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Quenching with Aqueous Polymer Solutions

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Quenching with aqueous polymer solutions has some distinct advantages over classical oil quenching. Among these are the good environmental properties and the possibility to adjust the quenching performance between oil and water quenching.Nevertheless, critical aspects must also be taken into account. When quenching steel parts with polymer solutions, explosive phenomena can occur, often accompanied by large cooling rate changes. These “explosions” can lead to pressure waves and vibrations in the quenching tank, which in the long run can even destroy weld seams of the tank. They are also capable of displacing even heavy components in a batch, creating a risk to worker safety. In order to be able to counter these risks, a research project was initiated by the AWT technical committee “Quenching” and carried out by Leibniz-IWT, in the framework of which, among other things, experimental investigations were carried out in a laboratory quenching bath and in an industrial quenching tank. The polymer type, the type of incident flow, the flow velocity, the bath temperature and the size of the test shafts were varied. Near-surface temperature measurements inside the shafts were performed to characterize the resulting quenching processes. Simultaneously, electrical conductivity measurements and audio and video recordings were made to localize insulating films on the surface and their collapse.
To systematize the large number of measurement results, four characteristic types of cooling processes were identified. These are defined by the following four characteristics: Speed of degradation of the insulating layer, existence of rewetting fronts, reheating and temperature plateaus. In this paper, the approach and specifics of the four types are explained and the assignment of the different quenching processes to the types is presented. Furthermore, results from tests in the industrial quenching tank are presented and conclusions for a follow-up project are derived.

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