



# PROPERTIES OF HOT ROLLED STEELS FOR ENAMELLING

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**Abstract:** The results of an investigation of the structure and properties of experimental produced hot rolled steels suitable for enamelling are presented in the paper. Hot rolled steels for enamelling represent a special group of the steels for conventional enamelling. Their quality has to be adapted to the method and conditions of enamelling. Therefore, these steels should meet some specific requirements. In addition to usual investigation of the chemical composition and mechanical properties, microstructure and quality of the steel surface also were investigated. The basic aim was to examine steels capability for enamelling, i. e. steels resistance to the fish scales phenomena, by trial enamelling, as well as quality of the steel - enamel contact surface, to evaluate the binding. Also, the changes of the mechanical properties, especially the yield point, during thermal treatment, as a very specific requirement, were investigated, by simplified method. Good results were obtained confirming the steels capability for enamelling.

## 1. INTRODUCTION

Hot rolled steels belong to the group of steels for conventional enamelling, but represent a special area. In comparison with cold rolled steels, they are less suitable for enamelling since they show a higher hydrogen permeability, and therefore, a higher susceptibility to fishscale occurrence. The effects of cold rolling in achieving an appropriate structure and reducing the hydrogen permeability are not present here. The coefficient of hydrogen diffusion has a higher value than that in cold rolled steels [1,2].

Hot rolled steels can substitute cold rolled steels for certain application, first of all in one-side enamelling, such as manufacturing of boilers, reservoirs, silos and similar equipment.

The main reason for production of hot rolled steels for enamelling is to provide lowering of production costs. Elimination some phases of cold rolling, such as rolling, annealing and skin-pass rolling contribute to shortening of the production process [3].

The results of an investigation of the properties of experimental produced hot rolled steels for enamelling are presented in the paper.

## 2. EXPERIMENTAL

Trial production of hot rolled steel suitable for enamelling, with required properties, for certain application, instead of cold rolled steel, was the task. In order to achieve these specific requirements, and regarding that this steel grade is not standardized, the chemical composition and temperature regime of hot rolling, with high coiling temperature, were proposed [4]. Microalloyed steel was rolled in the semicontinuous hot mill in strips with thicknesses of 2,0 and 2,5 mm. Hot rolled strips were pickled in order to provide better surface quality.

The chemical composition, mechanical properties, microstructure and capability for enamelling, first of all fishscale resistance, of produced hot rolled steel, were investigated.



### 3. RESULTS AND DISCUSSION

The obtained chemical composition of steel is presented in Table 1.

Table 1. Chemical composition

Range	Elements (mass.%)							
	C	Si	Mn	P	S	Cu	Al	TI
	0.030-0.050	0.013-0.017	0.230-0.315	0.006-0.014	0.006-0.018	0.015-0.044	0.025-0.053	0.040-0.056

All elements are in the projected concentration ranges.

The mechanical properties and mechanical properties after thermal treatment are presented in Table 2.

Table 2. Mechanical properties

Mechanical properties			Mechanical properties (after thermal treatment)		
Re (MPa)	Rm (MPa)	A (%)	Re (MPa)	Rm (MPa)	A (%)
292	339	37	325	343	36
290	342	37	331	356	35
301	344	37	335	353	35
297	342	37	325	352	34
306	344	38	345	366	34
292	358	40	325	360	36
297	358	40	333	361	36
300	351	40	333	360	36
297	360	43	316	360	36
272	344	45	298	346	36

The determination of the tensile properties changes, first of all of yield strength changes, during enamelling process, was customer's request [5]. It is very important for further steel processing that yield strength does not decrease during enamelling. A simplified method was used for testing the changes of yield strength during thermal treatment [3]. The obtained results show that all values of yield strength after thermal treatment are higher than before.

The effect of thermal treatment on the yield strength is presented in Fig. 1.

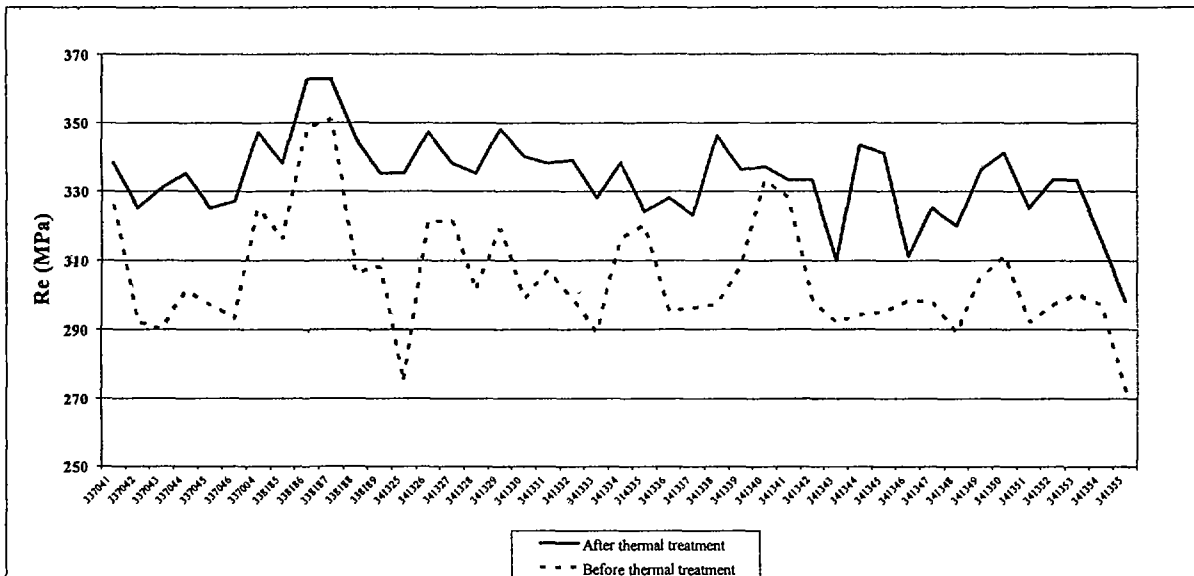


Fig. 1. Effect of thermal treatment on the yield strength



The microstructure of the samples, according to the metallographic examinations, is of the ferrite-cementite type, with separated coarse plates of cementite at the grain boundaries, which are characteristic for high coiling temperatures. Ferrite grain size is 8-9 (ASTM).

Capability for enamelling of produced hot rolled steel was investigated by trial one-side enamelling of steel samples and subsequent thermo-shock was carried out. Enamelled samples were inspected visually. The steel is resistant to fish scaling. Also, it was obtained satisfactory binding between steel and enamel. The produced hot rolled steel is capable for enamelling.

#### 4. CONCLUSION

The properties of experimental produced hot rolled steels for enamelling were investigated. The results show that projected chemical composition and temperature regime of hot rolling were obtained. The values of yield strength are increased after enamelling process. The produced steel is resistant to fish scaling and capable for enamelling.

#### References:

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- [4] European standard EN10290
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