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Reparation of damaged forging dies by hard facing (HF) technology

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Abstract: The forging dies are in exploitation exposed to elevated temperatures and variable impact loads, both compressive and shear. Steels for manufacturing of these tools must endure those loads while maintaining mechanical properties and being resistant to wear and thermal fatigue. For those reasons, the alloyed steels are used for making the forging dies, though they have less weldability, because alloying increases proneness to hardening. Any reparatory hard facing (HF) of the damaged dies would require the specially adjusted technology to the particular piece. In this paper reparatory hard facing of dies used for forging pieces in the automobile industry is considered. Prior to reparatory hard facing of the real tools, numerous experimental hard facings on models were performed. All the model hard facings were done on the same steels which were used for production of the real forging dies. To define the optimal hard facing technology one needs to derive the optimal combination of the adequate heat treatment(s), to select the proper filler metals and the welding procedure. The established optimal HF technology was applied to real forging dies whose service life was further monitored in conditions of exploitation.
Key words: Forging dies, hard facing (HF), filler metals (FM), hardness, microstructure.

1. Introduction

Problems related to reparatory hard facing (HF) of damaged forging dies, which are subjected to heating up to extremely high temperatures, are considered in this paper. Steels aimed for production of such tools ought to sustain high impact loads, to maintain the good mechanical properties, to be resistant to wear and thermal fatigue (ABACHI S. et al. 2010, CHOI C. et a. 2012, EBARA R. and Kubota K. 2008, LAVTAR L. et al. 2005, SUMMERVILE E. et al. 1995). Factors that lead to thermal fatigue are: thermo-physical and mechanical material properties and the piece geometry (MARKOVIĆ S. et al. 2011, LAZIĆ V. et al. 2009, LAZIĆ V. et al. 2011). Due to all those reasons, alloyed steels are used, despite their poor weldability. This is why any reparation by the HF procedure requires specially prescribed technology, adjusted for the particular working piece. Besides the optimal HF technology, it is necessary to define the corresponding heat treatment (MUTAVDŽIĆ M., et al. 2012). Resulting welds, obtained after the HF, were tested in order to establish the hardness distribution in some zones and the microstructure of the HF layer, heat affected zone (HAZ) and the base metal (BM) (MUTAVDŽIĆ M. et al. 2008).

In this case, forging dies for manufacturing parts in the automobile and truck industries were analyzed. During the extensive monitoring of those tools in exploitation, it was noticed that failures could be caused by an increase in dimensions of the forged pieces due to die wearing, deformation of the certain portions of the die, appearance of the cracks and local fractures. Those damages could be repaired by using