ТЕХНІЧНІ НАУКИ

Zaika L.D.
Student;
Koloskova H.M.
PhD, Associate Professor,
N.E. Zhukovskiy National Aerospace University
«Kharkiv Aviation Institute»

STRESS AND STRAIN IN BODY PART OF PISTON DISPENSER FOR VISCOUSFUL FLUIDS UNDER WORKING PRESSURE

Dosing equipment is used in various fields of activity. Today dosing is an indispensable part of the chain of technological processes in various industries. At the heart of any dosing is a dispenser designed to accurately measure a certain portion of the product. Due to its advantages, the dispenser of the volume-piston model is very popular. It is used to dispense thick liquids with various degrees of viscosity: from sunflower oil to honey. The work of such dispenser is completely built on the logic of pneumatic elements, and compressed air is only energy source [1].

When designing, an important role is played by the cost of manufacturing dispensers. Cost can be lowered by reducing the material consumption of construction, what can be achieved by thinning the wall thickness in unloaded sections of the design, and by using cheaper materials. However, the range of materials used is limited by the possibility of their contact with the dosed product. Thereby, the urgent task is to determine the stresses and deformations arising in the case-type parts of the piston dispenser at the working pressure created by the piston when dosing viscous fluid.

In the work, a 3D model of a piston metering unit was built in the SOLIDWORKS system. All geometric dimensions of the model were calculated by the method and according to the recommendations given in [2, p. 208]. Its working volume is equal to 0.5 dm^3. For the initial calculation, we have adopted the materials that are most often used in systems of this type. The body and bottom are AISI 304 steel, the piping system is aluminium alloy 2017A. All calculations were carried out in the SOLIDWORKS Simulation system. The dispenser body was loaded with an internal pressure of 60 kPa.

As a result of the calculation, it was found that the largest stresses of 8.2 MPa with a wall thickness of 3 mm take place at the contact surface between the bottom and the piping system (Fig. 1). This stress is not critical for the material used, which means that the bottom wall can be made thinner. However, when changing the thickness, it should be considered that the resulting stresses lead to deviations of the pipeline from the vertical, which can lead to violations of the centering of the tapping head. At the same time, the calculation showed that the walls of the casing and the pipeline system itself are understressed, therefore their geometric parameters and material must be changed.

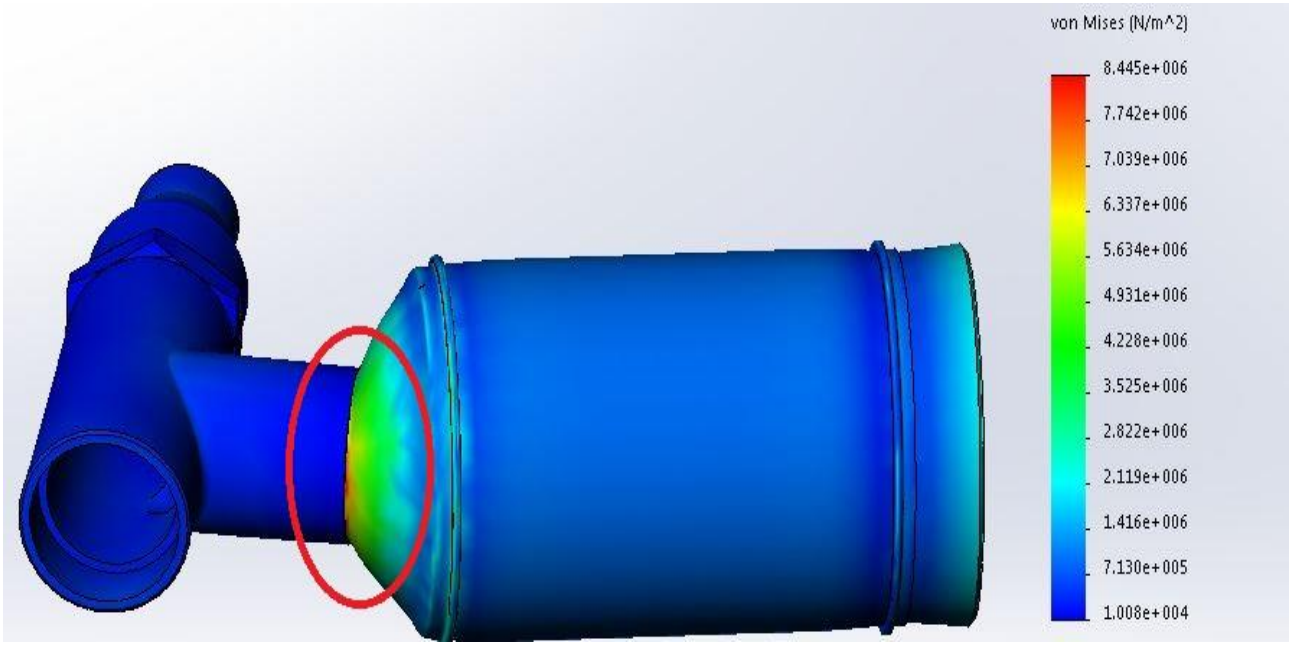

Figure 1. Stress diagram

Further research was divided into two stages. At the first stage, the materials used were replaced with cheaper ones and having a lower ultimate strength, so AISI 304 steel l was replaced by A 516-55 steel, and aluminium alloy 2017A by 1066 steel. However, this did not lead to a significant change in the level of stresses arising in the elements of construction.

At the second stage, gradual thickness reduction of the structural elements was carried out. Calculations showed that for given parameters, the wall thickness of the body and the pipeline can be reduced by 2 times, although the stresses arising in the structure will be 8.5 times lower than critical, further thinning of the material is not advisable since it can complicate the assembly of the construction. To evenly distribute stresses and lighten the weight of construction, it was also proposed that the bottom of the body be made of variable thickness. Due to the changes made, the deviation of the pipeline from the vertical was 0.1 mm, this value is not critical, but can cause vibrations arising during the operation of the dispenser. In the future, of great interest is the study of the strength and durability of a dispenser operating under dynamic loads. According to research we recommend to fix the position of the pipeline to avoid integrity breach in the place of its fastening.

The proposed changes allowed to reduce the material consumption of the dispenser by 32%, which will significantly reduce its cost.

References:

1. Osobennosty prymenenyia porshnevykh dozatorov (Features of the use of piston dispensers). Available at: http://openfile.ru/okrashivanie/osobennosti-primeneniya-porshnevyih-dozatorov.html (accessed 15 February 2011).

2. Gavva O.M., Bespalko O.P., Volchko A.I. Pakuvalne obladnannia [Packaging equipment]. Kyiv, 2008. 436 p.