Development of Mathematical Models Obtaining Quality Glass-Coating in "Metal-Glass-Coating"

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***Abstract*—In the article the method of experiment design a mathematical model based glass-adhesion of coatings on their composition and processing temperatures. The equations of regression allows us to conclude that at a ratio SíO2: D2O <2.5 region of optimal values of the alkali content of up to 16% and more than 20% R2O, and with increasing SíO2: D2O <2.55, this area is mixed in the direction the alkali content of more than 20%.**

Keywords—glass-coating, cybernetics, mathematical model of coupling.

INTRODUCTION

One of the main problems of chemical cybernetics is the application of the laws of statistical mathematics to find the optimal variants of the technological process.

In the synthesis of protective coatings for glass-has become one of the most important tasks is to create a quality cover in the "metal-coating." Quality coatings of this system depends on the strength of coupling which is characterized by the selection of the index of thermal linear expansion coefficient (hereinafter, coefficient of linear expansion) of the two systems, and, with a coefficient of linear expansion is selected such that its value was 10-15% less than the value of the coefficient of linear expansion of the metal indicator. But there is information about the composition of coatings, which differ strong adhesion to the metal, despite the failure to comply with the specified conditions [1], or vice versa, enameling aluminum and its alloys with a clear choice of indicators TFLE both systems, there is a stone chip coatings [2

Another common condition for strong adhesion is the incorporation into the vitreous enamel slip or some oxides (oxides of cobalt, nickel, antimony, etc.) That promote adhesion. Several studies have shown that as the oxides, providing a strong bond can be recommended as oxides of chromium, iron and molybdenum. Also known single-layer coatings composition having sufficient bonding strength to the substrate which do not contain oxides clutch [3].

The process of forming a durable adhesion of coatings to metal is a complex physical-chemical process, it can be represented in the form of structural and logic [4]. In this case, the process of forming a quality coating can be represented as follows (Fig. 1):

The external factors include the composition of the gas environment and temperature fixing surfaces and the inner - the composition, structure and properties of the coatings, the method of retreating the metal, which is determined by the degree of development and the creation of the surface layers of the phases involved in the subsequent coupling.

For lasting adhesion of the coating also affects the nature of the metal is determined by its view, the presence of alloy components, melting point and thermal boundary extreme of scaling [1].

Analysis of these factors indicate that among them the most important are those which are incorporated in the coating, i.e. its composition, structure and properties of which are determined by such factors as the reactivity, the presence in the oxide adhesion and coating integrity values of thermal expansion, which, in turn, influence the composition and structure of the transition layer. Based on the above mentioned factors, we have chosen the factors of variation values are listed in Table. 1. The interval and pitch variation for each of the independent variables were chosen sufficiently broad so as to take into account various possible options [5].

