Modeling and Simulation of single screw pump system based on AMESim

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Abstract

The mechanical and electrical integration of AMESim fluid simulation software for modeling and Simulation of hydraulic single screw pump oil production system based on screw pump and condition analysis, get the screw pump, hydraulic motor, three position four way valve pressure and flow and other important factors affecting the simulation results. From the simulation results we can see that the screw pump, the hydraulic motor and the four position three way valve with the inlet and outlet pressure of different flow rate changes, to meet the requirements of the hydraulic system and the use of. For the analysis of the errors, it is easy to set up the system parameters in the future. Through the simulation analysis of the hydraulic system of screw pump, can not only predict the system performance in the design, and the timely discovery of structural problems in the process of the system design is reasonable, system optimization design, shorten the design cycle and improve work efficiency; at the same time as the screw pump structure design parameters, and provide a theoretical basis for the subsequent optimization of screw pump structure design analysis.

Keywords

AMESim; parameterization; condition analysis; hydraulic drive CLC number: TH327 Document code: A.

1. Introduction

In the field of oil and gas resources extraction, oil extraction screw pump has a high application value. Most of the current domestic use of oil extraction screw pump for the mechanical drive, although this drive is simple, but in the application process there are a series of shortcomings. Such as: the need to design a separate set of "anti-reversal institutions"; self-protection capacity is poor; difficult to find and diagnose problems. In order to overcome the problems of mechanical drive, a new hydraulic pump system - hydraulic drive system was developed. Hydraulic drive screw pump oil recovery system with strong adaptability, less loss, easy maintenance and other advantages, the development prospects are broad. However, due to the late development, the hydraulic drive screw pump production system has not yet been popular in the country, only a small amount in the test run. At present, the analysis and research on the hydraulic recovery system of the screw pump at home and abroad are relatively few. The steady and dynamic performance analysis of the system is rough and the fault diagnosis of the hydraulic system is not only costly but also complicated in data collection. Therefore, the need for an effective means of hydraulic drive screw pump system related research and analysis. In order to solve this problem, the hydraulic drive screw pump oil production system model was established by using AMESim software as the platform, and the simulation and analysis were carried out on the basis of this study to study the steady and dynamic performance of hydraulic components and systems, and greatly shorten the fault detection cycle. Which can provide reference for the future optimization design of hydraulic drive screw pump oil recovery system, which is of great significance for further study of oil production system.

2. Design and Modeling of Hydraulic Control System

Hydraulic system is mainly composed of power pump, three four-way hydraulic servo valve, energy storage device, overflow valve, back pressure valve, signal source, gain, hydraulic motor and hydraulic pump. Its working principle is: the external control signal amplified by the amplifier, the control three-way four-way valve connected / cut off the supply of hydraulic oil and change the direction of oil supply, in order to achieve the hydraulic motor / hydraulic pump flow control. The relief valve controls the pressure of the whole circuit to prevent the occurrence of high pressure, to avoid high pressure accident; back pressure valve for the oil back to the ground when the wellhead pressure; accumulator is to make the power pump liquid flow tends to be smooth.

Firstly, the simulation model of the hydraulic control system is established under the Sketch mode of AMESim. Secondly, the sub-model is selected for the model. Then, the parameters of the sub-model are set according to the actual working conditions. Q_p= 20m^3 / d, n = 200r / min when the flow rate of about 14000cc / min, speed 20r / min when about 70cc / min. Take the fluid density is 1.0 ×103kg / m^3, g = 9.8m / s^2, H = 1000m. Single screw pump hydraulic control system circuit diagram shown in Figure 1.1, each component of the sub-model selection shown in Figure 1.2.

