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RESEARCH REGARDING THE QUALITY OF THE STEAL USED FOR MAKING ROLLING STOCK COMPONENTS

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ABSTRACT: The work presents the manner of settlement of the specific problems of steel ingot cast in a smooth cylinder format and its use as semi-finished product, compatible with the manufacturing of monoblock wheels, under the quality conditions thereof imposed by the manufacturing regulations. By means of the proposed research and experiments we intend to get to know the specific characteristics of the ingot and the optimization thereof in order to satisfy the quality requirements imposed on the products (monoblock wheels).
KEYWORDS: steel, quality, monoblock wheel, rolling stock

1. INTRODUCTION

Various flow sheets are used, around the world, for the manufacturing of monoblock railroad wheels, which use as raw material semi-finished goods cut from ingots or blooms.

The use of ingots has various inconveniences, which characterize the gross cast steel, namely: the inhomogeneity of the chemical and structural composition and of the section compactness along the height of the ingot; the need to increase the denting depth in order to break it; the inaccuracy of the cutting of the bars according to the established weight, and the need to check them piece by piece.

The use of semi-finished products cut from blooms has the following advantages: absence of contraction, porosities and other defects specific to ingots; better and constant density; cleaner exterior surface; size precision and weight tolerances precision.

The casting process for the steel wheels is constantly improved, which ensures an increase of the quality and efficiency of their production. In Romania the manufacturing of monoblock railroad wheels is 35 years old in the former Factory of Axles and Bogies of Balş, which is currently named as S.C. Subansambluri de Material Rulant – SA.

For the manufacturing of monoblock railroad wheels we have the following main technological processes: the obtaining of the starting semi-finished product which includes – the manufacturing of the steel, the casting of the ingots, the potential rolling of the blooms, the division of the ingots or blooms; the forging of the wheels which includes: the heating of the bars resulting from the division of the ingots or blooms, the actual forging with its stages (stamping, rolling, forming – calibration, perforation of the central hole in the hub), the cooling of the forged wheels; the thermal treatment of the wheels; the mechanical processing of the wheels which is usually performed in most of the cases in two stages, namely before and after the thermal treatment of the wheels.

2. RESEARCH RESULTS

The flow sheet for the manufacturing of the wheels at SC SMR SA Balş is shown in fig.1. In SC SMR – SA Balş the production of monoblock wheels had its qualitative evolution ensured by real facilities and a real flexibility of the technological process.

Starting from the obtaining of the starting semi-finished product, we can very well say that until the manufacturing of an almost ideal semi-finished product, obtained by computer assisted development in duplex or triplex system continuously cast conjugate aggregates, certain improvements can be obtained even with the current equipment: a chemical and structural homogeneity of the ingots; advanced purity regarding the non-metallic inclusions as well as the gases; economic format of semi-finished product.

The following shortcomings must be noted regarding the manufacturing of the liquid steel and the casting of the ingots: the full development of the steel in electric-arc furnaces is uneconomical, and the quality of the steel is not fully satisfying, due to the chemical and thermal inhomogeneity, the high content of endogenous inclusions and gas.

