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Dynamic performance analysis of workover power tong and boom based on AMESim

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Abstract: In workover operations, minor workover operations account for about 90%~95% of the total wellbore maintenance workload, that is, in oilfield workover operations, the longest operation time and the highest use frequency is the tripping operation of pumping tubing and sucker rod. According to statistics, the time spent in tripping operation of oil wells generally accounts for nearly three quarters of the total time spent in workover. Therefore, it is very necessary to improve the efficiency of tripping operation and realize the automation of tripping operation of tubing and rod for improving the mechanization level of oil fields in China and maintaining stable production of oil fields. In the lifting operation engineering, the most important part is the automatic make-up and breakout link. The efficiency and quality of make-up and breakout are determined by the power tong, so it is particularly important to study the dynamic performance of the power tong. In this paper, amesim is used to establish the hydraulic control circuit of the power tong, and the optimal control scheme is obtained by analyzing the performance curve of the power tong under different pressures.

Keywords: Dynamic performance analysis; Amesim.

1. The mechanism of the power clamp of the pipe rod

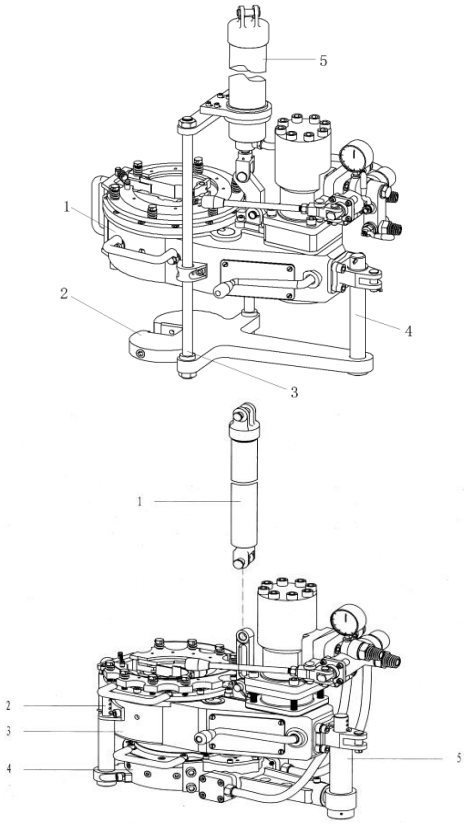


Fig. 1 Mechanical structure of tubing rod power pliers

2. Power clamp hydraulic system analysis

As shown in Fig. 2, the manual reversing valve (3) is used to control the oil motor reversing and also the back clamp reversing, and the back clamp rack plunger cylinder (2) is used to drive the back clamp forward and backward to clamp the pipe string; The oil motor (1) is used to drive the screw thread of the upper unload rod post of the master pliers, and the pressure gauge (4) is used to indicate the system pressure. Under the initial working condition, the synchronous control system needs to overcome a small load, requiring the pump source to output a low pressure and a large flow rate, and with the friction between the nut and the flange gradually increasing, the hydraulic torque wrench needs to increase the output torque, require high pressure, small flow. [1] [2] [3] [4].

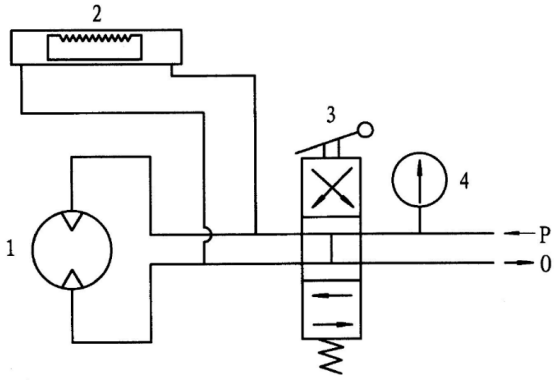


Fig. 2 Power clamp hydraulic system

3. AMESIM simulation of power clamp hydraulic system loop

Power Tongs in the release of the buckle, the buckle will require a larger torque, and the speed at this time slower. Under the initial working condition, the synchronous control system needs to overcome a large load, which requires the motor to rotate slowly and have a large torque, and the load torque decreases with the gradual decrease of the friction between the nut and the flange, at this time to improve the speed of hydraulic motor rotation. In order to meet the requirements of different stages in the bolt fastening process, it is proposed to divide into 11mpa and 8 mpa two different

pressures.

