or

$$\frac{w}{\Delta r}\ln S_w = 0$$

and becomes

$$\frac{p}{\rho w^2}\ln S_p = \frac{\mu\,\Delta x}{w\rho\,\Delta r^2}\ln S_w\left(\ln S_w + \frac{\Delta r}{r}\right)\cdot$$

and consequently

$$\mathrm{Eu}\ln S_p = 2\ln^2 S_w\,\Gamma_{\Delta d}\,\frac{1}{\mathrm{Re}},$$

where $\mathrm{Eu} = \dfrac{p}{(\rho w^2)}$, $\mathrm{Re} = \dfrac{w\rho\,\Delta r}{\propto}$, $\Gamma_{\Delta d} = \dfrac{\Delta x}{(\Delta d)}$, $\Delta d = 2\Delta r$

or

$$Eu = 2\frac{\ln^2 S_w}{\ln S_p}\Gamma\frac{1}{\mathrm{Re}} = 2C_{w,p}\Gamma\frac{1}{\mathrm{Re}}\cdot$$

In general, can be put as

$$\mathrm{Eu} = 2\frac{\ln^2 S_w}{\ln S_p}\Gamma\frac{1}{\mathrm{Re}} - \frac{\ln S_w}{\ln S_p}\frac{1}{\mathrm{Ho}}$$

or

$$\mathrm{Eu} = 2\frac{\ln^2 S_w}{\ln S_p}\Gamma_{\Delta d}\frac{1}{\mathrm{Re}} + 2\frac{\ln S_w}{\ln S_p}\Gamma_d\frac{1}{\mathrm{Re}} =$$

$$= 2\frac{\ln S_w}{\ln S_p}\left(\ln S_w + \Gamma'_d\right)\Gamma_{\Delta d}\,\frac{1}{\mathrm{Re}},$$

where $\Gamma_{\Delta d} = \dfrac{\Delta x}{\Delta d}$, $\Gamma_d = \dfrac{\Delta x}{d}$. Ho is the homochronicity number.

If the flow is unsymmetrical about the axis, gives

$$\mathrm{Eu} = 2\frac{\ln S_w}{\ln S_p}\left[\ln S_w + \Gamma'_d + \left(\frac{\Gamma'_{\text{в}}}{\Delta\theta}\right)\ln S_w\right]\Gamma_{\Delta d}\frac{1}{\mathrm{Re}},$$

Then equations are universal equations for flow in cylindrical tubes under laminar conditions; the resistance law in the interpretation used enables one to provide a more exact relationship between the parameters in the most complicated cases, can be used in computing flow hydrodynamics of the flow of a liquid or gas in the tubular devices applied in ferrous metallurgy.

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Analysis of statistical data of composition of the alloyed steels

Influence of a chemical compound on the carbon contents in a steel is analyzed and the mathematical model is received in the course of processing of month basic data. Optimum significances of source parameters at the carbon contents in a steel – 0,08 % have been found.

The task is the influence analysis of input data on output function. Data analysis files amounted to 31 smelting during one month. The table 1 shows average chemical composition of steel, produced at «OMZ – Spets`stal`» Ltd.

Literature and practical data gives us the idea of the impact of every element on steel properties. For example:

– Nickel makes steel high corrosion-resistant;
– Silicon is used as attached foreign material (silicon content ≤ 0.37% has no influence on the steel properties);
– Molybdenum provides increase of elasticity, oxidation resistance at high temperature;
– Manganese is used as attached foreign material (with content ≤0.8%) to avoid the detrimental steel effect;
– Copper increases corrosion-resistant properties

Change properties of the alloyed steels not only depends on the nature and the number of alloy elements but also on mutual influence and the interaction between the alloyed steels and carbon.

Table 1. Average chemical composition of steel										
C, %	Mn, %	Cr, %	Ni, %	Mo, %	Si, %	V, %	Cu, %	Al, %	N2, %	As, %
0.095	0.868	0.18	2.17	0.42	0.3	0.04	0.19	0.0084	0.0072	0.0086

