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The study on PLC control system design method of the hydraulic diaphragm pump

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ABSTRACT

Hydraulic diaphragm pump's power end control is studied, PLC is used to control the power end and diaphragm, design a hydraulically driven diaphragm pump power end control system solutions, study the PLC control model of the power end hydraulic system, draw the wiring diagram and ladder of the PLC control system, achieve the system design goals of stable and reliable operation, and increase the life of the diaphragm.

KEYWORDS

Hydraulic drive; Diaphragm; PLC control; Power end.

INTRODUCTION

In the 1970s, the first diaphragm pump was successfully developed[1]. The diaphragm pump are one of the kinds of reciprocating pump, which not only has the high pressure and durable advantage of the piston pumps, but also the advantages of Simple structure and corrosion resistance, and overcome the shortcomings in the seal wear of the mud pump piston, become the new generation of reciprocating pump of conveying two-phase medium of highly abrasive solids and liquid[2,3]. In the last ten years, the diaphragm pump's solid and liquid two-phase medium transmitting capability parameters has been considerable development, which include the flow pressure, temperature, abrasion resistance and other technical parameters, Meet the black, nonferrous metals, chemicals, building materials, coal, electricity and other industries for high abrasion solid - liquid two-phase medium transporting process requirements, promote the extensive use[4,5]. diaphragm pump is the key devices of the chemical process systems, the good operational reliability is required[6]. The controls of diaphragm pump include the fluid level detection and control, the flow cumulative and display, the diaphragm rupture prealarm and burst alarm, except of the control of the pump's starting and stopping, and also the diaphragm's draining and inletting. if the diaphragm happen an accident, need to stop the pump and replace the diaphragm and propulsion liquid. Thus, monitoring the working state of the diaphragm pump and the precise run of the diaphragm position are especially important. The diaphragm pumps are widely used in contact relay contacts, the control accuracy is low, also poor reliability, selecting more advanced PLC programmable controller is a trend of the development of the diaphragm control system[7]. The thesis selects the advanced PLC to control the pump's power end and the diaphragm, in order to seek the stable and reliable operation of the system while increasing the life of the diaphragm.

THE PLC SELECTION OF A DIAPHRAGM PUMP CONTROL SYSTEM

With the development of PLC technology, PLC product range is also increasing. the different types of PLC have the difference in its structure, performance, capacity, instruction, programming, price, applicable occasions have also different emphases. thus, the rational uses of PLC are of great significance to improve the technical and economic indicators. the main aspects of the PLC model, capacity, I/O modules, power modules, special function modules, communications net working capability should be considered in the PLC selecting. Mitsubishi pushed out FX series PLC in the year of 2010, absorb the advantages of monolithic and modular programmable controller, its basic unit, extended unit and expansion modules have the same height and width. They don't interconnect with the substrate, only use the flat cable connector form a neat rectangular, it is suitable for using in the mechatronic products[8].

The FXON has 12 kinds of basic unit, 3 kinds of extended unit, 7 kinds of expansion modules, it can be composed of 24 to 128 I / O points system. The user memory capacity is 2000 steps. The FX0N has 20 basic instructions, 2 step instructions, 55 function instruction. The FX0N also has strong communication function, the device can communicate with the built-in RS-232C communications interface.

The FX0N has eight analog input and output modules (2 inputs, 1 output). The FX0N-40MR-D has 24 inputs, 16 outputs, expansion modules are available for the 32 points.

The designed diaphragm pump PLC control system has 11 inputs,4 outputs, the FX0N-40MR-D-type PLC meet the requirements, and more than 20% of the margin.

THE DESIGN OF HYDRAULIC DIAPHRAGM PUMP POWER END CONTROL SYSTEM

The diaphragm pump power end automatic control system mainly use the hydraulic diaphragm pump power end PLC to auto control, Greatly enhance the operation and management level of the

diaphragm. The system control design includes: the pump starts or not, the diaphragm stroke position determination, solenoid valve control, etc.

