SPEEDING UP THE HEAT TREATMENT
OF BIMETALS

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The bimetal of low-carbon steel and the ASM antifriction alloy, used for tractor engine bearings, is subjected to special annealing after cold rolling. The bimetal is annealed in special boxes with sand seals in OKB-331 electric furnaces with forced air circulation. The total weight of the furnace load is 3-4 tons. The maximum heating temperature is 460°C. Heating at higher temperatures (500°C) leads to the formation of intermetallic layers [1, 2].

On annealing at 460°C the ASM alloy is completely recrystallized and acquires its former plastic properties. The steel base retains its cold hardening, which ensures the necessary "tightness" of the bearing when fitted in the seat [3].

The total annealing time is usually 34-35 h. The holding time amounts to only 10-15% of the total annealing time, and as a consequence the output of a single furnace does not exceed 0.1 ton/h. Furthermore, this annealing procedure, even in boxes with sand seals, does not prevent the formation of brittle oxides on the surface of the steel.

The purpose of this work was to determine the possibility of speeding up the heat treatment. We investigated the variation of second-order stresses in the steel base with the degree of deformation and annealing time at 460°C. The residual stresses were determined from the width of the diffraction lines by the method described in [4].

The x-ray analysis was conducted in the URS-50 apparatus with Fe Kα radiation at a potential of 35 kV, current of 8 mA, width of the slit 1 mm at the tube and 0.1 mm at the counter, with rotation in the vertical plane of the sample.

The standard was pure iron annealed 1 h at 850°C and cooled in the furnace.

Samples 15 × 20 mm were cut from the cold-rolled strip of low-carbon steel.

The strips were deformed 25, 37.6, 59, and 70%. The surface of the strips was removed by etching and electropolishing.

One group of samples was annealed in a laboratory furnace at 460°C with holding for 5, 15, 60 and 240 min. The oxide film was removed from the samples by electropolishing after annealing.

The results obtained show that the residual stresses increase with the degree of deformation. This is indicated by the true widths of the lines from samples after the various treatments (Fig. 1). It follows that the hardening of low-carbon steel during cold working is due to refining of the blocks and the increase of second-order stresses. The mechanical properties of the steel change in consequence.

On heating, the residual stresses are notably reduced (Fig. 2), the value of the stresses and rate of reduction depending on the degree of preliminary deformation. The higher the deformation, the higher the value and rate of reduction of the stresses. The stresses are relieved very rapidly, the
value of the stress after annealing 15 min being almost identical to that after annealing 240 min. This indicates that it is possible to speed up the annealing of the bimetal.

The rate of stress relief during accelerated annealing was studied under commercial conditions with the K-130 conveyer furnace. The heating coils in this furnace are divided into three sections. The movement of the conveyer was controlled with reducers.

The temperature was 760°C in the first section of the furnace, 650°C in the second, and 520°C in the third. The total time in the working space of the furnace (5–25 min) was controlled by the travel rate of the conveyer, which was varied from 1 to 5 m/min. The temperature of the bimetal was measured with contact thermocouples at the time of leaving the furnace. Under the given conditions the steel base of the bimetal reached a temperature of 460–480°C in 10–15 min; the temperature of the ASM alloy was 500–520°C. At these temperatures the alloy is completely recrystallized, while the steel remains in the cold-hardened condition. For comparison, the bimetal was also annealed in the OKB–331 furnace under plant conditions.

The properties of the bimetals annealed under the different conditions are given in Table 1. Tests of samples taken from the annealed strips showed that regardless of whether subjected to accelerated annealing in the K-130 conveyer furnace or long annealing in the OKB–331 furnace the adhesion strength of the two layers is satisfactory, there is no difference in the hardness of the components or the value of residual stresses in the steel base, and the requirements of VTU 5739–62 are satisfied.

In addition, the oxidation of the steel base during annealing in the conveyer furnace is considerably less than in the OKB–331 furnace due to the short time at high temperature.

**CONCLUSION**

For stress relief of cold worked low-carbon steel in bimetals it is expedient to use accelerated annealing in a furnace of the conveyer type.

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* A. A. Severyukhin took part in this investigation.