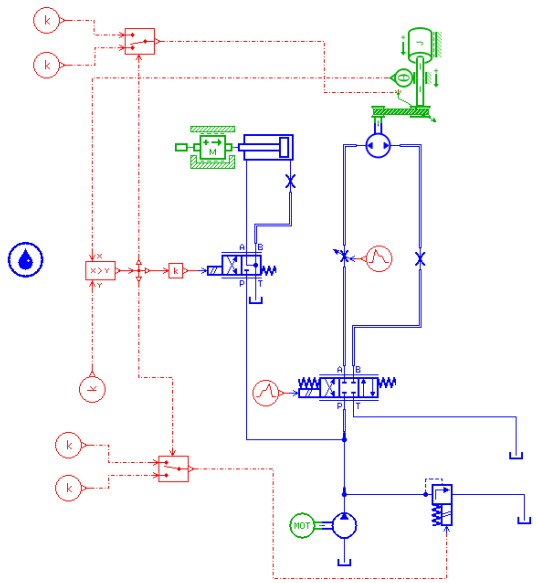


Fig. 3 Power clamp hydraulic system circuit

As can be seen in the following figure simulation results, in the snap link, the initial speed of the load to low speed, such as the speed of the snap link after the completion of the increase. Through the acceleration curve, we can see in the power clamp shift power clamp, motor mechanical vibration, this is a normal phenomenon, the other time relatively smooth.

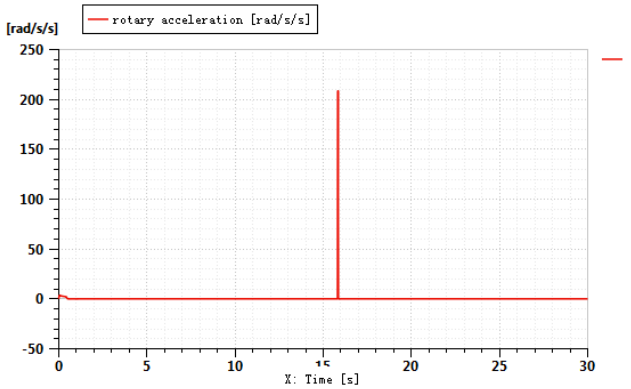


Fig. 4 Rotational acceleration curve of power clamp motor

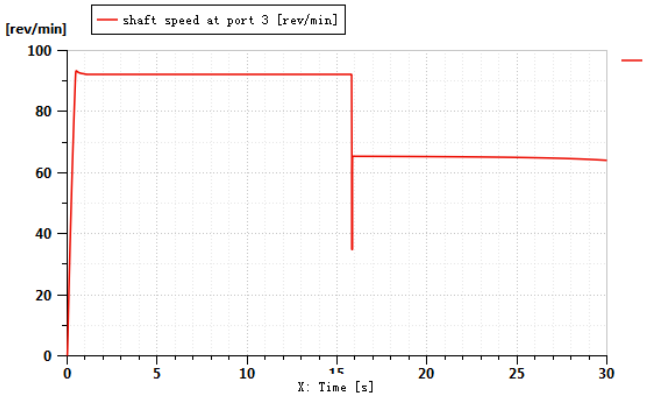


Fig. 5 Flow curve of power clamp motor

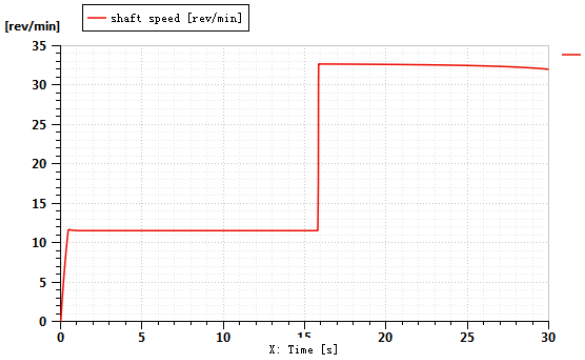


Fig. 6 Load speed curve

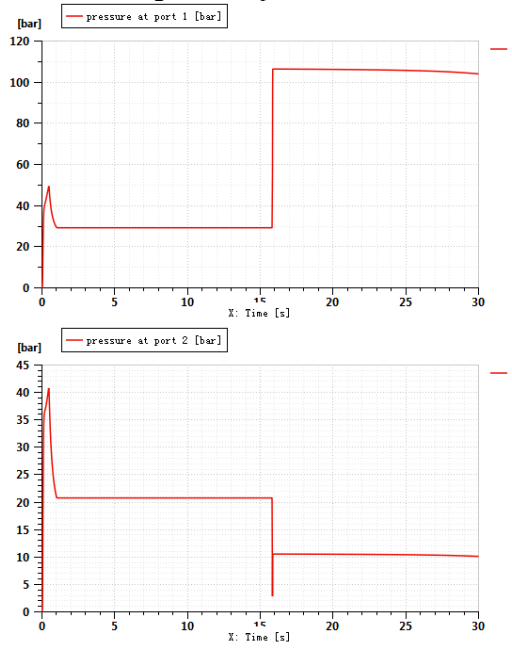


Fig. 7 Inlet and outlet pressure of hydraulic motor

4. AMESIM simulation of arm hydraulic circuit

In order to smooth the motion of the arm, the pressure of the hydraulic motor also needs to change accordingly, so as to control the output torque of the hydraulic motor. The pressure of proportional relief valve in hydraulic circuit is divided into two stages. The pressure of the hydraulic motor in the loop decreases linearly from 18 mpa to 9mpa when the arm rotates from 0 ° to 90°rotary encoder. The velocity of the upper arm will be faster after passing 90 ° because of gravity reversal. The pressure will be linearly reduced from 9mpa to 6mpa, and the motion characteristics of the upper arm will be observed. The following diagram shows the simulation loop in amesim.