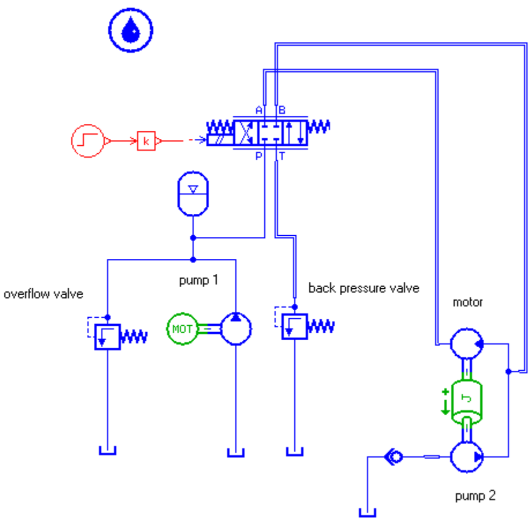

Fig.1 Single screw pump hydraulic control system circuit diagram

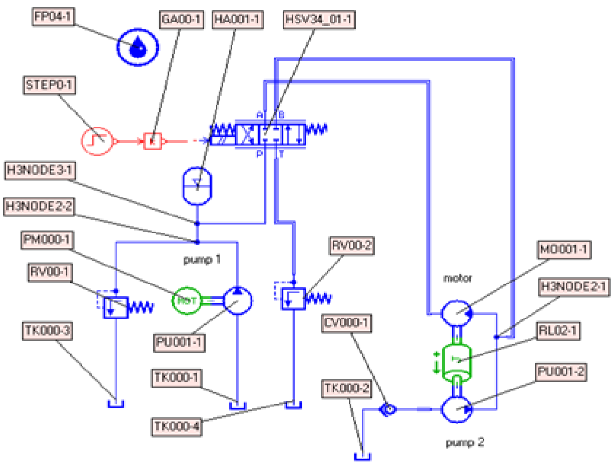

Fig. 2 Model of hydraulic system

3. Simulation results and analysis

Set the run parameters, after a number of time settings. The running time is set to 4000s, the communication interval is set to 0.1s is more reasonable, from the simulation of the curve, you can get a more stable working curve.

3.1 Screw pump analysis

① Pressure analysis

It can be seen from Figure 3, the screw pump inlet pressure before 180s there is a large fluctuations. At the same time as the passage of time, fluctuations gradually reduced until 180s or so, the pressure is 0MPa. The outlet pressure was maintained at 1000 m before the 200s column pressure 10MPa, until after 200s, the pressure gradually increased, eventually approaching 33.7MPa, and remained stable. From the figure you can see the pressure of the screw pump to go through about 3000s to enter a steady state.

② Traffic analysis

Through Fig. 4, the flow rate of the screw pump fluctuates before 180s and gradually approaches 0L / min, but the flow mutation occurs between 180s and 200s, and then gradually weakened until 800s, and remained stable at 1.876L / Min.

③ Input shaft torque, speed analysis

It can be seen from Fig. 5 and Fig. 6 that the torque and the rotational speed of the input shaft fluctuate before 180s; then the torque gradually approaches 50Nm and then gradually increases, and finally reaches the stability at about 3000s, 180s near the 0, but in the 180s when the mutation, and then gradually approach the smooth operation, and ultimately stable at 53.6rev / min.

