

## CONSTRUCTION OF THE REGRESSION MODEL OF THE SPECIFIC AIR CONSUMPTION FOR AN AUTOMOBILE PNEUMO-ENGINE

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The relevance of the research topic is related to the adequate description of the function of the opening-closing angles in the intake and exhaust valves using the regression model of the second degree, which is an essential result of the study.

The purpose of the work is to determine the extremum for the compressed air specific consumption of this pneumatic engine (PE) multifactorial dependence.

The object of the research is the working processes of a piston pneumatic engine with valve air distribution.

The subject of the research is the patterns and parameters of the working processes in the pneumatic engine with the combined power plant of the automobile with valve air distribution.

In compliance with the experiment plan, a series of measurements of the indicator flow rate of compressed air was carried out according to the speed characteristics of the pneumatic automobile engine 1I 9.2/9.2. The experimental study was conducted in the laboratory of the ICE of Kharkiv National Automobile and Highway University on a motor stand equipped with all the necessary measuring equipment [1,3,5,13]. The nominal capacity was reached at full filling at a pressure of  $p_{vp}=0.7$  MPa.

The static characteristics of PE can be adequately described using polynomials of the appropriate degree. In the study, the regression model of specific fuel consumption is presented in the form of a polynomial of the second degree as a function of the mode parameters of valve opening-closing angles.

Further construction of the mathematical model was carried out with polynomials of the second degree. As the calculations show, the model in the form of the second degree polynomial has high adequacy indicators. Thanks to the built-in MATLAB analysis packages, the following dependence of the regression model was obtained:

$$y = 9399,8871 + 0,26 + 0,18 + 0,057 + 0,03 + 2,6014x_1 - 62,9937x_2 - 19,9586x_3 - 15,9027x_4 + 0,2512x_1x_2 - 0,1x_1x_3 - 0,1x_1x_4 + (1) + 0,0044x_2x_3 + 0,002x_2x_4 - 0,0048x_3x_4$$

The work was carried out using the MATLAB data analysis package. To increase the accuracy of the result, calculations were made to build models in the form of a static function of the compressed air flow from the factors under consideration. Figure 1 presents the characteristics of the PE specific indicator air flow as a function of the opening-closing angles in the intake and exhaust valves.

