Numerical Simulation Study on Sand Washing System of Dual Nozzle Jet Pump

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Abstract

In oil well mining, the sand in the formation will fall off from the rock layer with the erosion of the fluid in the formation, as the fluid enters the oil well and deposits in the well. The accumulation of sand in the well is constantly accumulated and the oil layer is blocked, which will lead to the oil production decline and even the oil production, and the fine sand will go with the extraction fluid. The oil production equipment is seriously worn out, resulting in unnecessary losses. In this paper, numerical simulation is carried out to solve the problem of sand bed cleaning in the process of oil well production. The geometric model of the dual nozzle sand jet pump was established and analyzed by numerical simulation software. The shape of the sand pit during the sand washing process was simulated. By analyzing the change curve of sand volume volume fraction under non jet velocity, the sand washing efficiency curve is obtained. The mechanism of sand flushing by double nozzle jet pump is further understood.

Keywords

Sand clean; jet pump; multiphase flow.

1. Introduction

Sand production in oil well is one of the common problems in sandstone reservoir mining. The sand particles in the stratum will fall out of the stratum as the stratum liquid washes away. As the stratum liquid enters the oil well together and deposits in the well, the accumulated sand in the well will cause the reservoir blockage, which will lead to the decline of oil production and even no oil production. The fine sand grains will enter the oil production equipment along with the production fluid, causing serious wear on the mining machinery. The service life of each oil production equipment is greatly shortened, which increases the oil well production cost. Although there are various methods to prevent sand production from the oil layer, it is impossible to completely avoid sand production from the oil layer in all Wells for various reasons. Therefore, measures must be taken to remove sand blockage and resume production. At present, continuous sand blasting technology, bound water sand blasting, foam and polymer sand blasting technology are mainly used at home and abroad. Timely and thorough removal of sand deposits in wellbore has become a bottleneck problem that restricts the normal production of sand Wells in current oilfield process.

The efflux pump has the advantages of good sealing, simple structure, reliable work, easy installation and maintenance, easy comprehensive utilization, etc., and it has no mechanical moving parts, which can reduce the abrasive effect of fine sand contained in oil fluid to the maximum extent, and is an effective equipment for sand removal in well washing in oil field. Therefore, it is of great significance to study the characteristics and parameters of jet pump, the action mechanism of jet sand washing well and the flow field analysis in annulus flow field.

2. Numerical Simulation and Analysis

2.1 Simulation Scheme

Combined with the actual field conditions and calculation conditions, the entire sand blasting system was simulated with a cylinder model with a diameter of 130mm and a height of 2326mm, see Fig. 1. The inner sleeve diameter is 28mm, and the exit diameter of jet pump is 10.4mm.The boundary conditions are velocity inlet boundary conditions, pressure outlet boundary conditions and no slip boundary conditions of the solid wall. The simulated well depth is 2m, the diameter of the upper nozzle is 4mm, the diameter of the lower nozzle is 2mm, the inlet velocity is 100-700m /s, and the diameter of the gravel is 0.005mm~0.1mm.The grid is structured and the upper and lower nozzles and the suction chamber are encrypted. The whole geometric model is divided into 724,312 mesh units. See Fig. 2