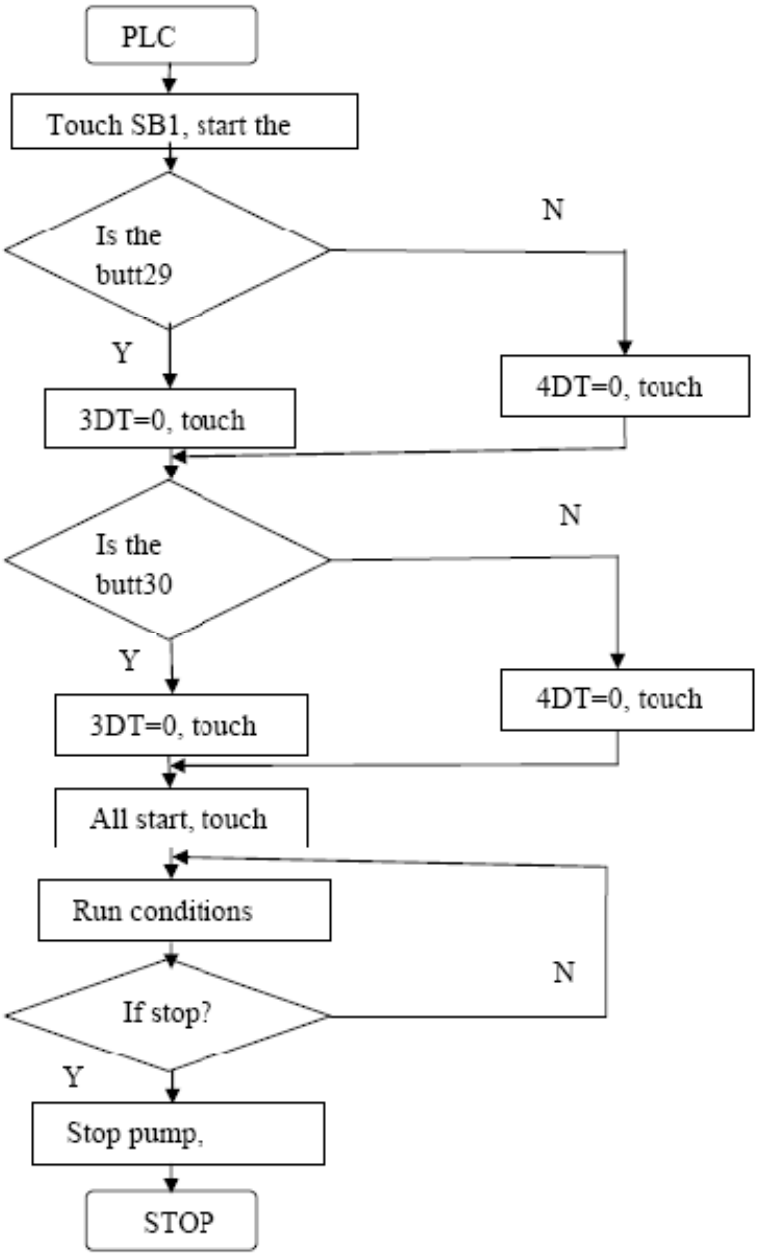

Figure 1 : The diaphragm pump control flow chart

As shown in Figure 1, when the solenoid 1YA is energized, solenoid valve 5 is a left-bit performance, the left chamber of the cylinder pressure chamber I is the high-pressure chamber, and the right is the low pressure chamber the back-oil chamber, push the piston I being moved to the right. When the hydraulic cylinder piston I which pushed by the piston I, the fixed butt on the piston rod 29 touches the contact limit switch8, make 1YA loss of power, piston I stay. At the same time, the electromagnet 3YA was electric, the hydraulic cylinder II push the piston II to the right. When the run to the left of the piston cylinder II, the fixed butt on the piston rod 30 touches the contact limit switch8, make 3YA loss of power, piston I move to the left. when piston I run to the left of the hydraulic cylinder I, the fixed butt on the piston rod 29 touches the contact limit switch8, make 2YA loss of power, piston I stay, 4YA was electric. When the piston II run the left., the fixed butt on the piston rod 30 touches the

contact limit switch8, make 4YA loss of power, piston II stay, 1YA was electric, then starting the next cycle., In order to achieve the system's automatic commutation.

According to the above-mentioned requirements, the electronic control components state have shown in TABLE 1:

TABLE 1 : The electronic control components status table

No.	Move conditions names	Signaling components		Actuators				Input components			
		Manual	Automatic	1DT	2DT	3DT	4DT	1XK	2XK	3XK	4XK
1	Start	SB1	—	0	0	0	0	0	0	0	0
2	Ⅰrun left Ⅱstay	SB2	—	1	0	0	0	0	0	0	0
3	Ⅰrun right Ⅱstay	SB3	—	0	1	0	0	0	0	0	0
4	Ⅰstay Ⅱrun left	SB4	—	0	0	1	0	0	0	0	0
5	Ⅰstay Ⅱrun right	SB5	—	0	1	0	0	0	0	0	0
6	total start	SB6	—	0	0	0	0	0	0	0	0
7	Ⅰrun right Ⅱstay	—	3XK	0	1	0	0	0	0	1	0
8	Ⅰstay Ⅱrun right	—	2XK	0	0	0	1	0	1	0	0
9	Ⅰrun left Ⅱstay	—	4XK	1	0	0	0	0	0	0	1
10	Ⅰstay Ⅱrun left	—	1XK	0	0	1	0	1	0	0	0
11	stop	SB7	—	0	0	0	0	0	0	0	0

Note : 1——be electric; 0——loss of power; I -No. I cylinder piston; II——No.IIcylinder piston

THE SOFTWARE DESIGN OF THE PLC PROGRAMMING

The PLC control flow chart

The diaphragm pump control process is shown in Figure1:

