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Charakterystyka ekologicznych ośrodków polimerowych do chłodzenia nawęglonych stali niskowęglowych

Praca doktorska

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Abstract

The subject of this PhD is the selection of cooling centres in heat and thermo-chemical treatment of steel. The aim of this doctoral dissertation is to select ecological cooling centres for heat treatment of carburized machine components. Particular attention has been paid to the aqueous polymer solutions used as an alternative cooling medium to conventionally used cooling media such as water and quenching oils. These water polymer solutions are used to quench the carburized structural steel elements to ensure the required uniformity of cooling and especially as replacements of commonly used flammable, mineral quenching oils. Suitable choice of cooling centres based on polymer, enables obtaining a very wide range of cooling speed and elimination of some technological defects, including quenching cracks, which are difficult to avoid when using other, conventional cooling media. Cooling capacity tests were performed, of selected cooling centres, including polymeric cooling centres with differentiated polymer participation, mineral oils and water. These tests were performed in a specially designed and built research station. The results of this study are graphically presented as graphs of temperature curves in terms of time and cooling rate versus temperature.

Aqueous polymer solutions with a lack of circulation $V = 0$ m/s have a Grossmann H factor of 0.339-0.576, close to the oil 0.276-0.310 and water 0.574-0.650. With the use of 5% aqueous polymer solution in motion ($V = 0.51$ m/s), a cooling rate similar to water's was obtained. The results of the research indicate that the aim of the research has been achieved and that the thesis of this PhD is fully proven. The constructed authorial research station also makes it possible to perform cooling capacity tests of tested cooling centres on specific carburized samples subjected to quenching from the temperature right for core, top layer and tempering. Therefore, in annex to the doctoral dissertation are included results of the co-authorial or literary research, within the research team strictly collaborating with the author of this PhD. These researches concern the impact of conditions of cooling on the structure and properties of carbon-hardened steels in stationary medium mixed mediums with controlled speed. The results of these supplementary studies confirm the practical usefulness of findings of the theoretical research, contained in this doctoral dissertation. An appropriately selected cooling polymer enables obtaining the same properties of carbonaceous elements as those obtained by the use of oils as a cooling medium and the expected structure in the top layer and in the carbon steel core. It was found that the maximum cooling rate values obtained in impact strength samples at two depths (0.6 mm – 0.64% C and 2.5 mm core – 0.14% C) were lower than those obtained with the probe Inconel 600 alloy. The 16MnCr5 steel structure and hardness test indicates that the use of a 10% aqueous polymer solution as a cooling medium allows obtaining proper structure as well as performance properties of the top layer and core. Increasing the mixing speed of

the polymer cooling bath increases microhardness on the surface of the cooled carburized element. In contrast, if each of the two quenching oils is used, the courses of the microhardness change profiles are very close to one another. The breaking energy tests showed that the highest breaking energy $KU = 1.2$ J of the samples of C20E steel was obtained using 25% aqueous polymer solution at a mixing rate of V = 0.24 and 0.52 m/s. The obtained results of the homogeneity of hardness HV and HRC hardness indicate that the structure on the cross-section of the carburized layer is most homogeneous when using aqueous polymer solution.