Fig 1. Geometric model diagram

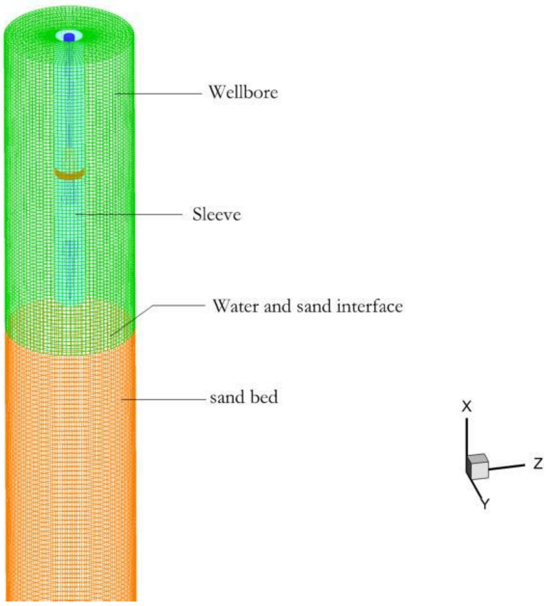

Fig 2. Schematic diagram of grid structure

2.2 Analysis of Simulation Results

The essence of the bottom cleaning mechanism is to transport sand and gravel from the bottom of the well. The movement of sand and gravel in the bottom hole field has three basic actions :(1) to overcome the pressure holding effect and make the sand and gravel separate from the bedrock;(2) being pushed to a position suitable for lifting;(3) the detached gravel is continuously impacted into the air of the ring, preventing the gravel from being deposited again. When the jet tool is used to flush the sand well, the high-pressure water jet impinges the wall of the well and the gravel at the bottom of the well through the disturbed sand nozzle of the jet pump, moves the gravel into the air of the shaft ring, enters the jet pump through the suction chamber of the jet pump, and is eventually transported to the ground.

Based on the established geometric model, this paper makes a simulation study on the Standard k-communication model. In the following figure, the inlet velocity is 500m/s, the outlet pressure is

5MPa, and the circumferential velocity distribution cloud diagram of fluid in the annulus is 0.005mm in diameter. It can be seen from Fig. 3 that the velocity distribution in the flow field is not symmetrical along the axis and the velocity distribution is not uniform. As the radial distance between the nozzle and the radial distance increases, the circumferential velocity of the fluid increases gradually and reaches the maximum value near the wall surface.

