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Study on the Separation Mechanism of Crude Oil by Cyclone Separator

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Abstract: In this paper, a cyclone separator for crude oil is designed and improved by using a traditional cyclone separator. The pressure and velocity fields of the two-phase flow in the cyclone separator are obtained by CFD software FLUENT and compared. Analysis, and the gas separation mechanism. Finally, the analysis of the internal cloud and internal liquid cloud shows that the degassing rate can reach 98%, and to a certain extent, the land space is reduced, the production efficiency is improved, and economic waste is saved.
Keywords: Cyclone separator, Petroleum degassing, CFD, Simulation analysis.

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1. INTRODUCTION

At present, most of China's oil fields have entered the stage of high-water-bearing mining, and the produced liquids often contain a large amount of associated gas. The traditional settlement methods occupy a large area, take time and effort, and cause huge economic waste. The cyclone separator is widely used in the petrochemical industry due to its small footprint, high efficiency and high reliability. The degassing rate of the cyclone separator designed in this paper can reach 98%, which reduces the economic waste [1].

In 1891 Bretney et al. invented and applied for the first cyclone separator patent and applied it for the first time in 1939. Because of its simple structure, high separation efficiency, small footprint and other advantages, it has been applied to modern petrochemical, biomedical and other production areas. Currently. China is also energetically developing cyclone separation equipment, and its technology has matured, providing a strong impetus for the development of China’s separation industry [2-6].

2. MODEL ESTABLISHMENT

2.1 Mathematical model

In the simulation process of the cyclone separator, the three major equations of fluid mechanics (continuity equation, momentum conservation equation, energy conservation equation) are mainly used to establish a mathematical model, so that the solver can solve the model. The

RSM model completely discards the assumption of isotropic eddy viscosity and considers the anisotropic characteristics of turbulent flow, which is beneficial to the calculation of the flow field of the cyclone separator [7]. Therefore, the RSM model is chosen to perform the simulation calculation. Because the Mixture model is suitable for phase mixing or separation in the flow, it is more consistent with the simulation of the cyclone separator, so the Mixture model is selected as the multiphase flow model [8-11].

2.2 Physical model

This paper uses SolidWorks software to model the cyclone separator. The structural parameters are shown in the following table. The model is divided by the ICEM software so that the FLUENT software can perform pressure and velocity on the flow field in the cyclone separator. Calculation and analysis of parameters such as concentration.

Table 1. Cyclone structure parameters

Column diameter D(mm)	Column heightH1(mm)	Overflow pipe diameter Do(mm)	Overflow pipe insertion depth H3(mm)	Import equivalent diameter Di(mm)	Cone height H2(mm)
50	150	15	70	10.88	180

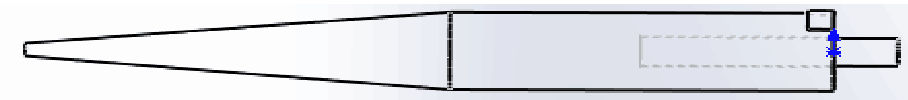

Fig. 1. Cyclone separator structure diagram

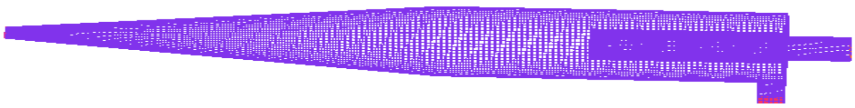

Fig. 2. Swirl separator flow field area mesh

3. SIMULATION RESULTS AND ANALYSIS

The distribution of velocity field and pressure field within the cyclone separator can reflect the movement of the material in the internal flow field. In order to analyze the influence of the shape of the underflow orifice on the separation performance, this chapter intercepts and analyzes the pressure cloud map and the velocity cloud map. The distribution of the pressure field and the velocity field and data analysis at different axial positions finally reached the conclusion.

3.1 Static pressure distribution

In the radial pressure field, precisely because of the existence of the pressure gradient, the inertial force and the resistance of the particles or the droplets are simultaneously acting, so that the particles or the droplets are radially displaced, thereby realizing the separation. The energy loss of the Hydrocyclone mainly includes the jet resistance when the material enters the cyclone cylinder from the feed pipe, the pressure loss of the material in the cyclone, the friction loss due to the viscosity of the material, and the material and the wall Between the friction loss and the loss of kinetic energy taken away from the material, these losses are mainly reflected in the pressure drop between the inlet and outlet materials.

