

---

# Study on structure optimization of aerosol mixing chamber based on multiphase flow mixing mechanism

Zhaoliang Liu<sup>a</sup>, Liangmeng Zhang

College of Mechanical and Electronic Engineering, Shandong University of Science and Technology, Qingdao 266590, China.

<sup>a</sup>993749480@qq.com

---

## Abstract

The 3d solid parameterization model of aerosol mixing chamber was established by using 3d modeling software soildwork. On this basis, CFD numerical calculation and analysis is carried out for the two design schemes. Based on the computational fluid dynamics study of the multi-phase flow gas in the aerosol mixing chamber, FLUENT software was used to analyze the flow field and aerosol concentration field in the mixing chamber, and to help improve the design. It was concluded that when the flow velocity was within the optimal range, the optimal and uniform mixing could be achieved. It provides a basis for the future study of two-phase flow hybrid simulation.

## Keywords

Mixing chamber, Structural optimization, euler - euler model.

---

## 1. Introduction

With the rapid development of China's economy, air pollution has become increasingly serious. Especially in recent years, Scholars at home and abroad have done a lot of research on this, Study on the cavitation flow field of the water pipe at the tail of the mixer water wheel by Yang jing [1] et al , Flow heat transfer characteristics of direct air-cooled units and optimization of air flow field of Bu yongdong [2] et al , Rehan Ali Shah, Sajid Rehman, M Idrees, M Ullah, Tariq Abbas [3]. Similarity analysis of MHD flow field and heat transfer of a second grade convection flow over an unsteady stretching sheet , Yuehong Bi, Lingen Chen, Chih Wu, Shihong Wang [4]. Effect of Heat Transfer on the Performance of Thermoelectric Heat Pumps[J]. Journal of Non-Equilibrium Thermodynamics, Rahmat Ellahi, Xinil Wang, Muhammad Hameed [5]. Effects of Heat Transfer and Nonlinear Slip on the Steady Flow of Couette Fluid by Means of Chebyshev Spectral Method[J]. Zeitschrift für Naturforschung after China entered the new normal of economy, air pollution has become a key problem affecting China's overall development. Equipment for detecting environment of aerosol mixing chamber structure based on multiphase flow mechanism has been widely used. It is very important to improve the structure of aerosol mixing chamber, especially to solve the common optimization problems. In this paper, using modeling software soildwork three entity parameterized model is established, and then use the fluid software FLUENT fluid simulation calculation, the mixing chamber in verification, on the basis of fully meet the design requirements, through the mixing chamber of different inflow velocity calculation and analysis of simulation and optimization of interval, the aerosol and air fluid-structure interaction analysis, structure optimization, and a series of optimization analysis, it is concluded that the most economical model of mixing chamber for multiphase flow after hybrid optimization design has reference significance.

## 2. Establishment of 3D Solid Model

Three-dimensional modeling software SolidWorks modeling cavity, two - phase fluid mixing in the cavity. The assembled model is imported into the ANSYS workbench software. The simplified model is shown in figure 1.

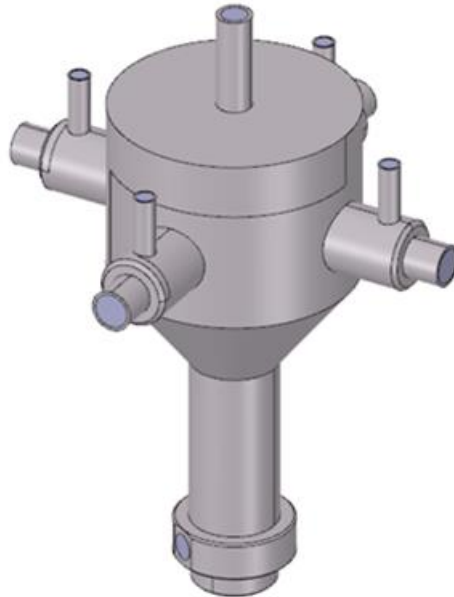


Figure 1. simplified model diagram

## 3. Static Strength Analysis of the Worm Gear

### 3.1 Determine the parameters of the Material

At the bottom of the mixing chamber, a high concentration of mixed gas was injected, with a flow rate of 4L/min, a particle size of 4 in centimetres, a concentration of 106 /cm cubed, and a material stearic acid, The clean air enters the side of the mixing chamber. The flow rate is in two operating modes, one is 50L/min and the other is 150L/min, None of the gases used have been heated or cooled, but have changed from a compressed state to a normal state.

