HIGH SPEED STEEL ROLLS

Lukáš Becák, Miroslav Tvrdý
VŠB - Technical University of Ostrava
Jan Jelínek
Vítkovice Foundries Ltd.

INTRODUCTION

The importance of quality of rolls for hot rolling is very high in this time. The main attributes of the rolls are wear resistance and hardness. Also the other mechanical properties, such as toughness, are taken into consideration. In this case we consider and realize the development and production of HSS rolls, which have strongly better qualities than e.g. High Chromium (Hi-Cr) or Ni-grain rolls. For best quality of HSS rolls are HSS rolls composed of two layers. For the shell part the high speed steel and for the core part the nodular cast iron are used. The cohesion of the shell and core part was solved. We are preparing optimal heat treatment for HSS rolls.

EXPERIMENTS

CHEMICAL COMPOSITION

The chemical composition of HSS rolls is usually situated in this range: 1.45–2.80% C, 0.20–1.00% Si, 0.30–1.00% Mn, 0.50–1.70% Ni, 3.00–9.00% Cr, 1.10–7.00% Mo, 2.80–6.10% V, 0–6.50% W, 0–0.02% Al, maximum 0.05% P and S. We are using the more precise chemical composition for HSS rolls, which is as follows: 1.5–2.0% C, 6.0–8.0% Cr, 2.0–5.0% Mo, 3.0–6.0% V. The optimization of chemical composition is still possible.

TECHNOLOGY OF PRODUCTION HSS ROLLS

The HSS rolls are made by centrifugal casting. This method was also in use for other type of rolls. In the beginning the shell layer from high speed steel is made followed by casting the core of roll by nodular cast iron. The diameters of rolls are 700 mm and the lengths are 1700 mm.

RESULTS AND DISCUSSIONS

Three HSS rolls were cast in the foundry pilot plant. Two of them were in excellent condition (Fig. 1). Three other HSS rolls were also cast under operating conditions in Vítkovice Foundries Ltd. Ostrava. Two of them have cracked and lost their integrity at the interphase between the shell and the core part. The third roll has some minor cracks and partially retained the integrity. In this roll we employed the internal surface for analysis.

First of all we have analyzed the chemical composition of the roll. But there were no marked differences in the contents of individual alloying elements. The notched specimens were used to open the interphase between the shell and the core region. Those fracture surfaces were analyzed using the optical microscopy and scanning electron microscopy. Also the sectional surfaces were used for the optical analysis. The reasons were only to detect the macro-impurities on the fracture surface or nearby the surface.

Fourth cast HSS roll was in excellent condition. From this roll we had cut off three specimens using the water beam cutting and analyzed region of contact of both layers – HSS and nodular cast iron (Fig. 2). We analyzed that surface using the optical microscopy and scanning electron microscopy with microprobe.

CONCLUSIONS

The problems of cohesion of the shell and the core part of HSS rolls have been analyzed by means of the optical microscopy and scanning electron microscopy. The main reason for metal disintegration may be explained by high carbon constituents supported by high level of internal
stresses. This problem was eliminated using special technique of casting. The heat treatment of HSS roll for was realized in temperatures above 1000°C and twice above 500°C.

From the HSS roll number five and six we have specimens after heat treatment for analysis. We will analyse macro and micro structure, hardness and residual austenite.

This research was realized with financial assistance of Czech Republic state funds provided via Ministry of Industry and Trade Czech Republic.

Figure 1 - HSS rolls cast in the foundry pilot plant

Figure 2 – Specimen from fourth roll
Figure 3 – structure of nodular cast iron – optical microscopy – 100x

Figure 4 – structure of HSS – optical microscopy – 100x

Figure 5 – structure of nodular cast iron – optical microscopy – etched – 100x
Figurer 6 – structure of HSS – optical microscopy – etched – 100x