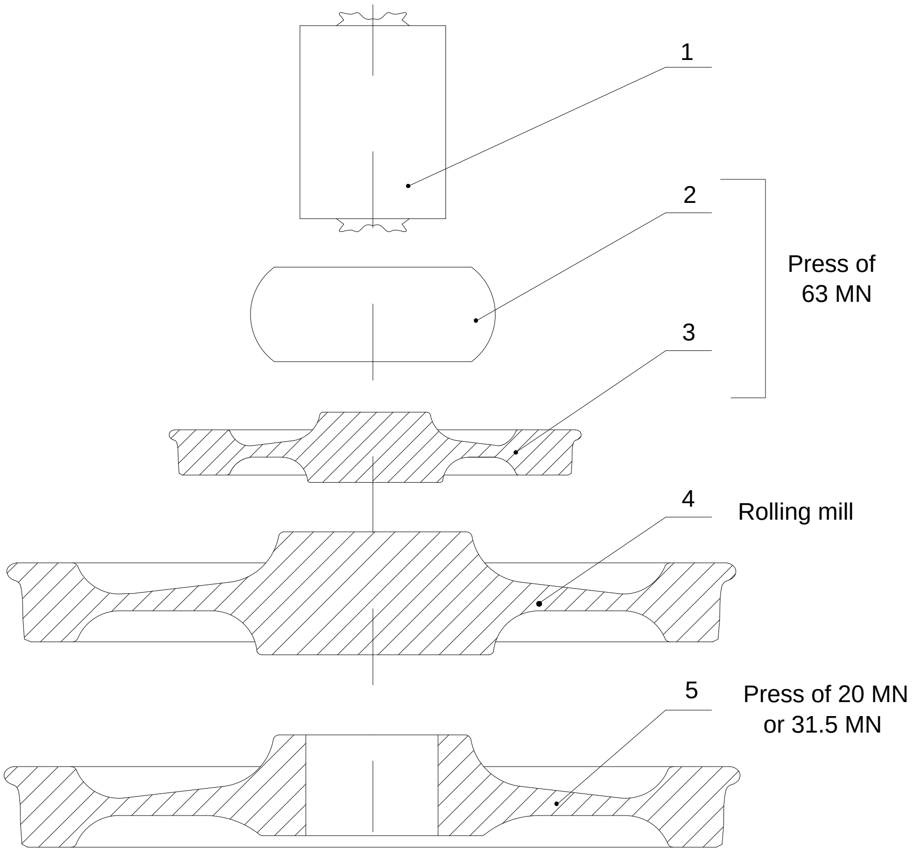

Fig. 1. Technological diagram for the manufacturing of the wheels by SC SMR SA Balş
1 – semi-finished product, 2 – upsetting, 3 – stamping, 4 – rolling, 5 – membrane forming, perforation, calibration, marking

For the performed researches, objectives were established which could harmonize the influences of certain ingot technological manufacturing – casting factors upon the behavior of the semi-finished obtained product in the process of plastic deformation and upon the physical – mechanical characteristics of the manufactured wheels.

For the manufacturing of the monoblock railroad wheels high quality carbon steels are used and only in few cases attempts have been made regarding the use of alloy construction steels.

The chemical composition of certain steels according to U.I.C. 812-3; A.A.R. M107 and G.O.S.T. 10791 is presented in table 1.

Table 1

	C	Si	Mn	S	P	Cr	Cu	Mo	V
UIC 812-3/84	0.48-0.58	0.4-0.5	0.75-0.90	0.035	0.035	0.30	0.30	0.08	0.05
AAR M107/84	0.47-0.77	min 0.15	0.6-0.85	< 0.05	< 0.05	-	-	-	-
BS 5892/92	0.48-0.70	0.4-0.5	0.8-1.2	0.04	0.04	0.30	0.30	0.08	0.05
JIS	0.60-0.75	0.15-0.35	0.5-0.9	< 0.045	< 0.045	-	< 0.30	-	-
GOST	0.44-0.65	0.2-0.6	0.5-1.2	< 0.04	< 0.035	-	-	-	0.08-0.15

Thus, the recent editions of the international regulations impose a series of requirements such as: the chemical composition of the steel with references to the content of the main elements (C, Mn, Si, P, S, Cr, Ni, Cu, Mo, V, H_2); the manner of processing of the samples, the position of the place in which the establishment of the chemical composition is carried out on the product; mechanical characteristics, the values which must be complied with, the samples processing position, the shape and sizes of the test specimens, the test procedures must be taken into account; the consistency of the thermal treatment (hardness test); the degree of purity in inclusions; the resistance to shock or fatigue; remanent tensions; breaking tenacity of the hoop; characteristics of the surfaces; dimensional tolerances; remanent static unbalance; anti-corrosive protection; marking. During the manufacturing of wheels the chemical composition and the gas content (hydrogen, nitrogen, oxygen) are to a large extent the decisive elements regarding the obtaining of the main characteristics of the wheals corroborated with the hot deformation of the cast semi-finished product and the adequate thermal treatment. The main physical and mechanical characteristics established for the wheels are: resistance to rupture; yield point; elastic limit; elongation; rupture resistance or energy upon shock bending; strength; K1C tenacity.

