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THE SENSITIVITY OF CHOSEN CORROSION RESISTANT STEELS ON INCREASED WORKING TEMPERATURES

CITLIVOSŤ VYBRANÝCH KORÓZIIVZDORNÝCH OCELÍ NA ZVÝŠENÉ PREVÁDZKOVÉ TEPLOTY

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Abstract

The components which are produced of chromium- nickel austenitic steels operate by extreme high temperatures could change its material properties during the operating time, which is occurred by decrease of lifetime /early ending of component lifetime/. On the corrosive resistance of chromium-nickel steels has influence geometry of structural element, surface quality, carbide occurrence and morphology of created oxides in interaction with component surface. Therefore is necessary to recognize the sensitivity of materials, which are using at high temperatures and therewith related changes of mechanical properties and structure changes. This work deals with long-time corrosive loading of chromium-nickel steels where was metallographic observed the structure and the first corrosion initiation.

Abstrakt

Chrómniklové austenitické ocele, z ktorých sa vyrábajú súčiastky pracujúce pri vysokých teplotách, môžu počas prevádzky meniť svoje materiálové vlastnosti, čo sa prejaví znížením životnosti (predčasným ukončením doby životnosti súčiastky). Dôjde k vzniku medzných stavov. Je dôležité poznať citlivosť materiálov, ktoré sa využívajú za zvýšených teplôt a s tým súvisiace zmeny mechanických vlastností a zmeny štruktúry.

Key words: limit state, corrosion resistant steel, sensitivity, microstructure

1. Introduction and the aim of work

The praxis experience occur us to allocation of corrosion resistant steels which have a lot of advantages but in spite of fact, there are liable to failure by specific conditions. It comes to this, that as normaly used steel underlie to degradation, also the austenite corrosion resistant steel is liable to failure, especially in case of technological process breach or working condition breach. By its these steels are able to retain their unique properties, e.i. the enhanced resistance towards very agresive environments, high resistance towards oxidation in gas atmosphere by temperatures over 600°C, the best resistance towards corrosion, heatresistance and high temperature strain.

Of this reasons was devoted the attention of influence the primary technologies on the quality of semi-products which are cold worked and their inclination to degradation.

The aim of this work was allocate on the sensitivity of chosen austnite corrosion resistant steels cold worked which were consequently cyclic loaded in area of critical temperatures (at 500 – 900°C).

2. Inverse problems in technical praxis.

Experimental part analysed the concrete examples the failure parts of austenite corrosion resistant steels. It deals of glass plate - a component of glass mould; which is in primary contact of hot molten glass.

The chemical composition of glass plates which are producing of austenite chromium nickel steels is on the next table.

Table 1 Chemical analysis of glass plate's material

Material	C	Mn	Si	Cr	Ni	P	S	Ti	Nb	Al	V	W
17255- standard	max.0,20	max.1,50	max.1,00	24,0-26,0	19,0-22,0	max.0,0455	max. 0,030	•	•	•	•	•
ZF-2 provider	0,08	0,83	2,06	24,16	19,85	0,02	0,004	•	•	•	•	•
ZF-2 new plate	0,117	1,011	1,909	24,66	19,91	<0,0014	0,0118	0,0215	<0,0010	0,1192	0,0438	0,2378

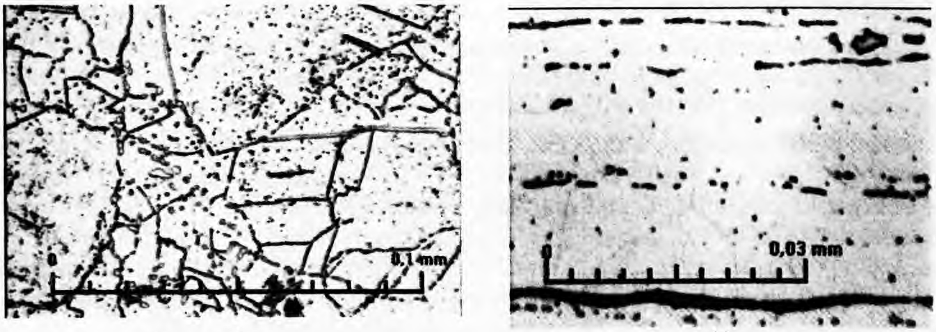
Where,
17255 – Standard – chemical composition of Cr-Ni austenite steel 17 255 [mass %] standard STN 41 72 55,
ZF – 2 provider – chemical composition of material ZF – 2 [mass %] of provider KIND&CO,
ZF – 2 new plate – chemical composition of material ZF – 2, new plate, nb. 32 255 [mass %]

Then was evaluated the quality of microstructure on basis of metallographical investigation.