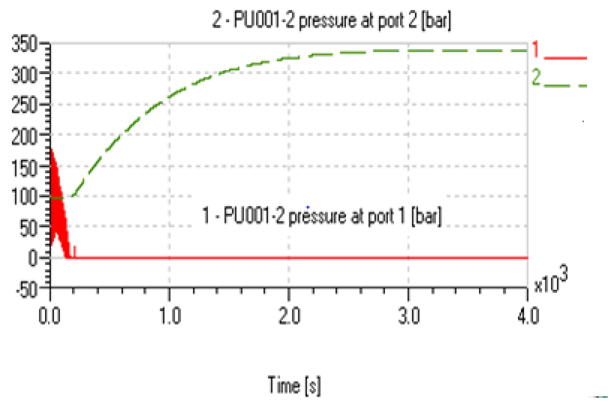

Fig. 3 Pressure curve of the screw pump

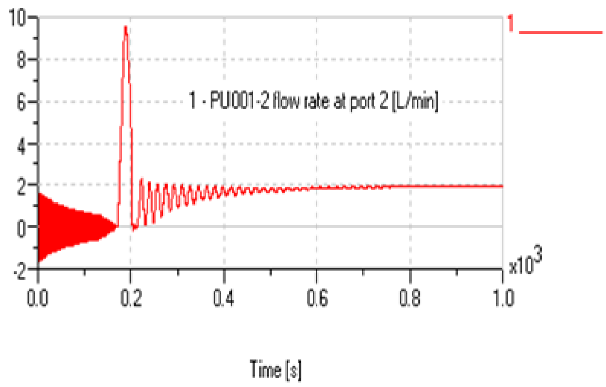

Fig. 4 Flow curve of screw pump

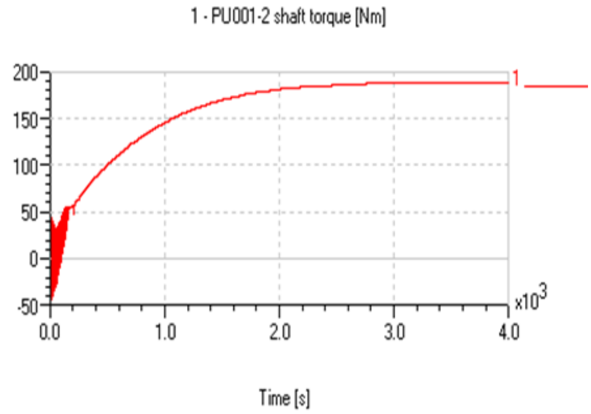

Fig. 5 Screw pump input shaft torque curve

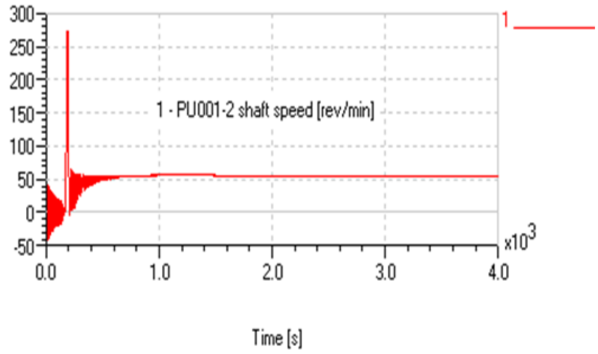

Fig. 6 Screw pump input shaft speed curve

3.2 Hydraulic motor analysis

① Pressure analysis

It can be seen from Fig. 7 that the inlet pressure and the outlet pressure of the hydraulic motor are 10 MPa before 1000 s, and the pressure is increased after 70 s, and the pressure is maintained at about 3000 s. The outlet pressure did not increase until after 200 s, eventually approaching 33.7 MPa and remained stable. Through the curve can be seen that the pressure of the hydraulic motor to go through about 3000s to enter a stable state.

② Traffic analysis

It can be seen from Fig. 8 that the flow rate of the screw pump fluctuates before 180s and gradually approaches 0L / min, but the flow mutation occurs between 180s and 200s, and then gradually weakened until after 800s, L / min.

③ Input shaft torque and speed analysis

It can be seen from Fig. 9 and Fig. 10 that the torque of the input shaft is kept at 0 s at 70 s and the torque increases gradually after 70 s, and finally reaches about 3000 s, and is maintained at 188 Nm. The speed of the input shaft fluctuates before 180 s In the vicinity of 180s approaching 0, but in 180s when the speed of mutation, and then gradually approach and smooth operation, and ultimately stable at 53.6rev / min.