The experimental data obtained regarding the influence of the chemical composition upon the resistance characteristics was processed with EXCEL software, the results being presented in a graphic and analytical form. The correlations resulting for the yield point and tensile resistance are presented in fig.2-11.

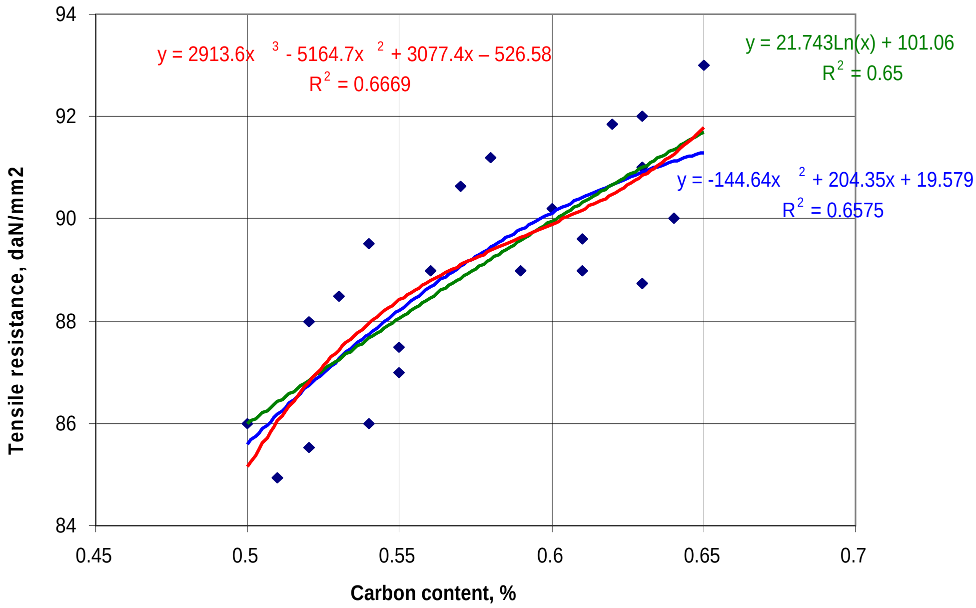

Fig.2. Variation of the tensile strength according to the carbon content

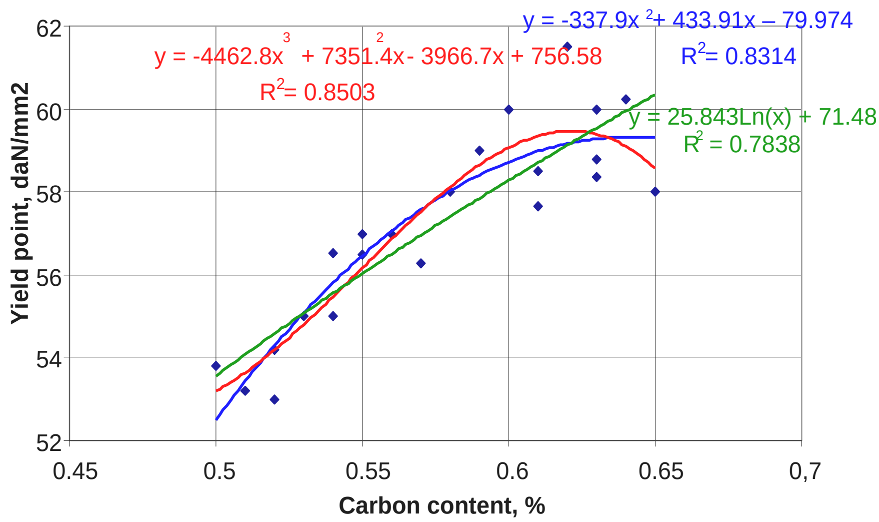

Fig.3. Variation of the yield point according to the carbon content.

