Advances and Trends in Engineering Sciences and Technologies – Al Ali & Platko (Eds)

Reparation of the fractured mandrel axle-shaft by welding

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ABSTRACT: Problems of reparatory welding of the broken mandrel axle-shaft are considered in this paper. After visual inspecting of the damaged part and analysis of the crack position and static and dynamic loads, which caused the fracture, it was estimated that the broken part could be repaired, but by a very complex welding procedure combined with heat treatment. The prescribed reparation procedure consisted of proposing the welding procedures, selecting the filler metals and way of groove preparation, welding with the so-called EB insert, defining the welding parameters, prescribing the heat treatment before and during the welding, defining the welds deposition order, selecting the additional machining and defining the control type. The axle-shaft was successfully repaired and the spinner was capable of operating. The downtime was significantly decreased and the costs of procuring/manufacturing the new part avoided. The reparation procedure was done in own plant what provided for significant techno-economic benefits.

1 INTRODUCTION

In this paper, a special emphasis was placed on selection of technology for welding by which the broken axle-shaft could be repaired. These authors have already dealt with the similar problems, when the optimal technology for reparation of certain machine parts and devices had to be prescribed, Jovanović and Lazić (2008a), Lazić et al. (2009), Lazić et al. (2015), Lazić et al. (2012a). In addition, certain research has been done, related to steel's weldability, based on which the welding technology should be prescribed, Mutavdžić et al. (2008), Lazić et al. (2012b), Arsić et al. (2015).

After the detailed analysis of weldability of the steel that the axle-shat was made of and of the fracture surface and operating conditions of this, dynamically loaded part, the complete reparation technology was prescribed, Jovanović et al. (2008). It consisted of proposition of the welding procedures (TIG and MMAW), selection of the filler metals, ways of groove preparation at the place of fracture, welding execution with the so-called EB insert, calculation of parameters for the selected welding procedures (TIG – TIG for the root welds and MMAW for the filling and finishing passes), prescribing the heat treatment (prior to and concurrent with welding), weld passes deposition order, selecting the final machining type, current and finishing control, etc. The prescribed technology was executed to an extent that was possible in the production conditions. For the cover passes, the MMAW procedure was selected due to its higher productivity with respect to the TIG method, Chen et al. (2014), Ericsson and Sandström (2003).

2 CHEMICAL COMPOSITION ANALYSIS OF THE AXLE-SHAFT BASE METAL

Chemical analysis has shown that the axle material was the low-alloyed steel (single alloyed by manganese) what approximately corresponds to steel Č3100 – SRPS (EN – E 355N, DIN – ST52.4). Percentage content of individual elements is shown in Table 1, Jovanović and Lazić (2008a), ASM – Metals Handbook (1979), while the mechanical properties of this steel, for thickness s = 16–40 mm are the following: $R_m = 470–560$ MPa, $R_{0.2} = 280$ MPa, $A_5 = 22\%$. The low-alloyed steel of this class has very low carbon content and it is well weldable. However, due to axle-shaft purpose, the