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Case study

Low hardness on bearing race—An investigation

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1. Introduction

During processing of bearing outer race, low hardness was observed on one of the faces of a few races (Fig. 1). Bearing races are generally processed from rolled bars. Bars are parted, forged, machined, heat treated and then ground. The processing sequences of a bearing outer race are given in (Fig. 2). While carrying out heat treatment, the races are austenitized in molten salt bath at around 870 °C [2] (Fig. 3) followed by quenching in molten salt bath at 220 °C (marquenching) [2] followed by air cooling, water cooling, tempering in salt bath at 180 °C and rinsing in hot water [2]. Races are inspected for hardness on sample basis after heat treatment. Hardness is measured on both the faces of the race. A few races were reported to be having low hardness on their faces (38–42 HRC against specification of 61–63 HRC) detected in course of grinding. A photograph of part of an outer race has been shown in Fig. 1, where low hardness was found only on a portion of one of the faces of the outer race as shown in Fig. 1. A detailed investigation was carried out to find out the root cause of the defect, i.e., low hardness.

2. Experimental

Chemical analysis of the samples was carried out using X-ray fluorescence spectroscopy (XRF). Carbon and sulfur contents were determined using combustion infrared technique. Hardness measurement was conducted using the Rockwell C scale. The samples having low hardness were taken out from the mould and macro-etched in boiling aqueous solution of HCl (50% HCl + 50% water) for approximately 20 min [3] and then were inspected to observe the forging flow lines along the

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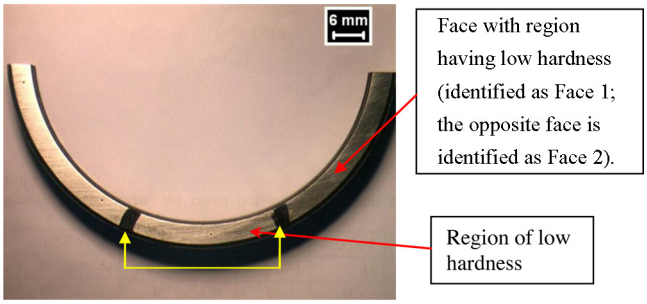

Fig. 1. Part of an outer race – marked region having low hardness. Hardness values of the rest of the portion of the face were within the specification.

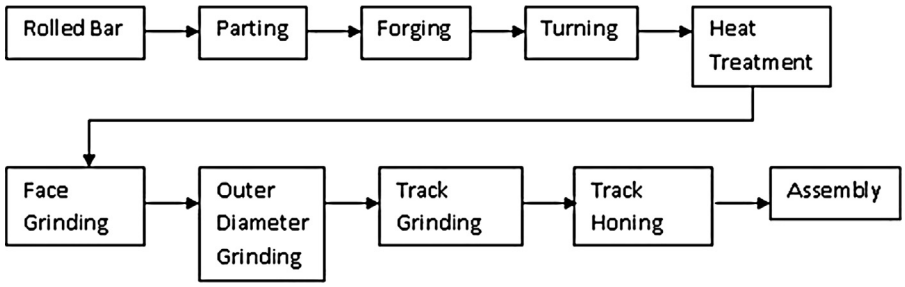

Fig. 2. Processing sequence of a ball bearing outer race.

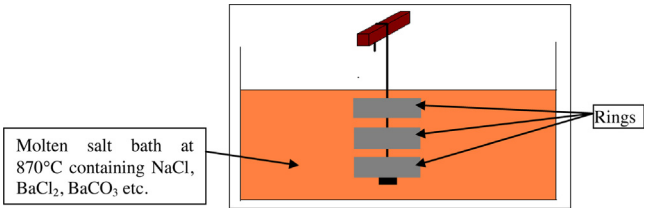

Fig. 3. Rings are held inside austenitizing bath by means of a stainless steel hook.

cross-section of the samples. Microstructural study was carried out using a LEICA DMRX6000 microscope. The samples were prepared by following the standard metallographic technique and etched with 2% nital solution.

3. Results

3.1. Chemical analysis

The outer ring sample chemistry conformed to SAE52100 steel. The chemical analysis of the sample in wt% is provided in Table 1.

3.2. Hardness measurement

Fig. 1 shows the region of low hardness on the face of outer race. According to quality check control generally performed to verify that hardness is compliant with technical requirements, it was decided to test hardness of outer surfaces by macro hardness tests, instead of micro hardness. Detailed hardness results in Rockwell C scale are provided in the Table 2.

Table 1
Chemical analysis result (wt%).

Elements	C	Mn	S	P	Si	Al	Ti	Cr	Mo	Cu	Ni
Specification SAE52100	0.98–1.1	0.25–0.45	0.025 max	0.025 max	0.15–0.35	0.010–0.060	0.03 max	1.30–1.60	0.10 max	0.35 max	0.25 max
Outer race	0.98	0.38	0.008	0.011	0.178	0.024	0.002	1.40	0.000	0.005	0.016