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PRÍSPEVOK K OPTIMALIZÁCII VLASTNOSTÍ OCELE POUŽÍVANEJ PRE ŽELEZNIČNÉ KOLESÁ Z HĽADISKA ICH OPOTREBENIA

A CONTRIBUTION TO THE OPTIMIZATION OF WEAR BEHAVIOUR OF STEEL USED FOR RAILWAY WHEELS

Článok sa zaoberá vplyvom tepelného spracovania na odolnosť voči opotrebovávaniu ocele používanej na dvojkolesia v súvislosti s ich prevádzkovanou životnosťou.

In the next chapter the paper deals with the influences in the state of heat treatment of the wheel steel related both to the wear resistance and to the reason of the runout.

1. Problem

With regard to the wear behaviour of wheels two problems are in the centre of interest:

1. Running time up to the given limit of the flange profile (wear of wheel flange and running in depth) and
2. Development of unwished deviations of roundness before the conditions are reached, which are mentioned under point 1.

The velocity of development of both facts is determined by the wear resistance of the material. The reason for the runout can be found in tribological differences in the state of material distributed in the circumference of the wheel. Such differences can be caused by variable conditions in the wheel circumference during the manufacturing process of the running tread, by special conditions at the beginning of using the wheel caused by vibrations of the wheel or the wheel set, but mainly it is caused by conditions of the heat treatment which differs along the circumference of the wheel.

2. Influences in the state of heat treatment to the wear behaviour

The following results were obtained from laboratory investigations using a block test bed with such test conditions that between the least wear state and the state of the highest wear resistance the whole range of wear mechanism was covered, i.e. from mainly metallic wear up to mainly oxidic wear.

The variation of heat treatment was performed by using specimen made of unalloyed wheel-steel with 0.72 % C; the counterpart of test specimen was made of temper hardened unalloyed (rail-) steel with 0.75 % C and a hardness of 335 HV.

The test results are shown in Fig.1. Following conditions of heat treatment have been recorded:

- temper hardening state above the martensite state with a variable tempering temperature,
- temper hardening state above the martensite state with a variable austenizing temperature,

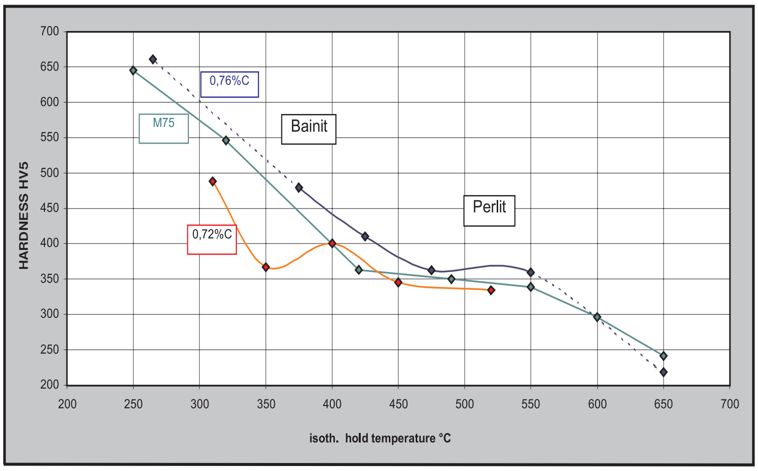

Fig. 1 Wear versus hardness for variable tempering temperatures, resp. austenizing temperatures for temper hardening states and for reduced holding temperature (direction of arrow) with isothermical temper hardening of unalloyed steel with 0.72 % C

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- an overhardened (austenizing temperature 1.200 °C) not tempered state,
- a continuous cooling state using moved air,
- isothermical transformed state with variable holding temperature.

In general, the results reflect that the wear resistance of steel with a determined hardness (and a determined structure) is the higher the less the cooling velocity is at the time of the last austenite formation. In parallel we can see the influence from the shape of cementite formation; the laminar shape of cementite (pearlite) shows the best, coarse globular cementite (high tempered martensite) the worst wear behaviour.

If the tempering state is formed from a bigger share of residual austenite (austnizing temperature 1.200 °C) then this tempering state in the mentioned sense - related to hardness- shows a remarkably better wear behaviour than a tempering state which is obtained directly from the martensite under all other conditions remaining the same.