On steel which are used in glass factory are posed some claims and there should have resistance towards:

- Temperature spikes,
- heat,
- cyclic thermal loading,
- consumption,
- corrosion,
- adhesiveness and running into molted glass.

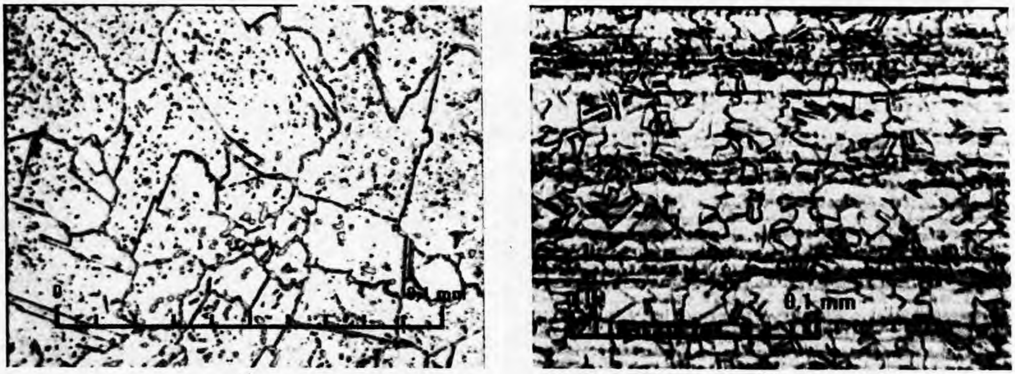
- Carbide occurence, intermetallic phase and δ - ferrite in case of chemical composition breach of austenitic steel, figure 1a,b.



a) b)

Fig. 1 Carbid segregation, intermediate phases and δ-ferrite

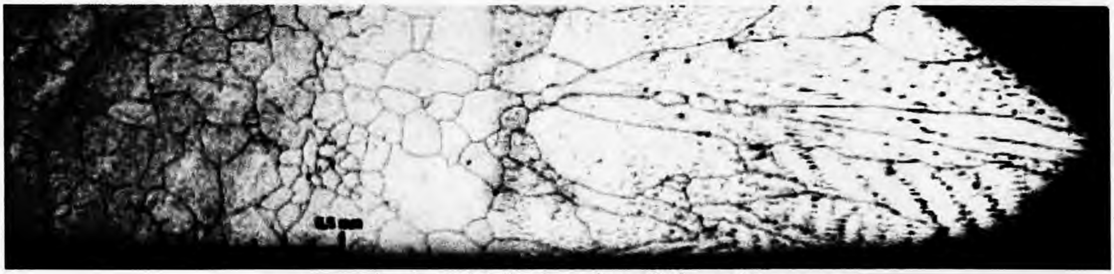
- Carbide segregationácia on grain boundary and precipitation inside grains, figure 2a leads to steel inclination on oxidation and material embrittlement. The material quality will dependent on size, morphology and spacing already segregated carbides.



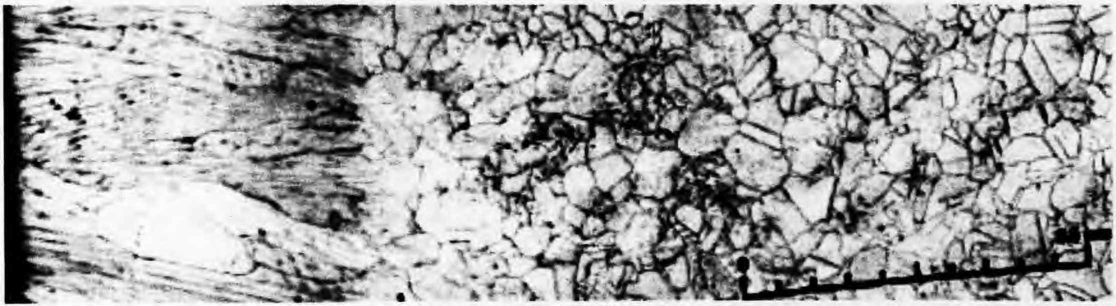
a) b)