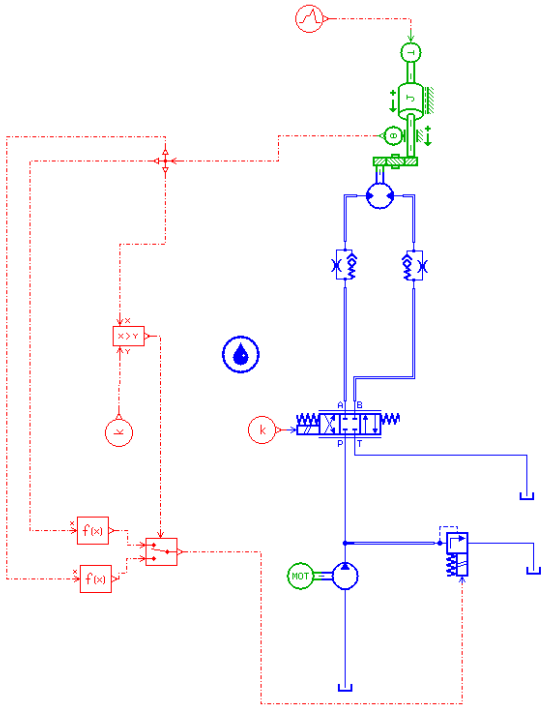


Fig. 8 Arm hydraulic circuit analysis

The figure below shows the pressure change curve of the upper arm hydraulic circuit, the pressure of the motor is consistent with the expected given pressure, from the beginning of 18 mpa linearly reduced to 6 mpa. The simulation time is set to 40s, which matches the actual movement time of workover rig's arm.

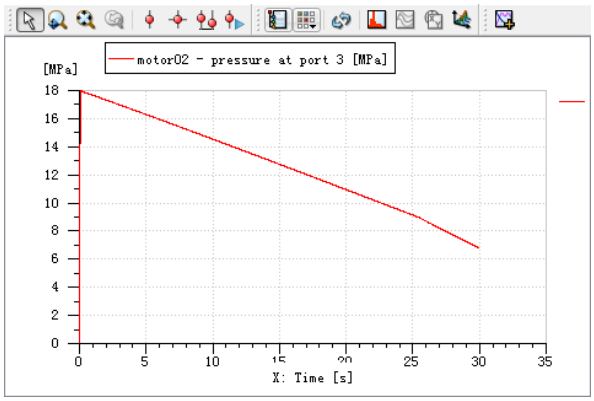


Fig. 9 Pressure curve of hydraulic motor

The graph below shows the speed curve of the upper arm.

From the graph, we can see that the speed of the upper arm gradually increases after 22 seconds, and gradually decreases after 22 seconds, reaching the maximum speed at 22 hours, at this time the position of the upper arm in the vertical position, at this time the workover rig caused the greatest impact, impact performance as a normal phenomenon.

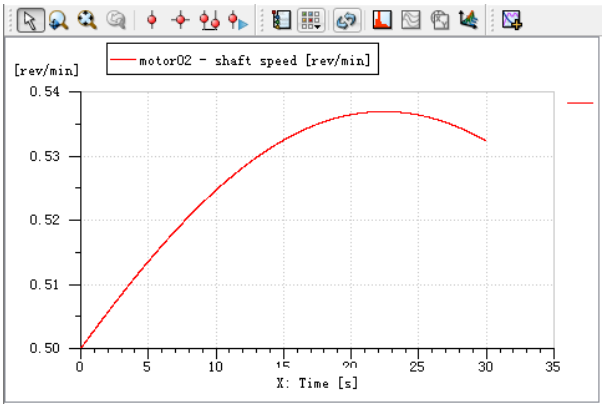


Fig. 10 Arm velocity curve

5. Summary

The hydraulic system of power clamp and workover rig's upper arm is simulated and analyzed by amesim software, and the pressure, speed and acceleration diagram of hydraulic motor is obtained, and the dynamic analysis of the graph line, the impact time, location. Important data are obtained for the optimization of the pressure control scheme and the modification of the mechanical structure.

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