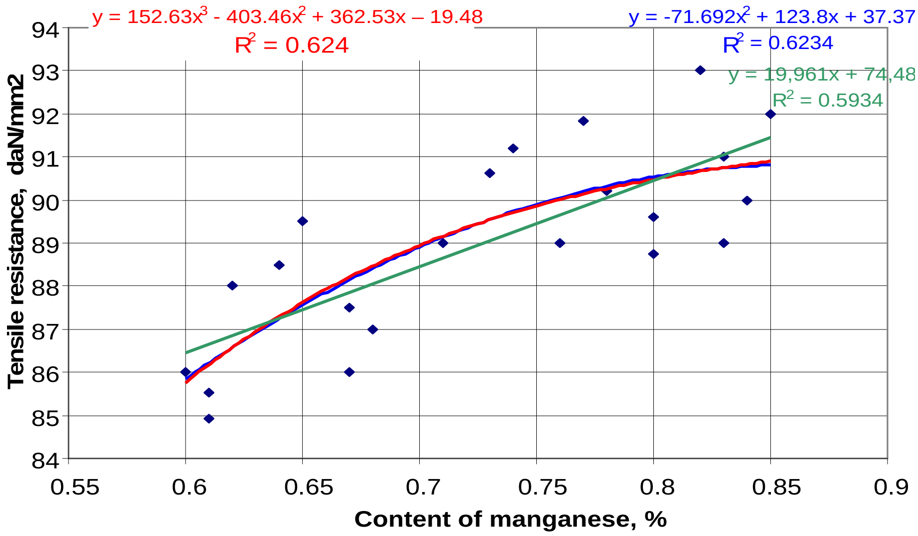

Fig.4. Variation of the tensile resistance according to the manganese content

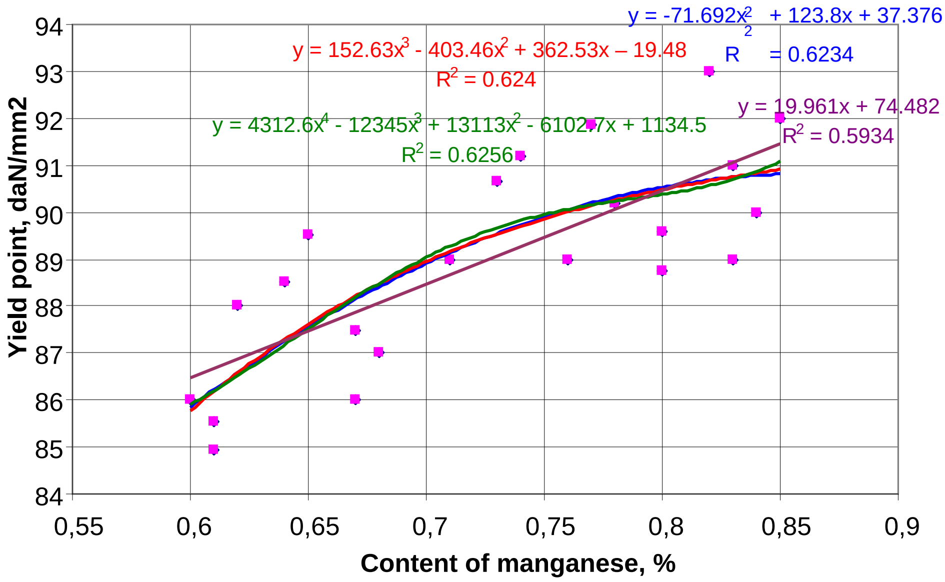

Fig.5. Variation of the yield point according to the manganese content

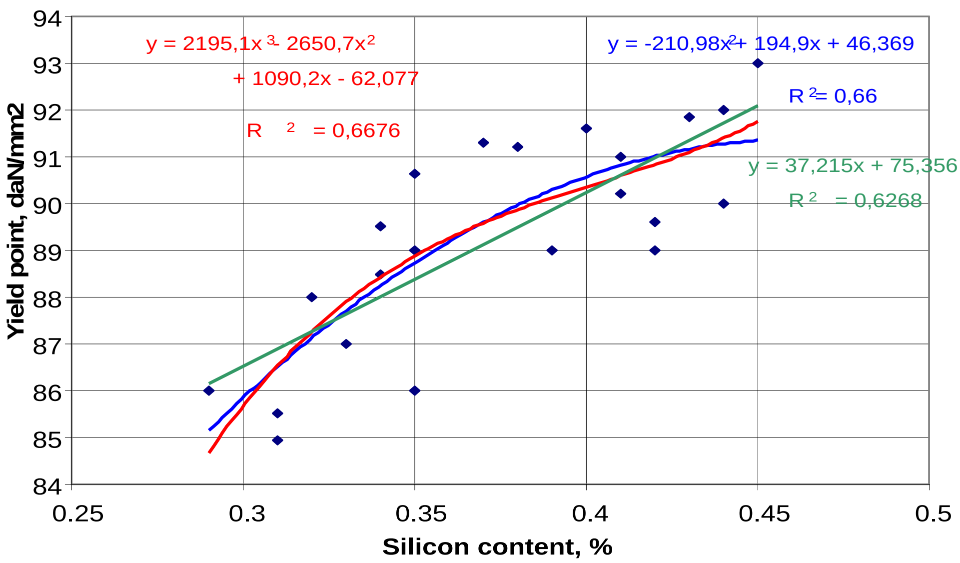

Fig.6. Variation of the yield point according to the silicon content.