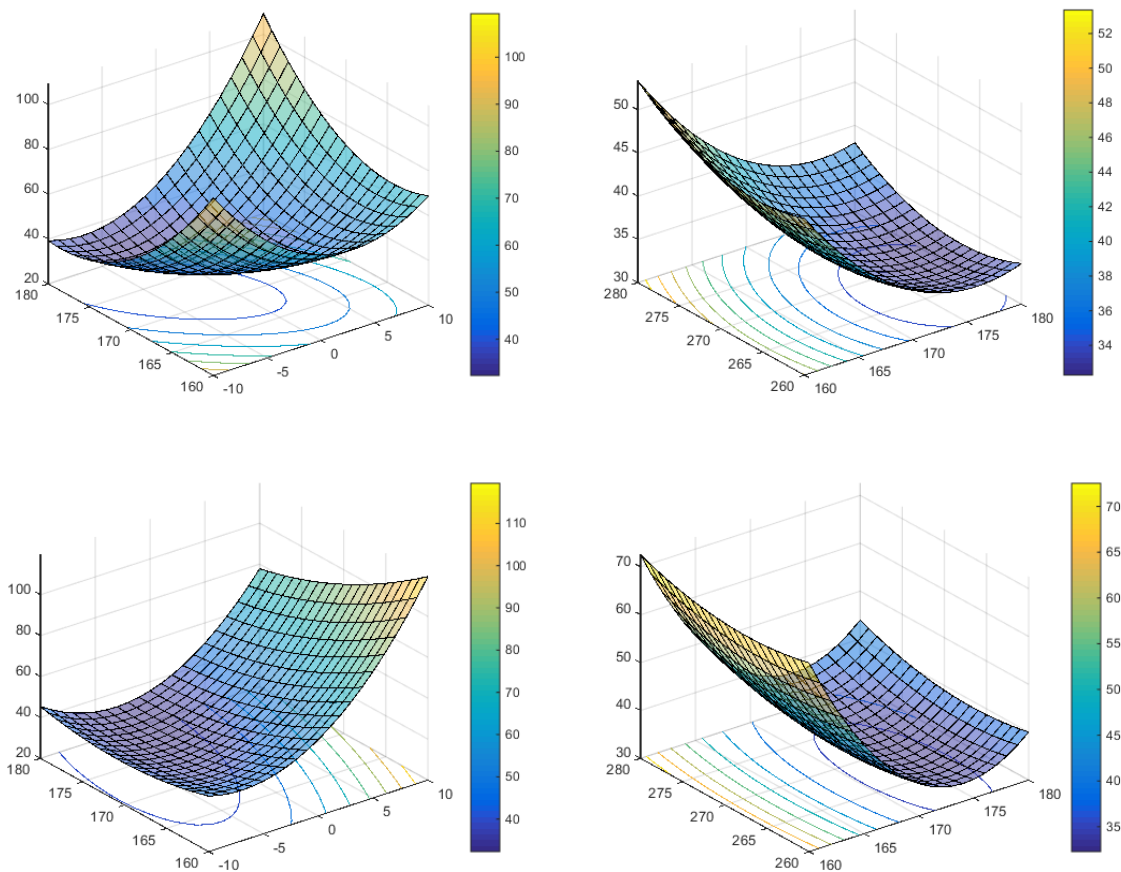


Figure 1 – Dependence of  $g_i$  on the angle of valve opening-closing

The point of the smallest specific indicator air flow  $g_{\min} = 32.29 \text{ kg/ kW}\cdot\text{h}$  was obtained at the following optimal angles of valve opening:  $\varphi_{\text{vpn}} = 3.9 \text{ deg bTC}$ ,  $\varphi_{\text{vpk}} = 174.0 \text{ deg aTC}$ ,  $\varphi_{\text{vpn}} = 176.2 \text{ deg aTC}$ ,  $\varphi_{\text{vypk}} = 266.9 \text{ deg aTC}$ .

When operating automobile PEs, the modes corresponding to the surroundings of this point should be observed, which will ensure the minimum consumption of compressed air  $g_{\min}$ .

In this case, the coefficient of determination is equal to  $R^2 = 0.9$ . Since  $R^2 > 0.85$ , we can conclude that the reliability of the significance level according to Fisher is considerably less than 0.05, based on which we conclude that the model is statically significant. At the same time, the coefficient of the mixed correlation set is equal to 0.95.

Graphs of the obtained model were constructed. The graphic construction shows that, in order to ensure the minimum values of the specific indicator fuel consumption, it is advisable to operate the analyzed PE with revolutions within  $1000 \text{ min}^{-1}$ .  $800\text{-}1000 \text{ min}^{-1}$  can be considered the optimal range for the revolutions of the PE crankshaft, when operation is achieved with a consumption of compressed air in the range of  $35\text{-}38 \text{ kg/kW}\cdot\text{h}$  at the required power.

As a result of the conducted research, the goal was reached and the extremum of the multifactorial dependence of this PE was determined. Dependences of the parameters - the specific indicator air flow of the PE simultaneously on four independent variables (opening-closing angles of the intake and exhaust valves) are constructed. Graphs of universal multi-parameter characteristics are built.

It was established that the curves of the specific indicator flow rate of compressed air can be adequately described using the regression model of the second degree of the function at the opening-closing angles in the intake and exhaust valves, which is an essential result. The obtained model of the second order is a significant advantage for the works of a similar direction.

Specific indicator consumption of compressed air becomes possible with the help of an electronic control unit which produces control signals to adjust the power supply system (dosing and regulation of the supply of compressed air) to transfer the PE to the most economical mode. In this case, the problem of substantiating the optimal operating modes is relevant for the analyzed PE, as well as other PEs.

### Conclusion

A multifactor optimization of the operation of the PE  $D/S = 9.2/9.2$  was carried out. As a result of the analysis of the calculations, the following optimal parameters were obtained:  $\varepsilon_0 = 0.12$ ,  $\varepsilon_1 = 1$ ,  $\varepsilon_3 = 0.59$ ,  $p_{vp} = 0.7$  and  $n = 780 \text{ RPM}$ . At the same time  $N_i = 2,23 \text{ kW}$  and  $g_i = 32.29 \text{ kg/h}$ .

The given sequence of determining the specific indicator flow rate of compressed air in different modes of operation of the automobile PE with the help of extended multi-parameter characteristics makes it possible to achieve the operation of the PE corresponding to the minimum specific flow rate of compressed air, and to provide compliance with automatic transmissions which are widely implemented in the design of modern city cars.

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