Design and Analysis of Hydraulic Loop System for Tile Forming of Tile Making Machine

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Abstract

With the continuous development of the construction industry, as the representative of the building to gangwa supplies industry occupies an important position in the national market in the field. With the improvement of living standards, the robot automation equipment technology as the representative of the will in the future become the main tools of production tile manufacturing industry, therefore need to develop to adapt to the high output and high quality tile equipment, various facilities around the tile industry is also gradually realize mechanization, large-scale. To effectively improve the company quality and production efficiency, to meet the demand of construction market. This paper uses system simulation technology parameter design theory and system design of AMESim system, completed the construction of tile molding machine hydraulic circuit, a HCD system based on AMESim simulation model, analysis of the loop motion characteristics and flow characteristics, and verify the rationality of the system design.

Keywords

Tile making; loop system; simulation analysis;HCD.

1. Introduction

At present, domestic brick and tile equipment is upgrading. More and more technology forces are invested in brick and tile equipment research and development[1], coupled with the macroeconomic regulation and control of national policies, has laid a great trend in the new trend of equipment in brick and tile industry[2]. The mould pressing machine is completed by the hydraulic system. The advanced and stability of the hydraulic system is the mature sign of the mould pressing machine. Through the analysis and Simulation of the hydraulic system, the reliability of the experimental results is verified and the intended purpose of the design is achieved. The design method of system design and characteristic simulation analysis, structure design and reliability parameters of a building tile tile billet manufacturing machine, realize the mechanization and automation of blank conveying and molding function[3], improve tile quality and automation level, reduce the labor intensity of workers. The research laid a theoretical foundation for the realization of automatic brick manufacturing industry, and provide a new idea for the improvement of tile production line.

1.1 Basic structure design of tile forming

In this paper, two kinds of molding methods are designed for the structural design of the tile forming. Fig. 1.is the design of the hydraulic cylinder molding. Tile die 1 is fixed on the frame body and the mounting surface 2, 4 cylinder head with flange axis vertical mounting of [4] driven by a motor oil pump, cylinder piston to drive the upper mold 3 complete tile mold opening and closing; by controlling the pressure control loop forming pressure; application of sensor technology can be detected on the tile die position, the highest adjust the position of sensor height can be adjusted conveniently on tile die. The design is suitable for the working conditions with large load. The electronically controlled hydraulic system satisfies the logical control function between units, flexibly detecting the molding pressure and realizing the unification of molding pressure parameters.
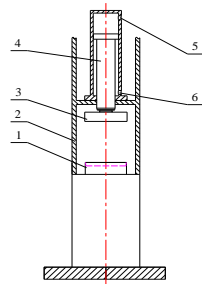
1- tile lower die; 2- frame; 3- tile lower die; 4- cylinder; 5- oil port; 6- oil outlet
Figure 1. Design of tile blank

2.   The design and analysis of the working principle of the hydraulic system

The principle of the hydraulic system for the mould pressing of the tile is shown in Figure 2. Tile forming hydraulic system consists of 2 pump oil; relief valve 3 is constant pressure overflow, regulator, unloading and safety protection function[5]; pressure relay 5 is mainly used for molding the left cylinder cavity pressure detection rate, can switch quantity output signal reaches the molding pressure value, the valve for the.

Cylinder out: solenoid valve 4 is arranged in the right place, the growth rate of cavity pressure oil into the first growth in oil cylinder, push the piston rod in the low load fast out, a rod cavity of the right chamber unloading, check valve 8 is opened, the accumulator 9 in oil rapidly added to the left cylinder to extend to the cylinder cavity; when the load increases, the system pressure, valve 6 to open, the rapid injection of the left cavity of cylinder pressure oil chamber pressure, left after the hydraulic control one-way valve 8 is closed, the accumulator is no longer oil output, when the left chamber pressure to the pressure setting valve relay 5, 4 reversing action.

The oil cylinder retracts: the reversing valve 4 is placed on the left side, the oil is injected into the right chamber, the hydraulic control one-way valve 8 is reversed opened, the left chamber oil flows through the hydraulic control one-way valve 8 to the accumulator 9, and the accelerating chamber oil is discharged to the oil tank.