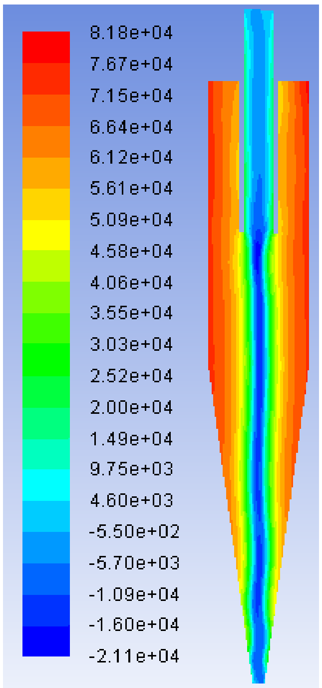

Fig. 3. Static pressure

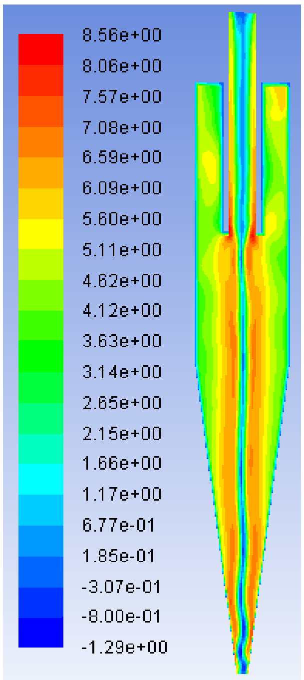

Fig.4. Tangential velocity

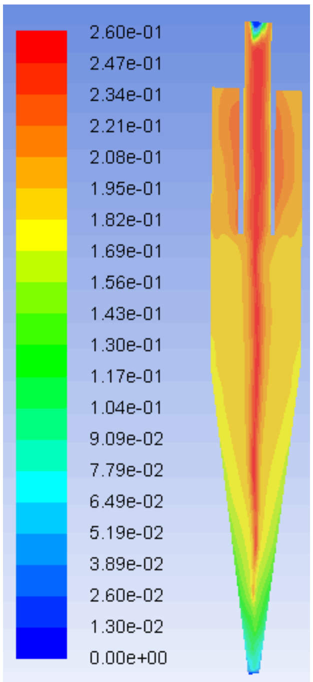

Fig.5. Air distribution

Fig. 3 shows the pressure distribution has axial symmetry, and there is a pressure gradient radially. There is a negative pressure zone in the center region of the cyclone. After the fluid enters the cyclone cylinder from the feed pipe, the pressure rapidly decreases due to the effect of the jet resistance, which indicates that the form of the mine pipe has an important influence on the performance of the Hydrocyclone. On the same plane, the pressure will gradually decrease from the wall to the cyclone, and in the vicinity of the air column in the cyclone, the pressure gradient increases sharply and eventually decreases to negative pressure.

3.2 Tangential velocity

Fig.4 shows the Tangential velocity distribution. In the three-dimensional velocity of the flow field inside the Hydrocyclone, the tangential velocity is the basic premise to generate the force of inertia, so it occupies the most important position. From the cloud diagram, we can see that from the Hydrocyclone wall to the center, the tangential velocity first increases and then decreases, and the tangential velocity peak appears at the periphery of the air column, which is favorable for the gas to move toward the center and discharge through the overflow tube. Liquid drains from underflow tube.

3.3 Air distribution cloud

Fig.5 shows the Air distribution. Through the analysis of the air distribution cloud, it can be seen that the air is discharged from the overflow pipe and the water is discharged from the underflow port. It can be seen from the derived data that the efficiency of the separation of water and gas can reach 98%. It can effectively separate natural gas from crude oil, and it can recycle natural gas and save resources.

4. CONCLUSION

gas from oil. The CFD software is used to study the internal flow field, the flow field characteristics in the cyclone are analyzed, and the pressure distribution in the three-phase separation cyclone is studied., gas volume fraction distribution three velocity distributions. Through the simulation analysis of the initial model of the separator, it can be seen that the pressure, velocity and concentration distribution of each phase of the separator have certain rules, and the separation effect is good, but there are still some defects, there is still a small part of the gas inside the bottom tube. Outflow, but the vast majority of the gas is discharged through the overflow pipe, the separation efficiency reaches 98%, so the entire design can initially separate natural gas.

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