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THE ANALYSIS OF THE CONTROL VALVE BODY STRAIN

1. Introduction

The inner leaktightness in spool control valves depends on the size of a gap between the spool and corresponding edges in the body. Under the influence of pressure the body can undergo a deformation and the pressure can cause a change of the gap size.

According to [1] the flow rate in a gap between cylindrical elements is as follows:

$$Q = \frac{(p_1 - p_2)\pi d j^3}{12\mu l}\left(1 + \frac{3\varepsilon^2}{2j^2}\right) \tag{1}$$

where: j - radial clearance of elements, μ - absolute viscosity coefficient, l - the width of the radial clearance, ε - eccentricity of elements, d - spool diameter

As it results from Equation (1) the quantity of leakage grow rapidly together with the growth of radial clearance and eccentricity of elements. This paper presents a strength analysis of the body of the control valve; the analysis allows assessing gaps under the influence of pressure. The strength analysis was performed using the finite elements methods in MSC/Nastran.

2. The Analysis of the Model

The object of the analysis is a section control valve with nominal quantity d = 10 mm and operating pressure 16 MPa. The control valve may come in a multisection system and with a different type of control. A geometric model of the control valve was performed in SolidWorks. Next it was used it in FEM software - MSC/Nastran. For the sake of the symmetry of the body in a plane perpendicular to the longitudinal axis of the spool only a half of the geometric model was used in the analysis.

A discrete model of the body (Fig. 1) with 68418 degrees of freedom (without boundary conditions) was performed in MSC/Nastran with the use of 12562 solid elements TETRA 10 type. The pressure of 30 MPa in delivery channels was set during the analysis.

It was also necessary to set equivalent boundary conditions. In this case the definition of constrains of model movement required the analysis of the body work as well as external factors influence.

The results of the analysis performed in MSC/Nastran as a reduced stresses and a translations are presented in a graphic form in Fig. 2 and Fig. 3. Radial translations and the form of deformation on the edge of the spool chamber is presented in Fig. 4.

The stresses in analyzed body do not exceed the stress limit. The maximum strain occurs in a socket of the check valve. For the sake of leaktightness assurance the translations occuring in the spool chamber are significant.