The I / O points and address number of the control system

The I / O address assignments of the Hydraulic diaphragm pump power end PLC control system are shown in TABLE 2:

TABLE 2 : The I / O address assignments

Inputtingaddress	Inputting device	Export address	Export device
X000	SB1 pump initiate button input	Y000	solenoid switch1DT input
X001	SB2 cylinderIleft-initiate button input	Y001	solenoid switch2DT input
X002	SB3 cylinderIright -initiate button input	Y002	solenoid switch3DT input
X003	SB4 cylinderIIright-initiate button input	Y003	solenoid switch4DT input
X004	SB5 cylinderIIleft-initiate button input		
X005	SB6 the pump total initiate button input		
X006	3XK limit switch input		
X007	2XK limit switch input		
X010	4XK limit switch input		
X011	1XK limit switch input		
X012	SB7limit switch input		

PLC wiring diagram

The PLC wiring diagram is shown in Figure 2:

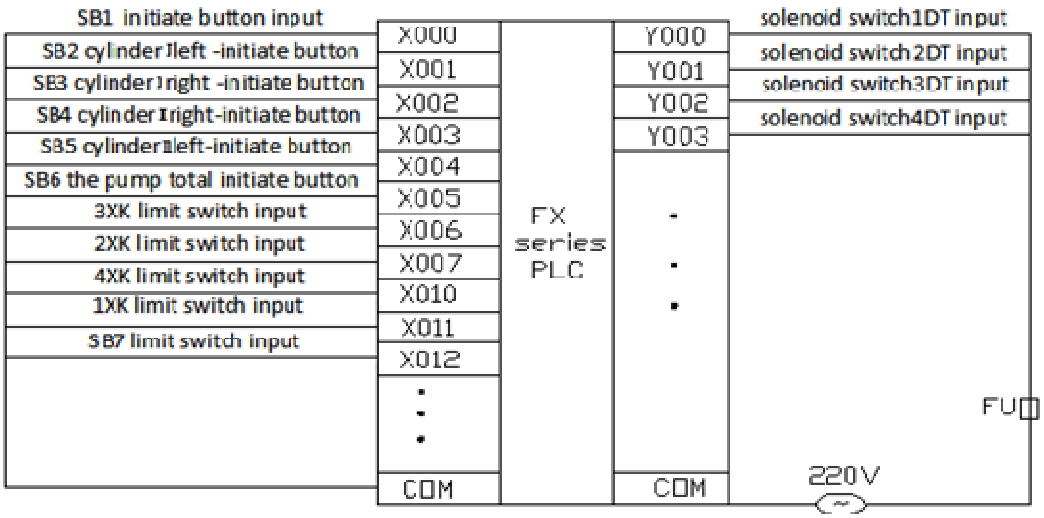

Figure 2 : The PLC wiring diagram

PLC ladder

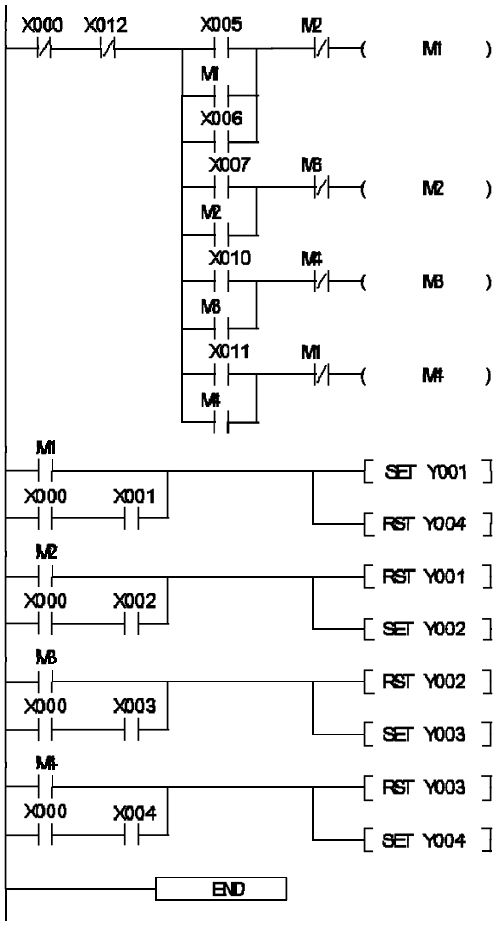

Figure 3 : PLC Ladder

CONCLUSION

The control system design of the double-acting cylinder hydraulic diaphragm pump power end are studied, A systematic analysis of the PLC system components, control methods, workflow, and gives the wiring diagram and PLC ladder diaphragm control. At the last, introduces and analyzes he PLC anti-interference measures. Diaphragm control system is controlled from the relay to explore beneficial PLC control technology, this model diaphragm practical, applied and market-oriented basis. Discusses the technical problems, which contact with the PLC control system to the relay control, solves the relative technical problems, lay a foundation on this model diaphragm pump practical application.

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