DETERMINATION OF THE OPTIMAL TEMPERING TEMPERATURE IN HARD FACING OF THE FORGING DIES

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Resume

Here is analyzed selection of the optimal technology for heat treatment during the reparation of the damaged forging dies. Those tools are manufactured from alloyed tool steels for operation at elevated temperatures. Those steels are prone to self-hardening, so in reparatory hard-facing they must be preheated, additionally heated and tempered. During the tempering, in temperature interval 500-600°C, a secondary increase of hardness and decrease of impact toughness occurs, the so-called reversible tempering brittleness. Here is shown that it can be avoided by application of metallurgical and technological measures. Metallurgical measures assume adequate selection of steels. Since the considered steels are per se prone to tempering brittleness, we conducted experimental investigations to define the technological measures to avoid it. Tests on models were conducted: tempering from different temperatures, slow heating and cooling in still air. Hardness measurements showed that at 520°C, the secondary increase of hardness occurs, with drop of the impact toughness. Additional hard-facing tests included samples tempered at various regimes. Samples were prepared for mechanical and metallographic investigations. Results presented illustrate influence of additional heat treatment on structure, hardness and mechanical properties of the hard-faced layers. This enabled establishing the possibility of avoiding the tempering brittleness through technological measures.

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1. Introduction

The forging dies are in exploitation subjected to numerous cyclic loads, thus, after certain operating time, the impression damages occur, and the tool has to be replaced or repaired [1-4]. The main causes of damaged dies withdrawal from exploitation could be: change of dimensions and form of impressions due to friction and wear, cracks all over the die due to thermal fatigue, and micro cracks caused by action of the stress concentrators.

Factors that are leading to thermal fatigue at elevated temperatures are: material thermo-physical characteristics (thermal conductivity, specific heat and coefficient of thermal linear extension), the geometry of part (size, shape, type of surface), and other material properties (mechanical, chemical, structural) [5, 6].

Some of the reasons for failure occurrences are: increase of the forged pieces dimensions due to worn die, deformation of the thin-walled portions of the die (ribs, mandrels), appearance of cracks at certain parts of the die, local fractures etc.

In order to select the optimum technology of forging dies hard facing, numerous tests were conducted at the model whose sizes were determined according to the similarity theory principle, namely the non-dimensional analysis.

Manufacturing of the new dies made of construction carbon steels, with working surfaces hard faced by the tool steel, presents an exception.