Measurement of some studied parameters of liners and its statistical evaluation

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Summary

The aim of the work was to evaluate, by mathematical-statistical methods, the mutual relation between the operation time and some physical-mechanic properties of the liners. Theoretically, optimal operation time in relation to the thickness and hardness of the liner ranged from 942.2 to 1263.9 hours.

Key words: *Teat-cup liner, physical-mechanical properties, regression analysis*

Introduction

In the previous experiment several physical – mechanical qualities of the selected liners were observed (Galik et al., 2003). This paper brings results of the test's evaluation carried out by means of multiple and simple regression analysis methods. A more extensive scope of literature on the problem of liners is given in further published works (Galik et al., 2003, Galik et al., 2002, Karas, 1996).

Material and methods

The method of multiple regression was used for the purposes of mathematical – statistical procession of the test's results. Basic form of the statistical model through which we evaluated causal relation between the values of the dependent variable (time of activity) simultaneously on several non-dependent variables (hardness, firmness at break, protraction at break, liner's thickness) was as follows:

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 \qquad (1)$$

where: y – dependent variable value, b_0 – allocation invariable, $b_1....b_4$ – regression coefficient expressing the influence of the unit change of non-dependent variable on the value of the observed dependent variable, $x_1....x_4$ – non-dependent variable value.

To assess the intensity of regression relationship between the dependent variable and non-dependent variables, as well as to assess suitability of the used regression model (equation 1), the determination index R^2 was calculated. To assess the characteristics and intensity of relation between the selected sets more profoundly, we applied a simple non-linear regression method, using the parabolic function ($y = a + bx + cx^2$), with the assessment of its suitability based on determination index (R^2). A detailed methodology for determining individual indicators of the performed test of liner is given in the previous paper (Galik et al., 2003).

Results and discussion

For sample 2, regression model equation reached the following form:

$$y = 6156{,}038 + 18{,}134x_1 - 204{,}999x_2 - 1{,}573x_3 - 1509{,}436x_4 \qquad (2)$$

Determination index (R^2) as a general measure for the expression of suitability of the above regression model reached the value of 0.467. Applying regression coefficients, it is possible to express, from the equation, a theoretically expected change of dependent variable (y). If, for example, the firmness of liner increases by 1 MPa, time of its activity would theoretically decrease by 204.999 hours. If liner's thickness increased by 0.1 mm, its operation time would decrease by 150.946 hours. Both regression coefficients for x_2 and x_4 reached conclusive values ($P < 0{,}05$). To assess characteristics and intensity of relation between selected sets with the highest determination index value (R^2), we bring also results of simple non-linear regression. Dependence of the time of the liner's operation on its thickness (sample 1), or hardness (sample 2) may be most suitably theoretically expressed through a parabolic function of the following type:

$$y = -114976 + 121124x - 31639x^2 \qquad (3)$$

$$\text{resp. } y = -83204 + 3437{,}3x - 34{,}969x^2 \qquad (4)$$

Graphical illustration of the relation (sample 3) is given in Fig. 1. It shows that the time of a liner's operation is influenced by its thickness expressed by the used function at 61.37 % (sample 1). As for sample 2, the operation time is influenced by its thickness expressed by the used function at 95.93 %. From regression function characterising relation between liner's thickness and time of its operation may be derived optimal value for the liner's thickness, namely, using the following equation:

$$\frac{dy}{dx} = 121124 - 63278x = 0 \qquad (5)$$

For optimal liner's thickness, this relation will give the value of $x = 1{,}914$ mm. If analysing regression function expressing dependency of the liner's thickness on the time of its operation, the liner's thickness optimal value is $x = 49{,}147$ Sh A. A reverse incorporation of optimal values of the liner's thickness and hardness into parabolic functions will give theoretical optimal value of operation time in relation to the liner's thickness (for sample 1) $y = 942{,}2$ hours, and in relation to its hardness (for sample 2) $y = 1263{,}9$ hours. The acquired results show that an unequivocal determining of the optimal value of operation time for both observed indicators is not possible, because it fluctuates in the given range.

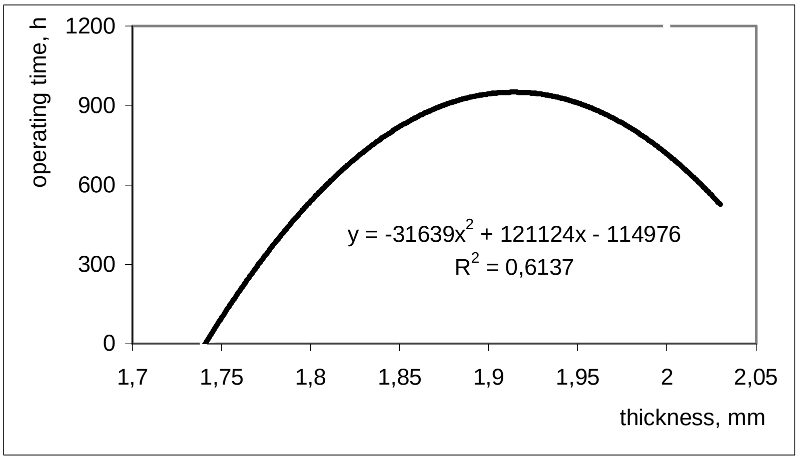

Figure 1. Regression relationship of dependency of operating time on thickness.

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