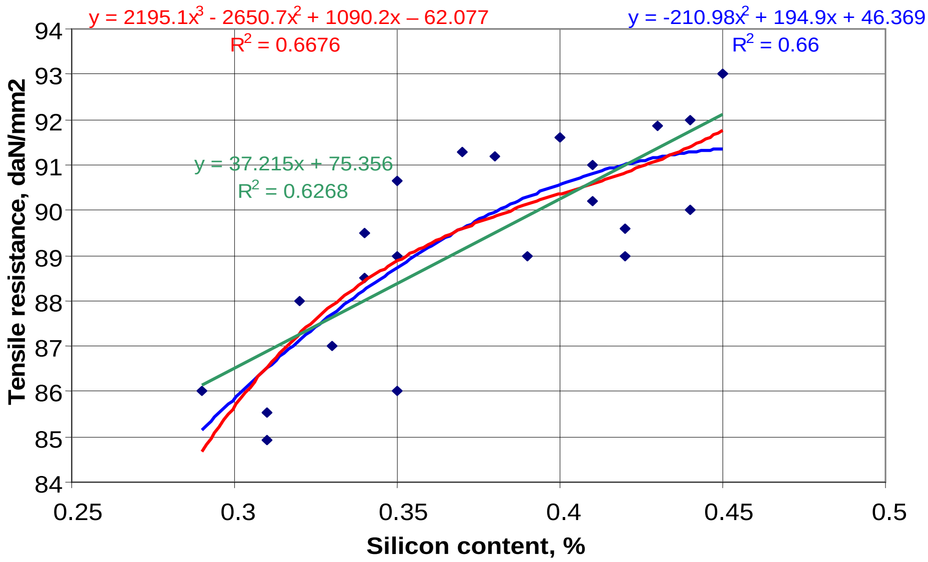

Fig.7. Variation of the tensile resistance according to the silicon content

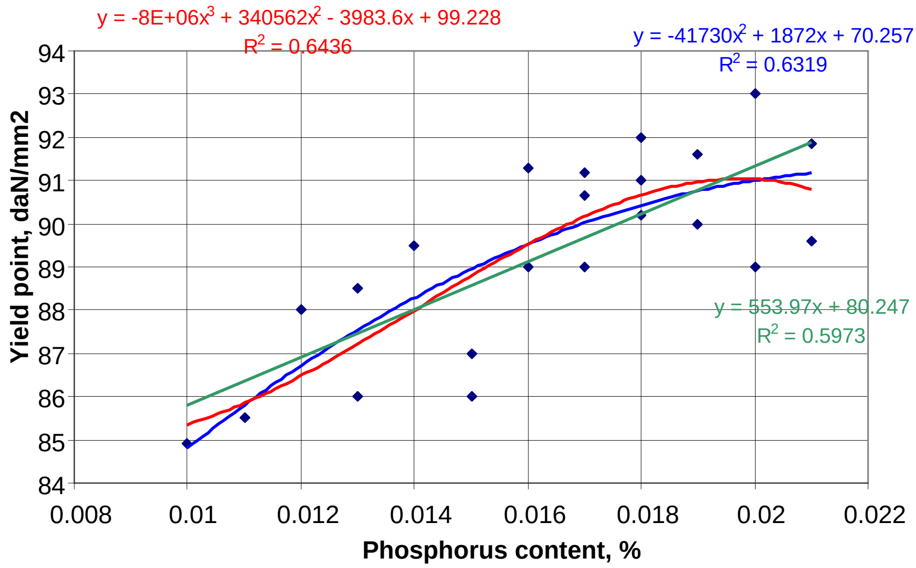

Fig.8. Variation of the yield point according to the phosphorus content