### 3.2 Physical Properties, Boundary Conditions and Numerical Algorithms

The material property of air adopts the physical parameters under normal temperature and pressure, and the density of stearic acid is 847kg/m<sup>3</sup>. According to the known conditions and simulation requirements, the Mass Flow Inlet is of the Mass Flow boundary type, and the Mass Flow rate is converted according to the given volume Flow rate. The mass flow rate and volume fraction of the aerosol at the mixed gas inlet are calculated according to the given conditions. Pressure Outlet boundary type is adopted for all 9 exits, and open Outlet is given. The wall surface is set as static and no sliding wall surface. In order to improve the calculation accuracy, the two-precision FLUENT solver was adopted. The pressure-velocity coupling method adopted the Phase Coupled SIMPLE algorithm.

### 3.3 Mixed Simulation Data Comparison

The following comparisons are obtained through the simulation of some column vectors and other data:

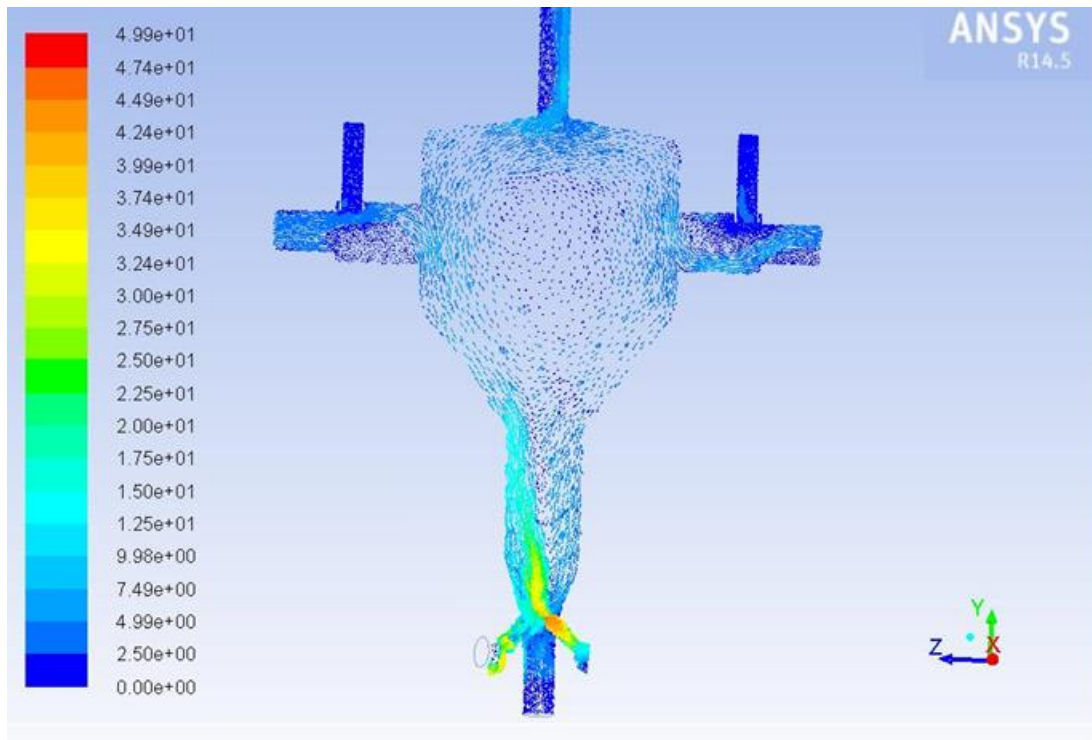


Figure 2. Cross section velocity vector  $x=0$

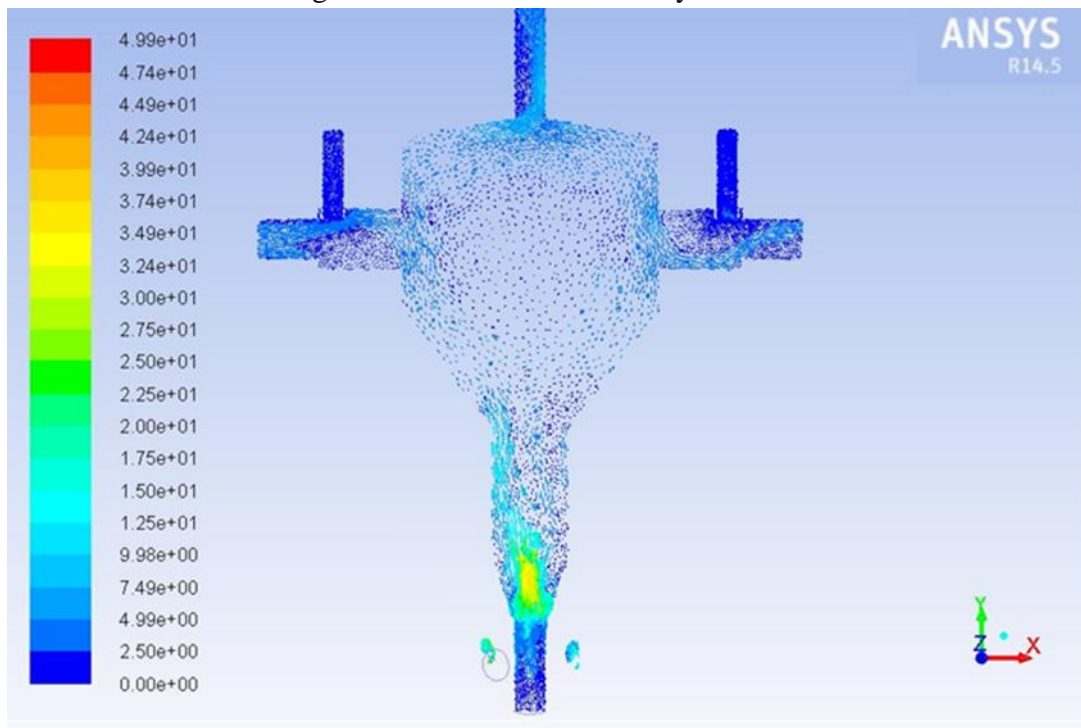


Figure 3. Cross section velocity vector  $z=0$

#### 4. Analysis of Cross Section Aerosol Concentration

The comparison and simulation of the concentration distribution of aerosol on the cross section was carried out.