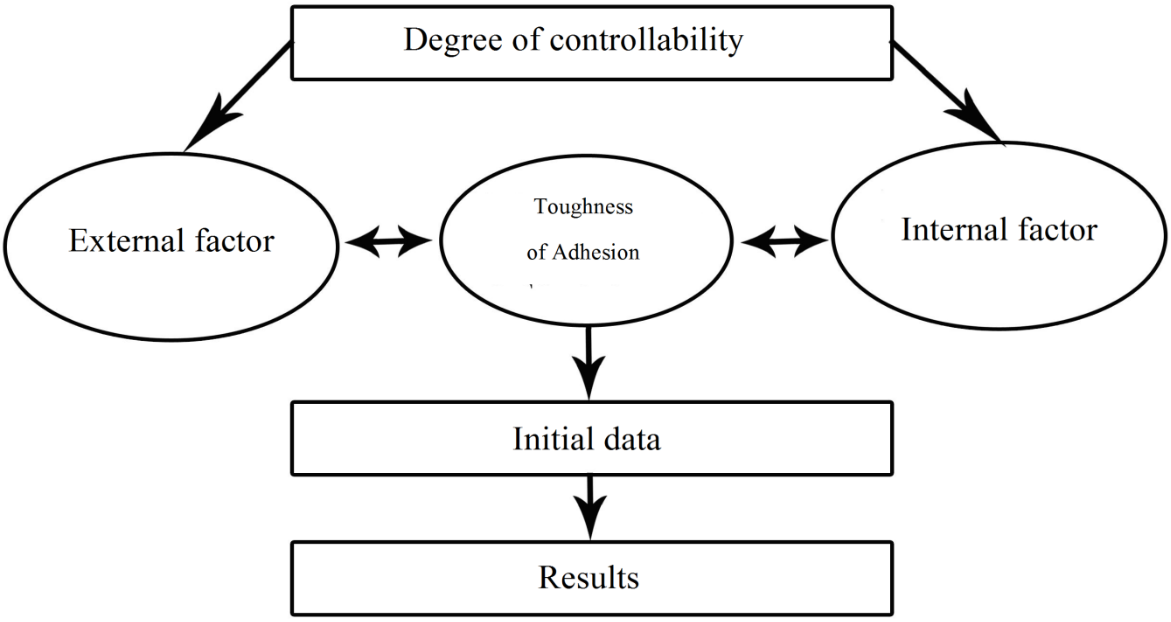

Fig. 1. The structural logic of the formation of strong coupling.

The dependent variable is selected adhesion strength of coating on steel, determined by the method of the NIP [6].

Table 1 The levels of factors and varying intervals

Factors	Factor	The limits of variation	The interval of variation
X_1	The ratio of SiO2: B2O3 when the amount is 60% by weight	2,0 – 4,2	0,6
X_2	The weight content of R2O at a ratio Na2O: K2O = 1,1: 1,0	16-22	2
X_3	The firing temperature, 0C	700-900	50

Matrix planning, combined with the results of the experiment are shown in Table. 2.

Most interesting are the dependencies for multiple groups of data with different X1 X2 at change. Temperature 8500S optimally regarding energy savings, since at lower temperatures results of adhesive strength is low in absolute value and are unstable. As can be seen, with the proviso x2 <20, with increasing X1 Y value decreases; when X2 = 20, with an increase in the value of X1 Y increases; and if X2> X1 20 with increasing value of Y stabilized. Analysis of the same pair, depending on the Y = X3 X2 at 8500S showed that in the entire range of variation of the sustainability of growth is maintained adhesion with increasing the total content of the alkaline component. After processing of the experimental results obtained by regression equation:

$$Y= - 287,16 – 11,18 X_1+6,90 X_2+0,28X_3 \quad (1)$$

Table 2 Matrix experiment planning

Factors of variation		The response function Y (bonding strength)% and X3 0C				
X_1	X_2	740	780	800	850	900
2,0	16	0	85	72	56	90
	18	80	95	95	96	98
	20	0	0	0	0	25
	22	25	0	95	95	98
2,6	16	0	16	20	10	20
	18	80	85	85	90	90
	20	0	0	55	60	60
	22	0	90	92	95	95
3,2	16	0	0	30	30	60
	18	0	0	10	20	20
	20	30	85	90	90	85
	22	10	95	90	85	95
3,8	16	0	0	0	20	25
	18	0	0	25	25	25
	20	0	0	35	35	35
	22	10	90	95	90	95
4,2	16	0	0	30	30	30
	18	0	0	20	20	40
	20	0	85	85	50	50
	22	1	95	95	80	85

The coefficient of determination of the equation is equal to 0.32, ie, the variability of the variable Y near other regression is 0.67 initial dispersion. Also to derive equations describing the three-dimensional projection surfaces on the two-dimensional plane in the X1 ≤2,55:

Y = - 1099,05 - 99375H2 + 2.3 (x2) 2 H2H3 0.012 - 0.003 (x3) 2

when X1 = 2.55 and 3.10:

Y = - 2020,44 + 35,32 + X2 3,79H3 - 2.57 (x2) 2 0.08 H2H3 - 0,002 (x3) 2

when X1> 3.65:

Y = - 1333,27 - 109,84H2 5,25H3 + 2.27 + (x2) 2 + 0,04H2H3 - 0,002 (x3) 2

Similar equations were obtained for Y depending on the X2 and X3.

Chart Analysis of three-dimensional surfaces led to the following conclusions:

- When X1 <2.5, close to the optimum values for the adhesion region located at a content of up to 16 and more than 20% R2O;

- With an increase over 2.55 X1, the optimal values of the area in the direction of mixed alkali content of more than 20%.

Thus, the method of experiment design a mathematical model based glass-adhesion of coatings on their composition and processing temperatures. The equations of regression allows us to conclude that at a ratio SíO2: D2O <2.5 region of optimal values of the alkali content of up to 16% and more than 20% R2O, and with increasing SíO2: D2O <2.55, this area is mixed in the direction the alkali content of more than 20%.

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