Tesla Valve

Author: Vera Lyabzina, AESC MSU, Moscow, Russia

Supervisor: Sladkov Klim, student of MSU

1. Introduction

A Tesla valve is a fixed-geometry, passive, one-direction valve which resists to flow that is much greater in one direction compared to the other. The main principle of the valve is that the stream going through it separates into two streams. Those streams go the way which would reduce their kinetic energy.

2. Research Methods

The goal of my work is to create Tesla valve and investigate what parameters affect the diodicity of the valve. Diodicity (Di) is the main characteristic of any valve that characterize difference of flow resistance in forward and in reverse directions

$$Di = \frac{\Delta v\ reserve}{\Delta v\ forward} \quad (1)$$

I have modeled Tesla valve in Kompas-3D.

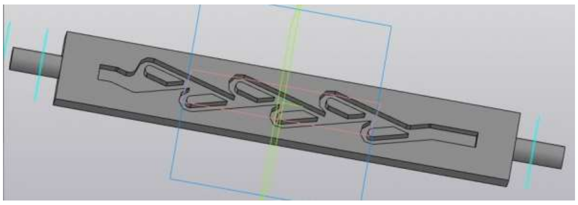


Fig.1 3D model of the Tesla valve

Then I have created valve on 3D printer.

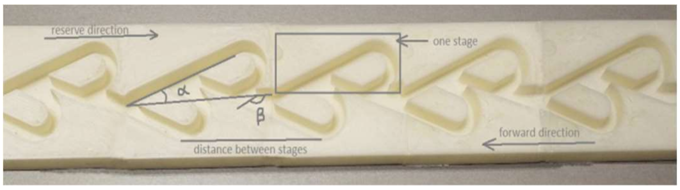


Fig.2 printed Tesla valve

$\Delta p\ reserve$ – pressure drop in reserve direction, $\Delta p\ forward$ – pressure drop in forward direction, p_{input} - pressure in starting point, p_{output} - pressure in ending point, $\Delta v\ reserve$ – velocity drop in reserve direction, $\Delta v\ forward$ - velocity drop in forward direction

In my work I measured diodicity as follows : A little piece of rubber was put on the water near the input of the valve. And used Tracker program to calculate the velocity of rubber in forward and reverse directions of valve. Then I used (1) to count the diodicity.

3. Results

Using results got from expirements with different α and β (see Fig.2) dependence of Di on α is nonmonotonic, achieve the maximum in α ≈50 º -60º.

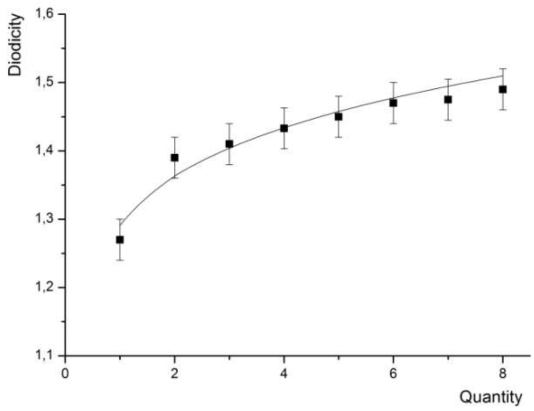
It was established that while I increased distance between stages diodicity monotonic decreased. Minimal diodicity is equal one-stage valve diodicity.

The velocity of the stream reduces on every stage. The more stages there are, the bigger reduction of the velocity is. As the result, diodicity increases:

$$v_{output} = v_{input} * e^{\frac{1}{\cos\alpha}} * \sqrt{cos^2\alpha + 2cos\beta} \quad (2)$$

$$\Delta v_n = v_{input}(1 - (e^{\frac{n-1}{\cos\alpha}} * \sqrt{cos^2\alpha + 2cos\beta})^{n-1}) \quad (3)$$

v_{input} - velocity in starting point, v_{output} - velocity in ending point, Δv_n – velocity drop after n stages



Graph 1 – The dependence of the Diodicity by the quantity of stages.

4. Conclusion

In the course of this work I have modeled and created the Tesla valve, have studied its characteristics and have investigated parameters and their effect on the valve diodicity.

5. References

[1] T.-Q. Truong and N.-T. Nguyen. Simulation and Optimization of Tesla Valves. Tech. Proc. Nanotech 2003, vol. 1 (2003)

[2] S. M. Thompson, B. J. Paudel, T. Jamal and D. K. Walters. Numerical investigation of multistaged Tesla valves. J. Fluids Eng. 136, 8, 081102 (2014)