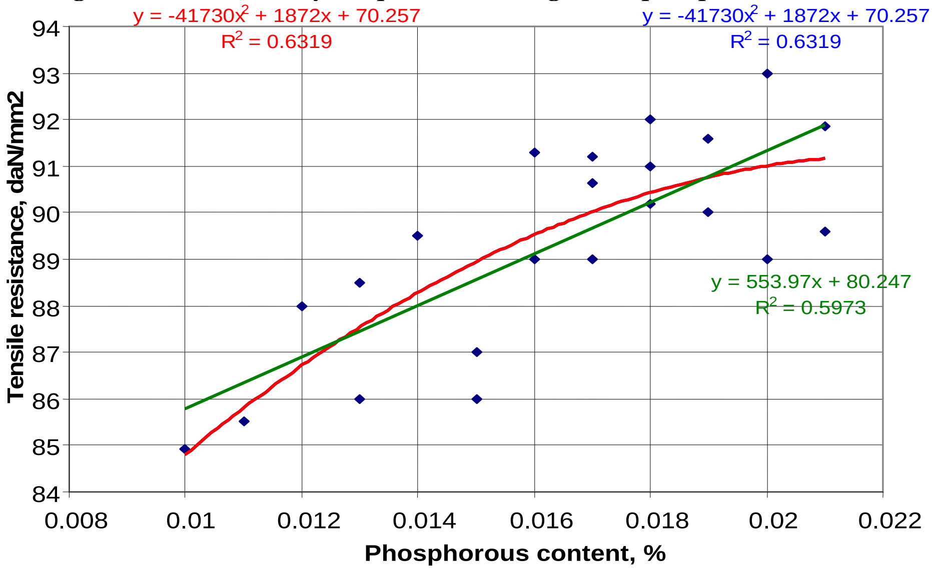

Fig.9. Variation of the tensile resistance according to the phosphorous content.

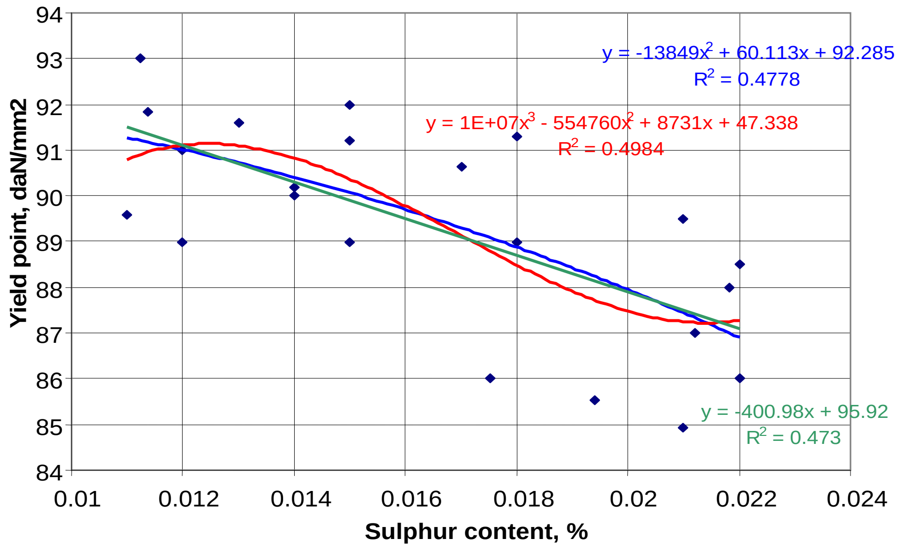

Fig.10. Variation of the yield point according to the sulphur content.