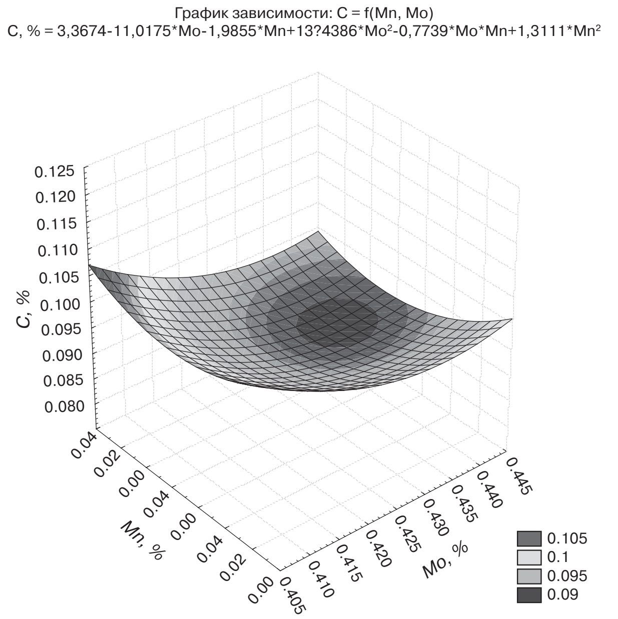

Fig.1. Dependence diagram of carbon content on managanese and molybdenum content

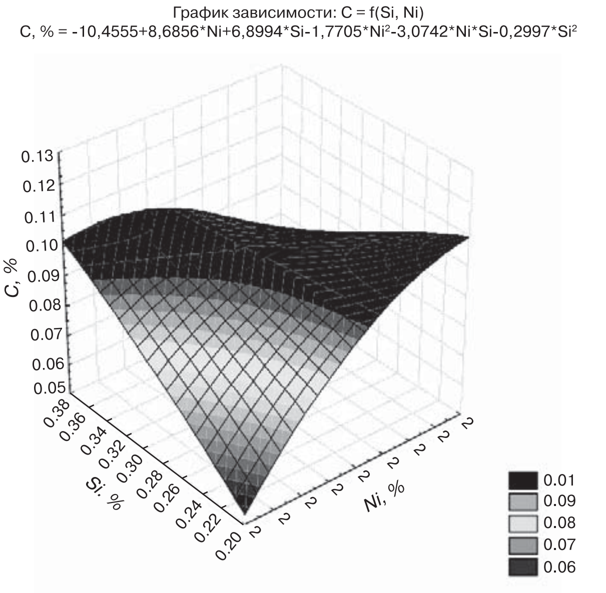

Fig.2. Dependence diagram of carbon content on silicon and nickel content

Carbon content was taken as output function as carbon content influences steel properties. Chemical composition was taken as input data.

In the course of monthly source data processing of steelmaking, next mathematical model was obtained and its final form is presented by formula

$$C = 0,197 - 0,111Mn + 0,035Ni - 0,156Mo + 0,096Si - 0,240Cu \quad (1)$$

The formula shows *Si, Ni, Cu, Mn, Mo* have highest impact on output function.

Increasing silicon and nickel content it is possible to increase also carbon content of steel, while molybdenum, manganese and copper content have contrary impact. Binary diagrams of *C-Ni, C-Cu, C-Mn, C-Mo* were analyzed in order to explain conformity data. The diagram of *C-Ni* shows carbon and nickel making solid solution with the limit of 1.5% carbon solubility in nickel at T = 1050 ^{o}C.

Today due to examined state diagram we know that manganese and carbon form a several chemical compounds such as Mn_3C and Mn_7C_3 (carbides). Molybdenum and carbon form the chemical compound Mo_2C .

If we`ll try to compare impact of the above-mentioned elements (silicon and nickel) on carbon, we can testify that silicon has a higher impact. In the course of steelmaking, silicon is removed primarily as it and oxygen have features in common.

Copper is in oxidized condition in the initial fusion mixture as carbon and oxygen have much more features in common than copper; carbon burn out in the form of *CO* or CO_2.

According to the obtained data, dependence diagrams *C = f(Mn, Mo)* and *C = f(Si, Ni)* were constructed (Fig. 1 and Fig. 2). The diagrams show that minimum percentage C~0,08 % occurs at output data content as follows (%): *Mo* = 0.44-0.45; *Mn* = 0.88-0.92; *Si* = 0.2-0.28; *Ni* = 2.10-2.14.

The best value of input data at the minimum percentage C~0.08 % for this steel grade was found. The results are listed in the table 2:

Table 2. The best value of input data					
0.08%C	0.9%Mn	2.15%Ni	0.44%Mn	0.25%Si	0.22%Cu

Obtained results confirm the source results of monthly data of medium alloy steelmaking and the output data is carbon that described by equation.

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