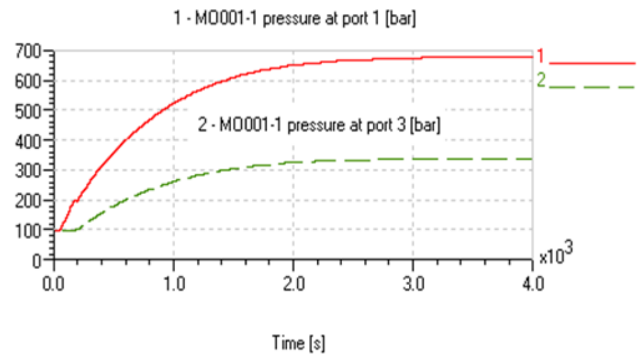

Fig. 7 Inlet and outlet pressure curves of hydraulic motors

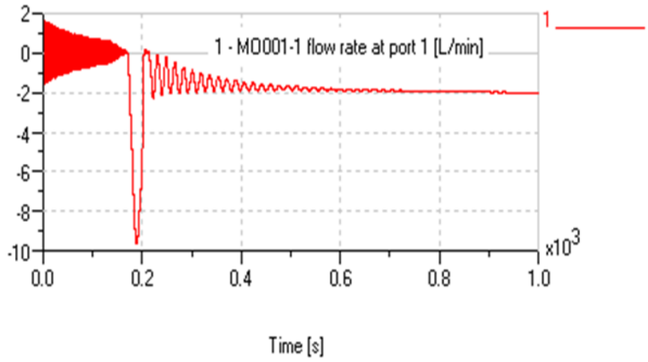

Fig. 8 Flow curve of hydraulic motor

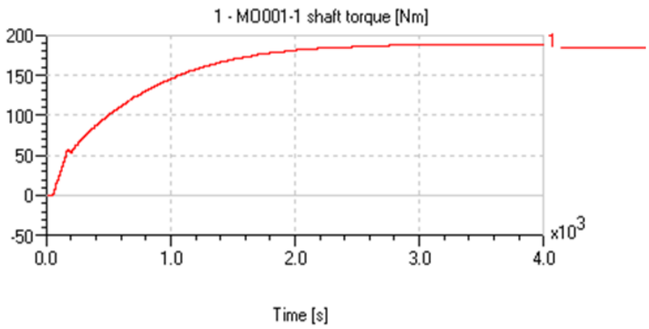

Fig. 9 Torque curve of output shaft of hydraulic motor

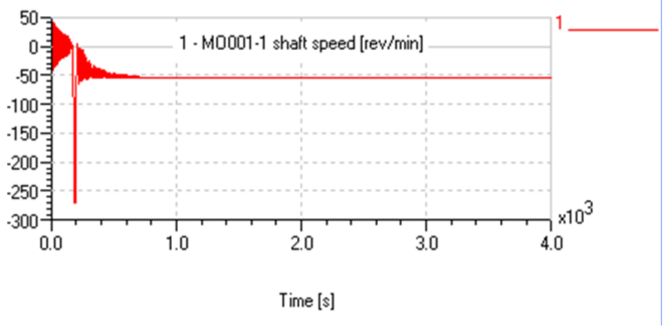

Fig. 10 Speed curve of output shaft of hydraulic motor

3.3 Three four-way valve analysis

① Pressure analysis

From the three four-way solenoid valve simulation results can be seen that the pressure of A mouth began to increase around 70s, B port pressure increases with time. The pressure of the T port began to increase after 200 s, and the pressure of 1.6 MPa was maintained at about 250 s.

② Traffic analysis

It can be seen from the flow chart that the flow of port P and port A decreases gradually with time and tends to be stable. The flow of port T and port B increases gradually with time and becomes stable.