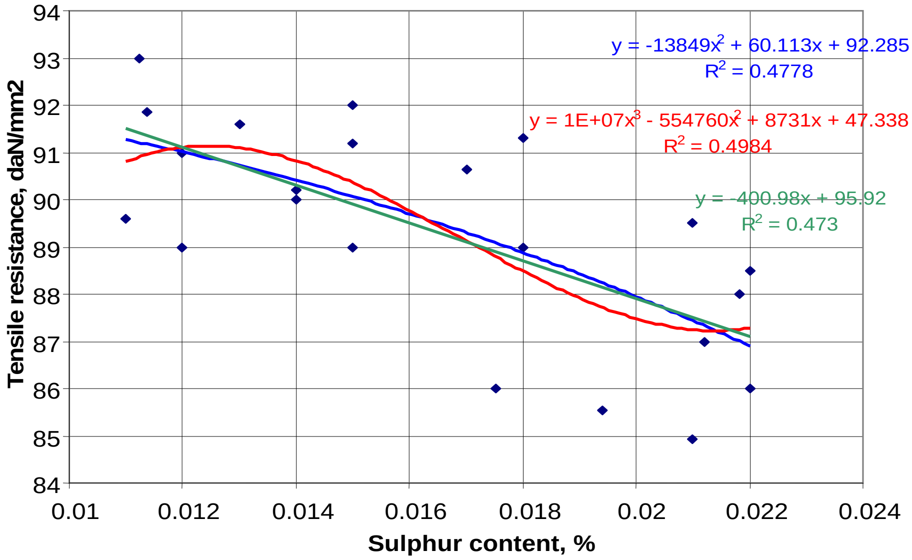

Fig.11. Variation of the tensile resistance according to the sulphur content.

3. CONCLUSIONS AND PROPOSALS

From the analysis of the data processed in a graphic and analytical form a series of conclusions can be drawn:

- the increase of the resistance to traction and of the yield point with the increase of the carbon content is due on the one hand to the increase of the pearlite ratio in the structure, constituent with superior values for these characteristics, and on the other hand due to the favorable action of the carbon upon the deoxidation and desulphuration process;
- manganese as element which is present in almost all steels dissolves in iron and forms solid solutions increasing their resistance. On the other hand, the manganese from the steel also has a deoxidation and desulphuration role, which can be noticed in the improved resistance characteristics;
- regarding the silicon, it dissolves in ferrite increasing its resistance and toughness. At the same time, the silicon is also a deoxidizing agent with a great deoxidation power having the capacity to calm the steel completely and as a consequence decreases progressively the oxygen content of the steel, element which has a negative influence upon quality;
- in the analyzed steels phosphorous is present in very small concentrations and therefore it causes no negative effects, on the contrary when dissolved in iron it leads to the formation of mixed crystals which in their turn determine an increase of the toughness of the steel. The existing phosphorous content of the analyzed steel does not create the risk of the formation of a ternary

eutectic Fe_3P – Fe – C with a melting temperature of 953°C which would cause the cracking of the ingot upon its processing due to the plastic deformation;

- regarding the sulphur content a decrease of the values for resistance to concentrations of more than 0.018% was found. Regarding the range of 0.011-0.018% we can say that its negative influence is insignificant. We believe that for values between 0.018 and 0.022% an inhomogeneity may exist regarding the distribution of the sulphur in the structure of the ingot, which may influence its characteristics;

Further research shall be performed in order to establish certain complex dependence relations, namely the data will be processed with the Matlab software by analyzing the influence of three independent factors (C, Mn, Si) upon the independent parameters (tensile resistance, yield point etc) and based on the obtained results we will be able to establish an optimal chemical composition. Moreover, we will also have in view the establishing of the dependence relations for other characteristics: toughness, resilience, elongation, as well as the gases content of the steel (a very important aspect for the steels destined for the manufacturing of rolling stock components).

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