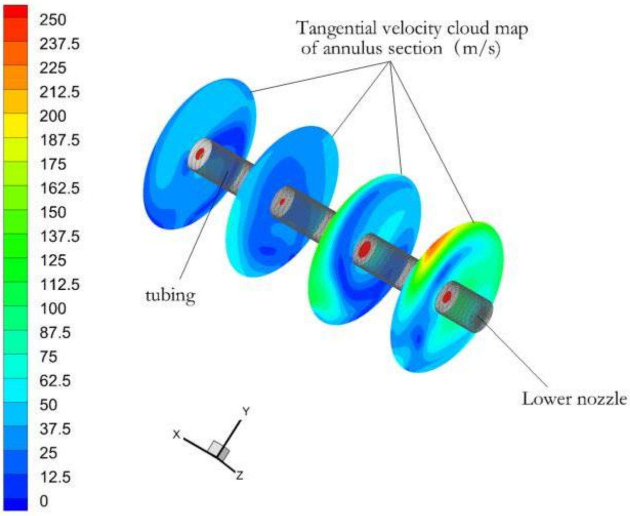

Fig 3. Flow velocity cloud diagram in annulus

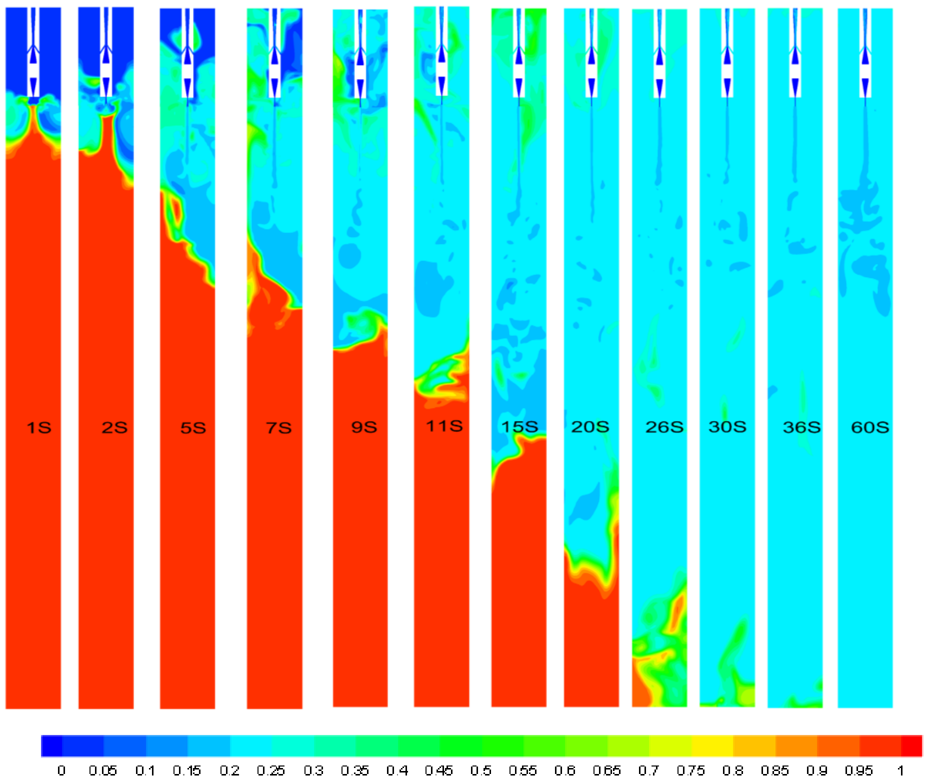

Fig 4. Volume fraction cloud diagram of gravel

Fig. 4 shows the volume fraction distribution cloud diagram of gravel under conditions of a speed of 500 m/s, an outlet pressure of 5MPa and a diameter of 0.01mm.It can be seen from the figure that, with the increase of time, the volume of the sand layer at the bottom of the well decreases significantly, and the gravel diffuses into the air of the ring. The volume fraction distribution is not uniform and there is obvious asymmetry. Under the simulated conditions, when the operating time reached 60s, the sediment concentration at the bottom of the well was about 20%, and the basic flushing was completed.

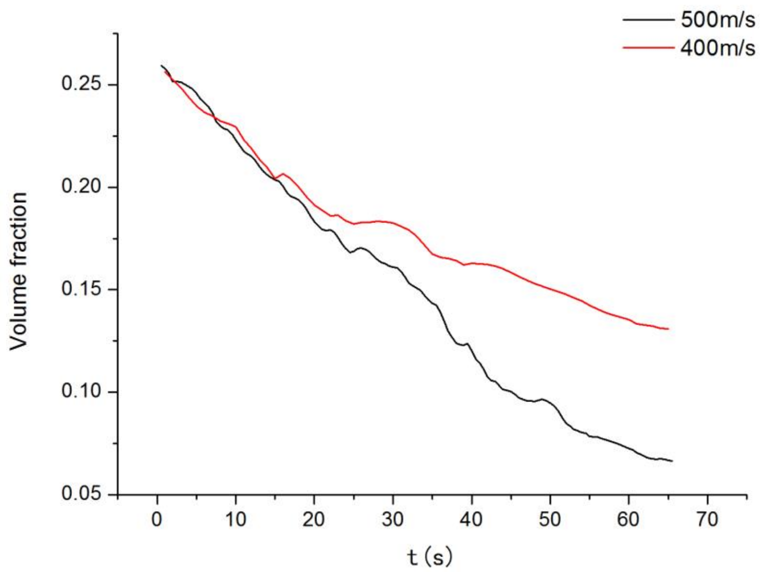

Fig 5. The variation rule of gravel volume fraction with time

Fig. 5 shows the regularity of the changes of the residual gravel volume in the hole over time under different velocity inlet conditions when the diameter of the gravel is 0.01mm and the outlet pressure is 5MPa.It can be seen from the figure that, with the increase of working time, the volume fraction of sand and gravel decreases gradually, and the decreasing rate decreases gradually.In the same working time, the higher the speed, the lower the residual volume fraction, the higher the washing efficiency.

3. Conclusion

(1) The jet velocity of nozzle and the diameter of sand and gravel are important factors influencing the washing efficiency of the debris. The numerical simulation results show that with the increase of the inlet velocity, the volume fraction of sand and gravel decreases faster. As the diameter of the gravel increases, the rate of volume fraction decreases.

(2) Asymmetric annulus flow field is formed in the wellbore in the process of sand washing by jet.

The strength of annulus flow field increases with the increase of nozzle velocity, and decreases with the increase of distance from nozzle.

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