CFD MODELING OF A GAS CYCLONE

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INTRODUCTION

This study presents application of CFD tools and commercial code ANSYS Fluent for modeling and determination of the pressure drop for gas flow and solid separation efficiency of the cyclone. Gas cyclones are widely used in industries to separate dust from gas or for product recovery because of its geometrical simplicity, relative economy in power usage and flexibility. The most important performance variables of a gas cyclone are usually gas pressure drop and solid separation efficiency [1,2].

GEOMETRY, MESH AND CFD MODELING

The geometry of the cyclone separator used for simulation is depicted in Figure 1 and the geometrical parameters are given in Table 1. Unstructured mesh is used with 55 541 elements, as shown in Figure 2. The effect of mesh refinement had previously been evaluated in the simulation process.

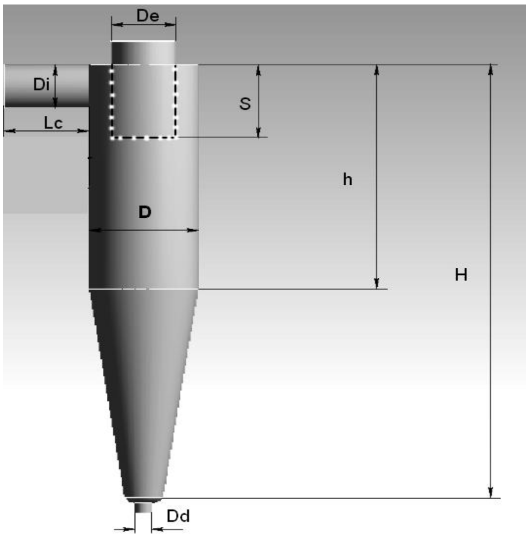


Figure 1, Geometry

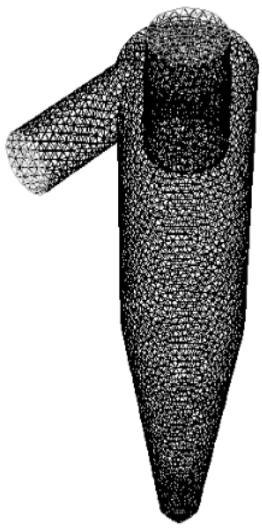


Figure 2, Mesh

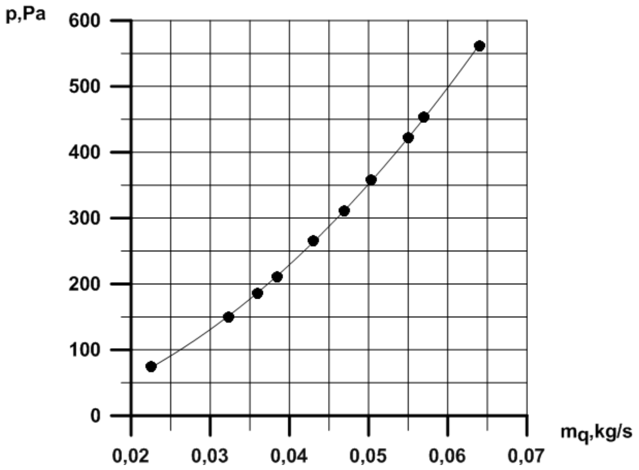
Di	De	D	Dd	H	h	S	Lc
110	150	255	40	1100	570	160	200

Table 1, Dimensions of the cyclone in mm.

For strongly swirling flows, the standard *k*-ε model has limitations [2]. In the RNG *k*-ε model, the effect of rotation is included in the calculation of the turbulent viscosity and because of that reason this model is used to describe the gas and gas-solid flow in a cyclone. The pressure-velocity coupling algorithm SIMPLEC and the second order upwind interpolation scheme are used in all numerical experiments. The boundary conditions are: inlet – gas mass flow rate and outlet – pressure. Presence of the solid phase is modeled by means of the Euler-Lagrange method, which is implemented into the ANSYS FLUENT software as a Discrete Phase Model (DPM). The computations take into account the gravity force of the particle and the coefficient of restitution with the wall.

RESULTS

In this work numerical experiments have been done to find the effect of gas inlet velocity (mass flow rate m_q) on pressure drop *p*. As shown in Figure 3, the pressure drop increases with the inlet gas velocity. Pressure drop will be used as the major parameter for the purpose of validation in the next future work.



The solid separation efficiency is determined for different particle size with density 876 kg/m^3 and gas velocity 30 *m/s*. Figure 4, Figure 5 and Figure 6 present separation efficiency 37,5% , 80.4% and 100% with particle diameter 0.5 μm, 5 μm and 10 μm. As shown the separation efficiency increases with the increasing size of the particle.

Figure 3, The effect of gas mass flow rate on the pressure drop

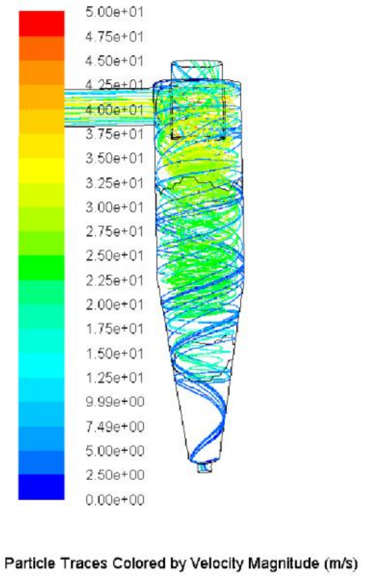


Figure 4, Efficiency 37.5%

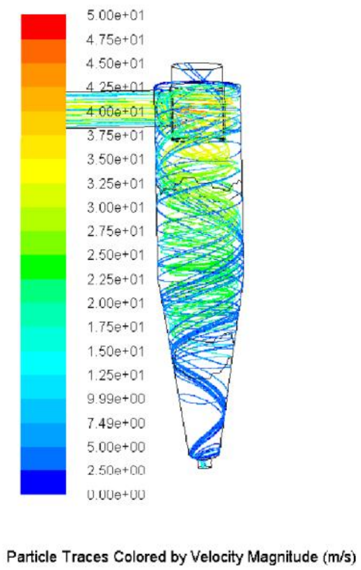


Figure 5, Efficiency 80.4%

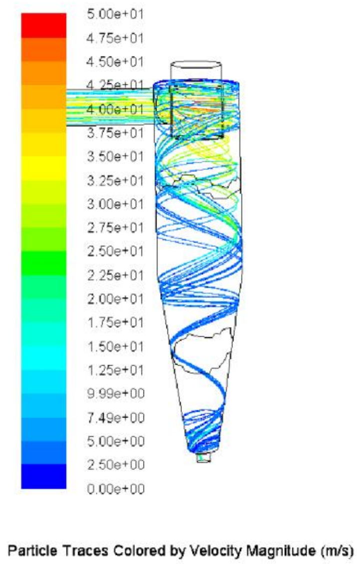


Figure 6, Efficiency 100%

CONCLUSION

In this study, the pressure drop and the solid separation efficiency have been obtained by application of the RNG *k*-ε model. The results obtained in this work are the basis for future study, which will include their validation.

REFERENCES

1. Altmeyer S., V. Mathieu, Comparison of different models of cyclone prediction performance for various operating conditions using a general software , Chemical Engineering and Processing 43 (2004) 511-522.
2. Bernardo S., Mori. M., 3D Simulation of a gas flow in a cyclone using a commercial CFD code, 17th International Congress of Mechanical Engineering November 10-14, 2003.

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