and its basic assumptions were formulated. In Chapter 5 the process of casting degradation was described, using as examples the castings withdrawn from use. Chapter 6 discloses the results of studies on the choice of chemical composition of a conventional Fe-Ni-Cr-C cast steel and of the stabilised austenitic cast steel used for construction elements of carburising furnaces. The research was conducted under typical conditions of the steel carburising process, i.e. at the temperature of 900°C, and carbon potential of the carburising atmosphere amounting to 0.9%. The first stage of the research covered the following range of the content of alloying elements (wt. %): 18 — 40% nickel, 17 — 30% chromium, and 0.05 — 0.6% carbon. Mathematical relationships were derived to describe the effect of individual elements on the resistance to carburising and mechanical properties after the process of carburising and on the tendency to crack formation and dimensional stability after carburising and under the effect of thermal fatigue. The derived relationships were used in optimising of the chemical composition of alloys. As a result of this optimising, cast steel of the following composition was produced: 0.3%C - 30%Ni - 18%Cr. At the second stage of the research an attempt was made to examine, basing on the same criteria of choice, the possibility of extending further the chemical composition of alloy to include niobium, titanium and increased silicon content. The content of niobium was changed in a range of 0 — 2%, of titanium in a range of 0.03 — 1%, and of silicon in a range of 1.2 — 3% (wt. %). As an output of the conducted research and calculations it has been proved that additions of niobium and titanium, besides resistance to carburising, reduce the performance properties of 0.3%C - 30%Ni - 18%Cr cast steel. Chapter 7 presents the results of investigation on the possibility to protect castings from an adverse effect of the carburising atmosphere by means of coatings based on aluminium. The coatings were fabricated by three methods, i.e. as powders, as paste, and by casting. It has been proved that coatings can serve as a temporary protection against high-temperature corrosion for creep-resistant construction elements of carburising furnaces. Chapter 8 is a summary of the obtained results of research with conclusions and final remarks.