Fig. 2 Carbide segregation on grain boundries and inside the grains, Plate microstructure of longitudinal section after working

- Presence of glide bands – twins, figure 2b indicate presence the residual stresses after plastic deformation which is spurious by thermal or mechanical – thermal loading,
- Oxide creation – like figure of "blisters" which are unsticked of the surface and caused the surface roughness is incurred by cracks correction on surface by welding.
- Creation of big "columnar" grains, figre 3. after plate repair leads to deformations and quickly surface consumption in area of internal zone point (zero radius),
- Repair in thin places of plate are created big deformation – stress states, which are potential source of cracks in area of zero radiuses.



a) Longitudinal section of glass plate



b) Cross section of glass plate,

Fig. 3 Repair of glass plate in area of internal outlet by welding

Structure studying and the basis of other knowledges was achived:

- markedly heterogenous structure of input material, figure 4 causes the degradation, loss of lifetime and mechanical, physical and thermal properties.

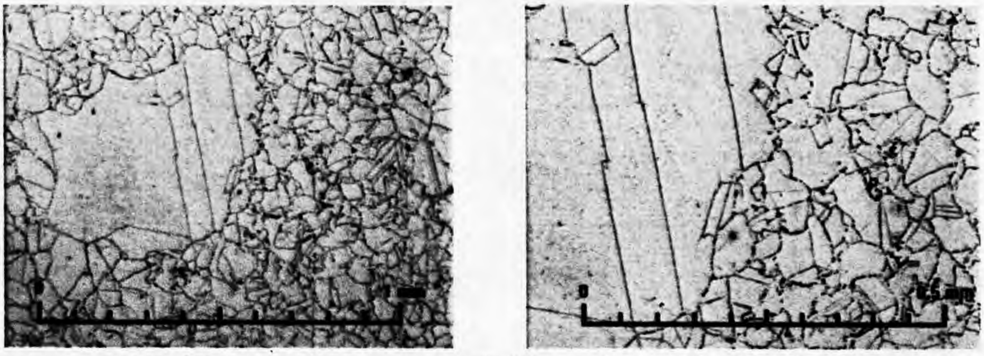
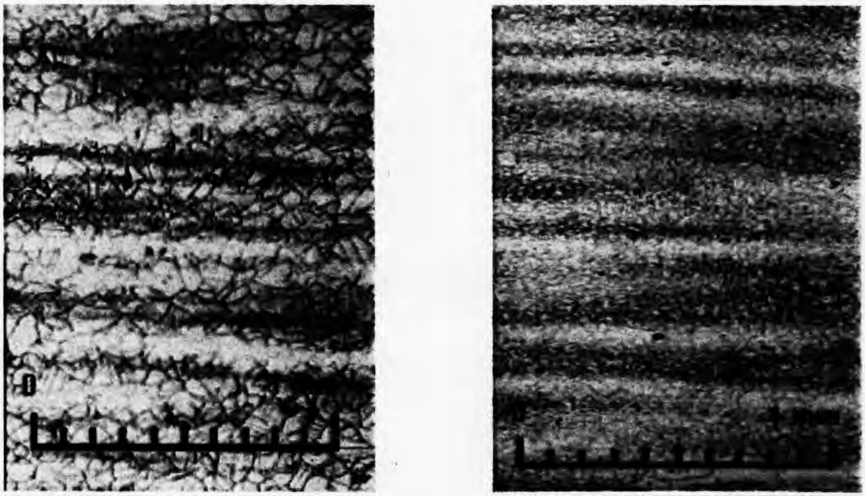


Fig. 4 Cross section of output material – various grains size – detail

- Low quality of this structure (also in case of chemical composition breach) by its accidental thermal - mechanical loading leads to surface tarnisch which are in contact with hot modten glass. Thereby occurs to limiting state of consumption,
- geometric state of glass plates gives an assumption of structural heterogeneities creations in various areas, figure 5a, b which is occured by grain size change.



a) middle area after etching b) marginal area after etching

Fig. 5 Microstructure of glass mould part

The mutual sign of above soluted problems was, that we deal with failure of whole construction elements of Cr-Ni austenite steels which were cold rolled; from which was suggested the resistence of temperature changes and corrosion. We could observe the creation of limiting states (LS) before its lifetime. Acquired knowledges are possible to summary in figure 6 in term of creation of limiting state of structure.