Bainite obtained by isothermical transformation shows a similiar wear level like pearlite formed with continuous cooling. Both show a wear behaviour which is remarkably better than a temper hardened structure. The pearlite which was formed by isothermical transformation shows the most advantageous wear behaviour. The overhardened state (austenisation at 1.200 °C/water) is an exception in this range of hardness: The especially high wear resistance results obviously from transformation of residual austenite to martensite in the friction area. In case of practical operation in such a state exists the danger, especially at lower surrounding temperatures, that the mentioned transformation of residual austenite appears also in wheel-, wear-flange-cross-section with all negative consequences especially through the increase of volume and brittleness.

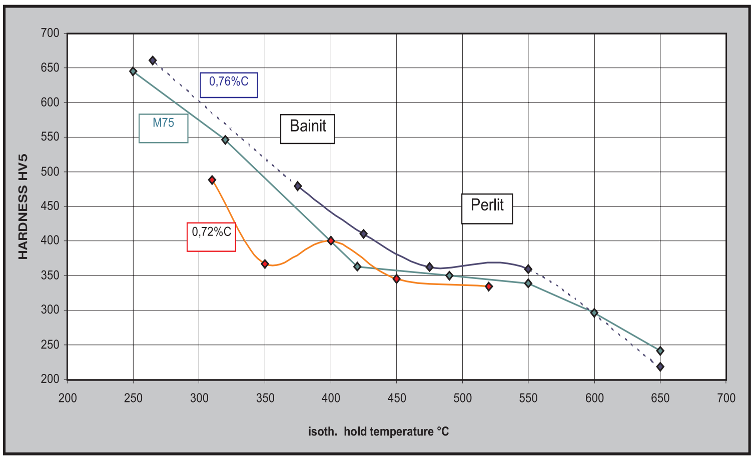

Fig. 2 Hardness versus isothermical holding temperature for different unalloyed steels (by own findings and after HERBST, B., Dissertation A 1978)

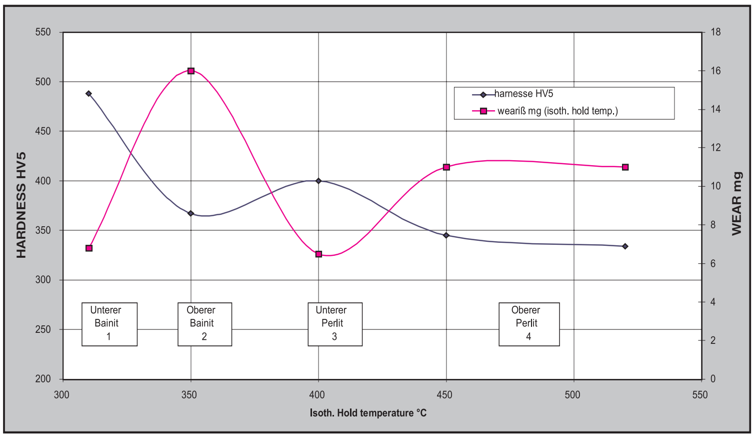

Fig. 3 Hardness and wear versus isothermical holding temperature for an unalloyed steel with 0.72 % C

3. Realization of constant conditions of heat treatment

The necessary constancy of the state of heat treatment for reducing the tendency of runout of wheels relates in the first place to the circumference of a single wheel but also to a pair of wheels within a wheel set.

Therefore, the conditions of the heat treatment should be chosen in a way that unavoidable deviations in the heat treatment process will cause only insignificant differences in structure. Applying continuous cooling this requirement is the better met the slower the cooling velocity is chosen.

At isothermical transformation in the range of a holding temperature within 450 °C and 500 °C a large independence of the hardness towards the height of the holding temperature is shown (Fig. 2). Appropriate investigations of the steel with 0.72 % C, which you can see in the diagram, showed that this constancy is also valid for the wear behaviour (Fig. 3).

4. Summary

From the numerous variants for the realization of the heat treatment states for transformable steels results the possibility, that even for equal hardness very different wear behaviour can be reached.

"Normal" temper hardening provides the most unfavourable wear behaviour, isothermical temper hardening during the pearlite step the most favourable.

The least of the influences from deviations in the conditions of the heat treatment to the structure result from continuous transformation with a slow cooling rate, for isothermical transformation at a holding temperature around 500 °C.

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