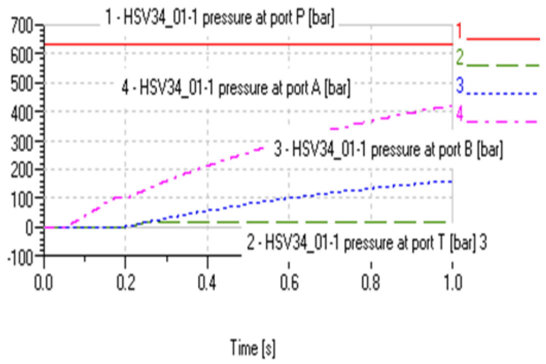

Fig. 11 Pressure curve of three position four way valve

way valve

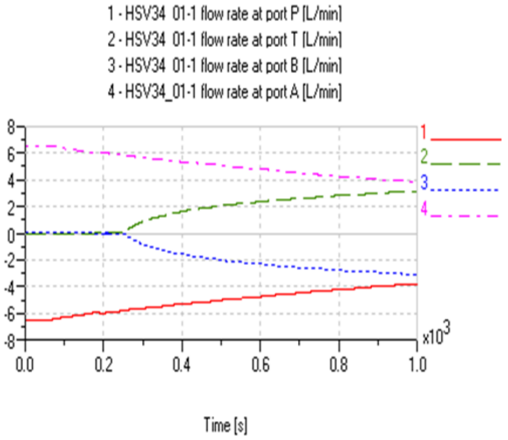

Fig. 12 Flow curve of three position four way valve

4. Analysis of Factors Affecting Simulation Accuracy

By the screw pump inlet and outlet pressure curve, the screw pump flow curve, hydraulic motor flow curve can be seen, the system there is shock, not stable, and there are some simulation results there is a certain error, the main reason for this phenomenon are the following aspect.

(1) Model will be properly simplified when modeling.

(2) Due to incomplete parameters, some soft parameters difficult to determine, the use of default values, such as the characteristics of hydraulic oil, hydraulic cylinder viscous damping coefficient, pipe wall roughness, diameter, thickness, etc., they have an impact on the dynamic performance of the system.

(3) System impact factors, such as in a single system, some of the parameters of the change may not affect the results, but it will be connected with other systems to form a complete sequence of action loop, these parameters may have a great impact on the results , The impact of each parameter is mutual, extremely complex.

5. In conclusion

Through the hydraulic control system analysis can be obtained by the pressure of the power fluid in about 70s to the hydraulic motor, when the pressure reaches 20MPa that is 200s when the hydraulic motor began to work, driving the hydraulic pump rotation, the hydraulic pump to pump the liquid to the ground, the pressure gradually approaching Stabilized and reached the pressure of 1.6MPa, the flow after 800s close to stability. The entire hydraulic system pressure after 3000s finally stabilized at 33.7MPa. The simulation analysis of AMESim's electromechanical integrated hydraulic system not only predicts the performance of the system, but also reduces the design time, and analyzes and evaluates the hydraulic drive single screw pump system, so as to optimize the system and improve the stability of the system.

References

[1] Tu Jihui, Zhao Yingqiu, Xiao Feng, etal. Optimization design method of hydraulic drive screw pump oil production system [J]. Petroleum Machinery, 2007,12: 24-27 + 95.
[2] YANG Dianyu, MI Shuan-shan, HAN Cuie. Simulation of lifting device for a certain type of vehicle hydraulic system based on AMESim [J]. Journal of Sichuan Warji University, 2009,06: 33-35.
[3] Control system improves screw pumps[J].World Pumps.2010,Vol.2010(No.10):6.
[4] WANG Qingnan. Optimization design and software development of hydraulic drive screw pump oil well production system [D]. China University of Petroleum, 2007
[5] HUANG Youquan, HE Yan, CAO Gang. Daqing Oilfield screw pump oil production technology new progress. Petroleum Machinery, 2003; 31 (11): 65 ~ 69
[6] LIU Yanping. Domestic and foreign drilling and oil production equipment new technology. Beijing: China Petrochemical Press, 2005: 21 ~ 102
[7] D.W Wright, R.L Adair. Progressive Cavity Pumps Highest Efficiency /Lowest Operating Cost in Mature Permian Basin Water flood. SPE,25417
[8] A. I. Biryukov and N. V. Rozumeenko.Study of the suction systems of duplex screw pumps [J].Chemical and Petroleum Engineering.1985,Vol.21(NO.4): 194-196.
[9] YANG Xiu-ping, GUO Jin-jin. Parametric finite element analysis of screw and bushings for single screw pumps. 2006 Annual Conference of Users, 2006
[10] LI Huacong, Li Ji. Mechanical / hydraulic system modeling and simulation software AMESim. Computer simulation, 2006,23 (12)