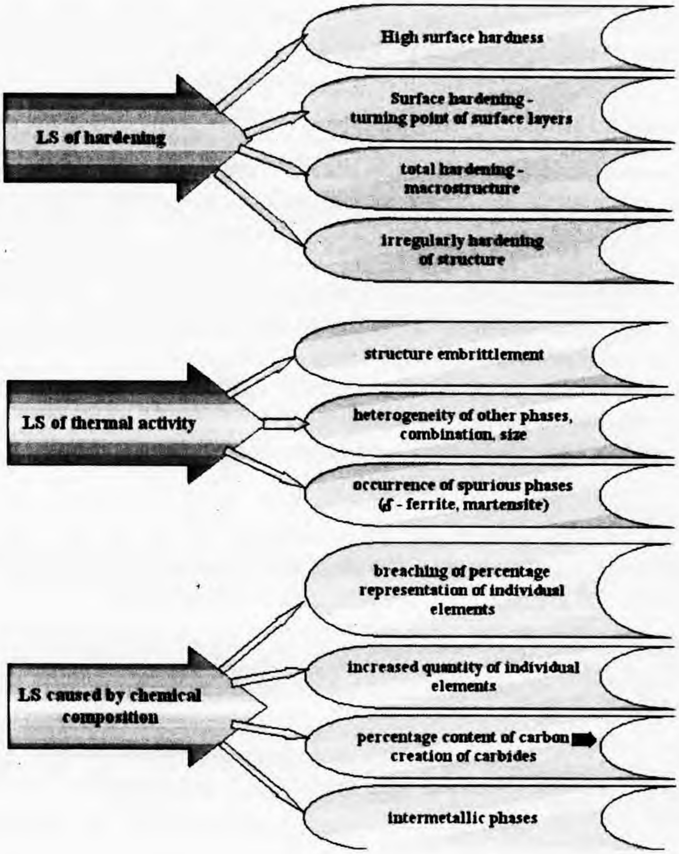


Fig. 6 Creation of limiting state in glass plate

3. Conclusion

Primary metallurgical process, dezoxidation of steel and casting process can induce carbid creation $M_{23}C_6$, which lead to change of brittlefracture properties by segregation on grain boundaries.

Stable carbides (on basis of Ti, Mn) are partly dissolving in austenite by high temperatures with consequently precipitation of carbidic and intermettalic phases which cause the loss of plasticity and tendency on intercrystalline corrosion (at 500-900°C).

At temperatures about 700°C occurs to structures embrittlement which relate with decaying of δ – ferrite and possible creation of δ – phase (in areas of increased content of Cr).

The spare content of sulphur in austnite steels caused sulphide creation and consequently point corrosion creation on basis of Mn and Cr.

Dezoxidizing ability of Si, Ti and Al increased the strength of O and Cr bonds which affected the corrosion process.

In praxis the cyclic thermal loading of structure (with high thermal gradient) forwarded creation of oxide processes on glass plate surface and leads to material embrittlement.

Intercrystalline corrosion creation caused the concentration changes in microlocality of structure which effects resistance reducing towards whatever corrosion. The hightest corrosion sensitivity is occurred by temperatures of 650-700°C when carbides draw Cr on grain boundary areas by the occurrence of structure embrittlement.

Recommendations

- The observance of chemical composition which proves by change of structure by thermal – mechanical loading. No occurrence of surface and internal failures which lead to irregularly structure hardening and to unacceptable stress states.
- Minimal occurence of δ a σ ferrite, which leads to changes of mechanical and physical properties and corrosion resistance changes.
- Saved dimension stabilities after the repairs, failing which can lead to state of stress in structure and thereby into limiting states of failure.
- For each chromiumnickel austnite material is necessary to ken the deformation – stress states by working temperatures, providing that this material and its components will work by high temperatures. The experimental and computer modelling is needful for each stell

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