When the piston is extended and pressurized, some oil is injected into the left cavity through the sequence valve. When the piston is retracted, the liquid of the left cavity is all injected into the accumulator 9. Therefore, the growth rate of each cylinder of a reciprocating, there will always be a part of the oil (liquid into the oil cavity through the left valve order) to increase the accumulator, therefore, increase the amount of oil accumulator with cylinder reciprocating times will gradually increase, regularly discharge excess oil in storage capacity of [6], or in accumulator tank to the upper cavity pipe hammer.
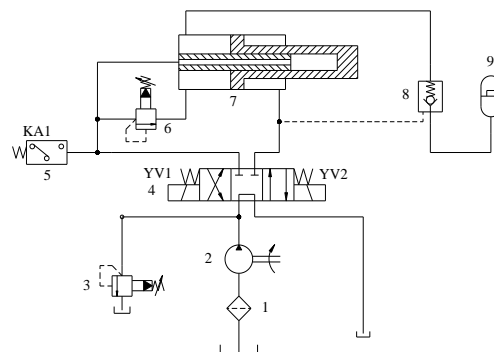
1- filter; 2- oil pump; 3- overflow valve; 4- three position four way reversing valve; 5- pressure relay; 6- sequence valve; 7- speed increasing cylinder; 8- hydraulic check valve; 9- heavy hammer accumulator.
Figure 2. The principle of molding hydraulic system

3. Simulation Analysis of hydraulic circuit characteristics based on AMESim tile forming

It is found that the average protruding speed of the existing manual tile die pressure is about 200mm/s, the stroke is 400mm, and the oil cylinder is more than 2S when the cylinder is extended. In this paper, the speed increase cylinder is designed. The average protruding speed is up to 400mm/s, 1s is extended, the booster 0.5s is formed, and the lifting time is 1.5s. The AMESim system simulation technology is used to analyze the characteristics of the molding hydraulic system [7-10], to verify the rationality of the design of the mold pressure system [11-12].

According to the structure characteristic of the speed increasing cylinder [13], the HCD simulation model of speed increasing cylinder, as shown in Fig. 3. is set up. Set the growth chamber piston cylinder cavity diameter 40mm, diameter 160mm, rod diameter 40mm, under the cylinder diameter 160mm, rod diameter 150mm, mass 86.35kg, mud resistance model is extended to the cylinder displacement is 390mm, the resistance function of F(x) and displacement x, retracted dieless resistance:
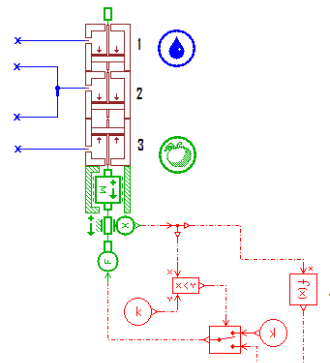
$$f(x) = a - c \cdot (x_0 + x)$$

f (x) - resistance, N;

a - compensation, $N, a = 4.3 \times 10^5 \, N$
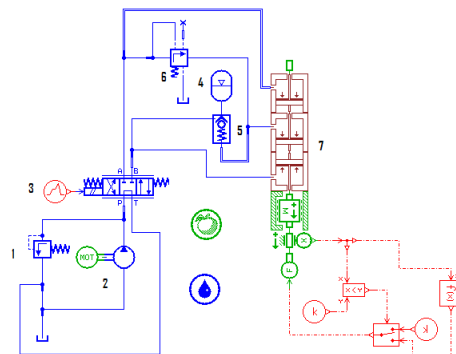
c - increment coefficient, N/m，$c = 4.3 \times 10^7 \, N/m$

x_0 - maximum displacement, m, x0=0.4m;

x - mass displacement, m, and the signal is -0.39~-0.4m.

1- growth cavity; 2- oil cylinder upper cavity; 3- cylinder lower cavity; 4- load model
Fig. 3 HCD simulation model of speed growth cylinder

1- overflow valve; 2- motor oil pump; 3- reversing valve; 4- accumulator; 5- liquid controlled one-way valve; 6- sequence valve; 7- speed increase cylinder
Fig. 4 Hydraulic simulation model of mould pressing system

A hydraulic simulation model [14] for the molding system is set up, as shown in Fig. 4. The signal setting valve before 2S is 40, 1.5s is -40, namely before two 2S 1.5s rewind state, after setting out,

the emulsion density is 998kg/m3, the bulk modulus is set to 21000bar 1500r/min; the oil pump motor, pump displacement of 40ml/r relief valve opening pressure; 23MPa; between the reversing valve and the cylinder line growth the inner diameter of 32mm and length of 2.5m; the volume of the accumulator pressure 10L, 0MPa; set the initial time of simulation for 0s, stop time is 3.5s, 10-3s simulation step, the growth rate of cylinder out displacement curve as shown in   Fig. 5. The accumulator gas volume curve as shown in Fig. 6. The growth rate of cylinder output flow curve shown in Fig. 7.
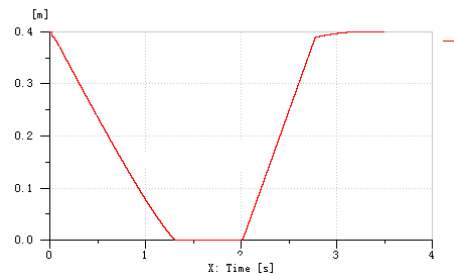