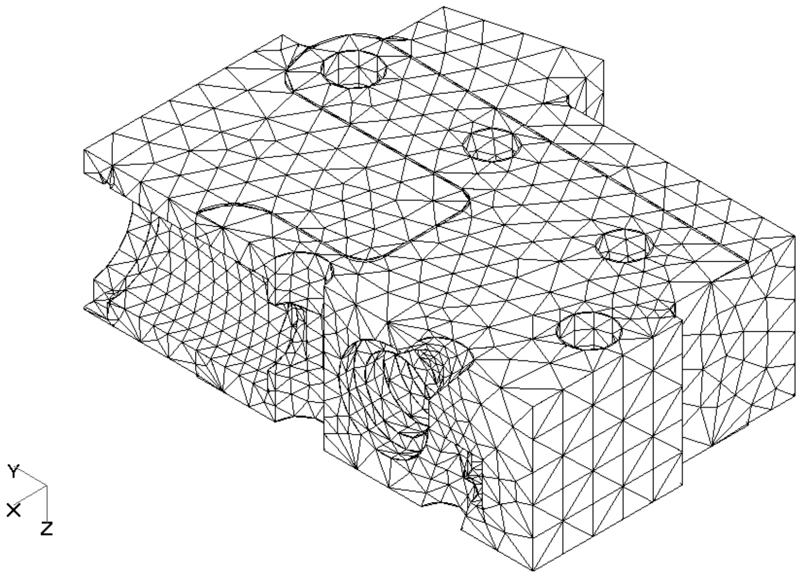

Fig. 1. The discrete model of the control valve body

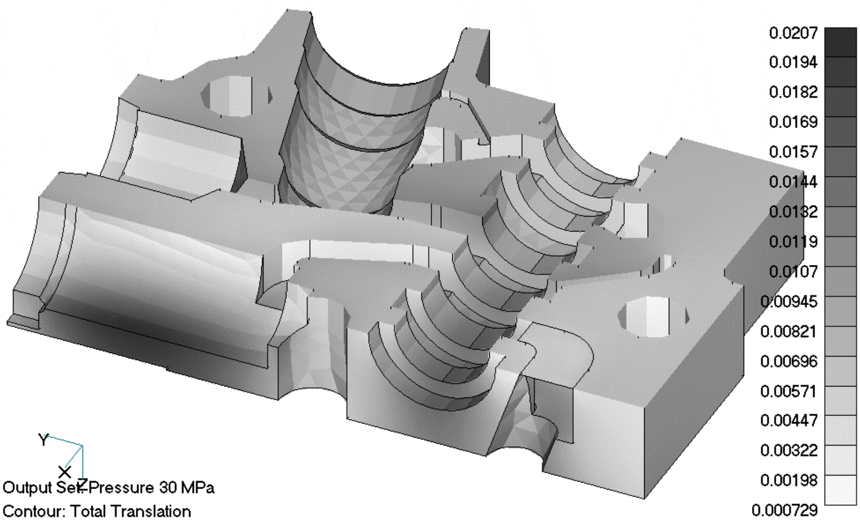

Fig. 2. The total translations (in mm) for pressure 30 MPa in the control valve body

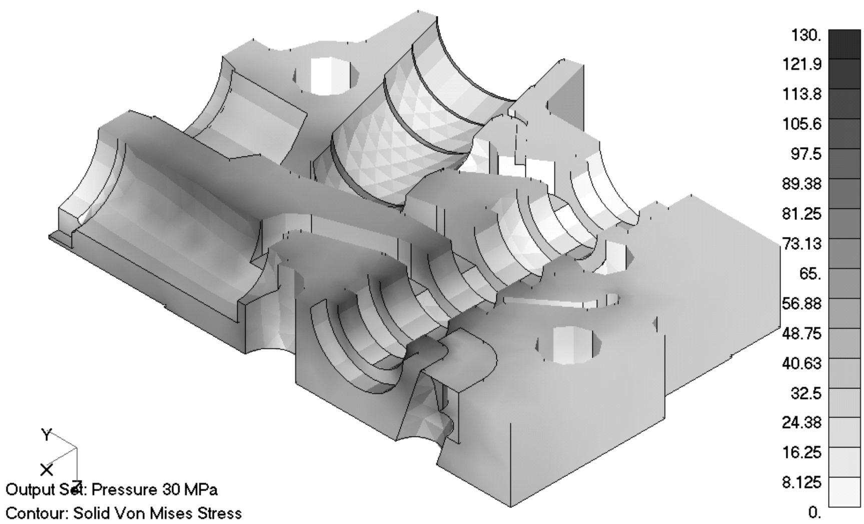

Fig. 3. Reduced stresses (in MPa) in the control valve body

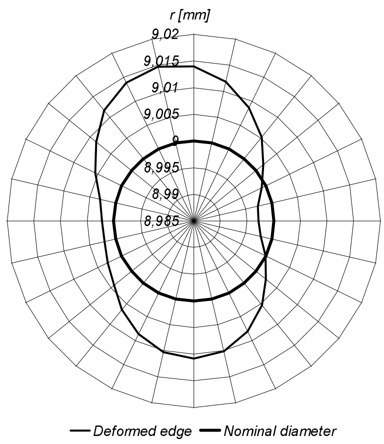

Fig. 4. The radial translations on the edge of the spool chamber

3. Summary

The finite elements method analysis of the body of the control valve was presented in the paper. The performed analysis allowed to defining of stresses and translations in the body. The results of this analysis were used to evaluate the size of the gap between the spool and the control edges in the body in the working pressure function.

References

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