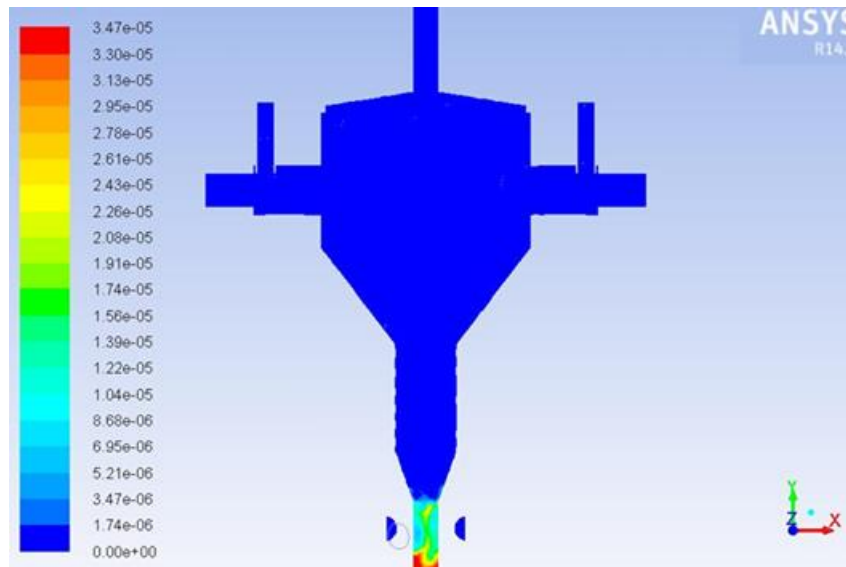


Figure 4. Cross section aerosol concentration distribution cloud map  $x=0$

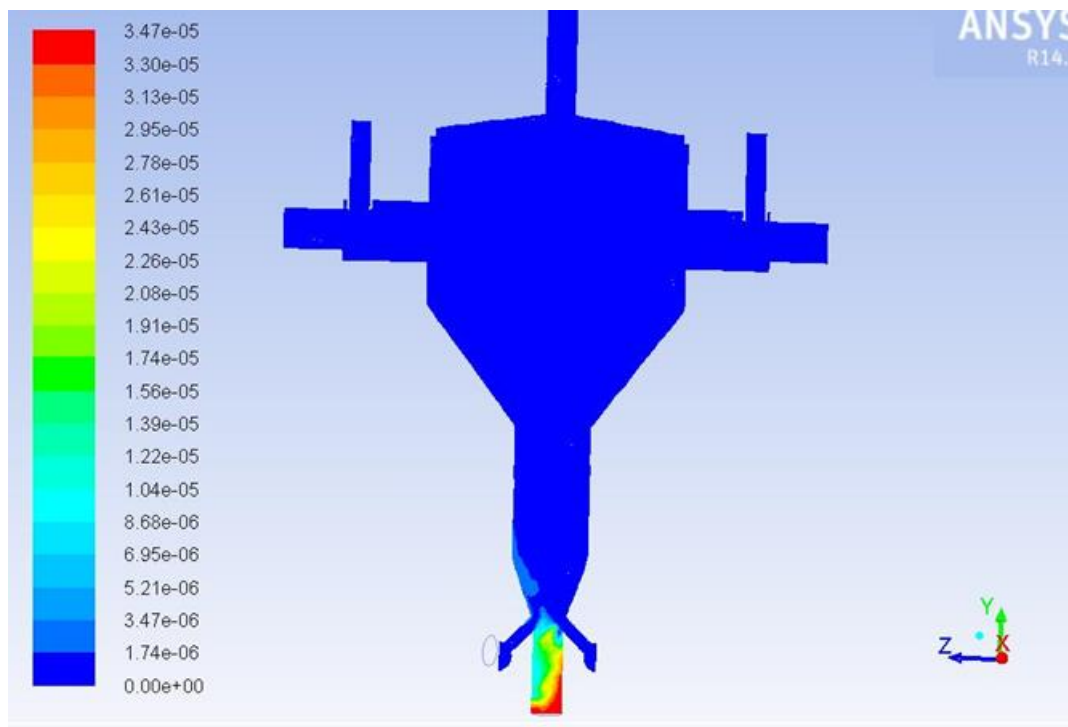


Figure 5. Cross section aerosol concentration distribution cloud map  $z=0$

### 5. Conclusion

A conclusion is drawn by using snsys to simulate some data of the mixed process :

Based on the distribution of interface concentration and interface velocity over time, the time interval of optimal mixing uniformity was obtained, which saved a lot of time and produced great economic and social benefits.It can be seen from the simulation of velocity and concentration that there are some differences in the data of different sections

### References

[1] Yangjing. Study on cavitation flow field of water pipe at the tail of mixer water wheel [D]. China Agricultural University,2013.

- 
- [2] Buyongddeng. The flow heat transfer characteristics of direct air cooling unit and the optimized structure of air flow field [D].North China Electric Power University,2013.
  - [3] Rehan Ali Shah,Sajid Rehman,M Idrees,M Ullah,Tariq Abbas. Similarity analysis of MHD flow field and heat transfer of a second grade convection flow over an unsteady stretching sheet[J]. Boundary Value Problems,2017,2017(1).
  - [4] Yuehong Bi,Lingen Chen,Chih Wu,Shihong Wang. Effect of Heat Transfer on the Performance of Thermoelectric Heat Pumps[J]. Journal of Non-Equilibrium Thermodynamics,2001,26(1).
  - [5] Rahmat Ellahi,Xinil Wang,Muhammad Hameed. Effects of Heat Transfer and Nonlinear Slip on the Steady Flow of Couette Fluid by Means of Chebyshev Spectral Method[J]. Zeitschrift für Naturforschung A,2014,69(1-2).