Fig. 5 Protruding displacement curve of accelerating cylinder

Growth analysis of cylinder displacement curve, the input signal of 2S before reversing valve 3 is 40, the work in the left position, the cylinder quickly began to retract, but 0.03s slowed down the oil into the growth chamber to push the piston to move smoothly, a short time after the rapid growth tends to be stable with the increase of the amount of growth of cylinder retract the speed, at a steady decrease in amplitude of 1.3s; when the piston displacement reaches 0m, the growth rate of cylinder fully retracted, cylinder stop action, waiting to enter the next working state; when 2.0S, the input signal change valve 3 is -40, the valve working in the right position, the cylinder extends, in 2.8s~3.2s when the piston pole shift is above 0.39m, the forming load is involved, the tile mold contact with mud, with the piston displacement and resistance increases, the piston cavity pressure increases gradually With the increase of the oil pressure and the sequential valve, the pressure oil supplied by the pump is supplied by the sequential valve for the upper cavity of the oil cylinder, and the accumulator stops working. At this time, the expansion speed of the cylinder obviously slows down, and when the piston rod reaches the maximum value, the cylinder stops acting.
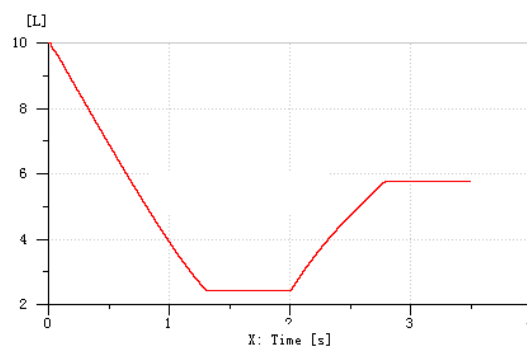

Fig. 6 Accumulator gas volume curve

Analysis of accumulator gas volume curve, in 0s~1.3s, the growth of cylinder retraction process, because of its superior oil all back into the accumulator, the accumulator oil volume is always increase the gas volume has been reduced, when the cylinder stop action, accumulator in the gas volume did not change; in 2.0s~2.8s, the growth rate of cylinder quickly extend in the process of accumulator for growth cylinder provides pressure oil, the accumulator in the oil to reduce gas volume increasing, while in 2.8s~3.2s, the growth in cylinder feeding, stop work storage. - Fast - feeding [15] retracted the cycle of growth in cylinder cylinder, due to growth in the progressive period corresponding to the oil flow is provided by the pump, but the outflow is returned to the accumulator, which resulted in the accumulator in the oil liquid is added in a [16] cycle after the end of the process, which can reduce the gas storage in the volume, which we previously described is consistent.
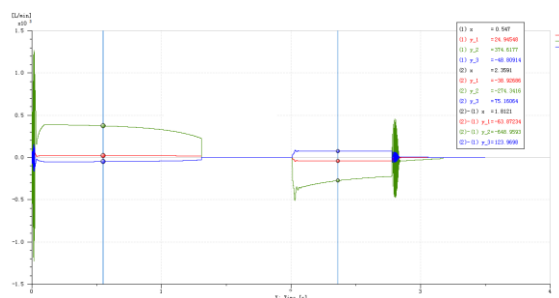
Fig. 7   Output flow curve of accelerating cylinder

Analysis of cylinder flow growth curve, 0~0.95s, sequence valve, hydraulic cylinder cavity flow curve and the hydraulic control valve flow, namely fast out of phase, the oil cylinder cavity consists of a liquid storage; 0.95s fluid control valve flow tends to 0, the order on the same valve flow and cavity flow, namely hydraulic control check valve closed, the hydraulic cylinder cavity by sequence valve for liquid chamber pressurized by the pressurizing phase sequence valve flow added to the cylinder cavity to shock form, 1.48s into the cylinder cavity flow tends to 0, the system flow tends to 0, the 1 pressure relief valve overflow, meet the design requirements.

4. Conclusion

The parameter design and system configuration of the hydraulic circuit system of the building tile making machine is mainly carried out. The simulation loop of the AMESim hydraulic system is used to complete the simulation analysis of the loop characteristics. The AMESim system simulation method is used to solve the characteristics analysis of the hydraulic circuit, and the rationality and reliability of the circuit design is verified. By using the design theory and method of system parameters, the growth rate of molding cylinder hydraulic circuit system, using the AMESim analysis method of system simulation, the motion characteristic curve and flow characteristics of the hydraulic system and motion curve, analysis the characteristic curve of satisfy the design requirements, comparative analysis of observational data, and further verify the motion characteristics of transport requirements of reliability. The simulation system also provides parameter basis for debugging.

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