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DESIGN OF FLYING SHEAR DEVICE AND ALGORITHM BASED ON MOTION CONTROL SYSTEM

Liu Qi1, Li Shuo1, Wang Ying1*, Liang Kai1, Li Baohua1, Mo Huili1, Liu Jinran2

¹Jilin Institute of Chemical Technology, Chengde street, Jilin, China ²No. 2 Jihua Primary School, Yingkou road, Jilin, China *Corresponding Author Email: wangying20002@sina.com

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ARTICLE DETAILS

ABSTRACT

Article History:

Received 26 June 2018 Accepted 2 july 2018 Available online 1 August 2018 The flying shear device and algorithm design using the SIEMENS S7-300 series PLC SINAMIC SI20 motion controller and the motion control system based on the realization of the servo motor with high precision and high stability control are no traction test data under the condition of Kun and disc cutter by inertia compensation and the control algorithm of PID system, analysis of the causes of the control process and material tension linear velocity error analysis. The system analysis and algorithm design can be used for reference in industrial flying shear and motion control design.

KEYWORDS

SIEMENS PLC, motion control, flying device, PID.

1. INTRODUCTION

The flying shear machine is a kind of equipment for the implementation of the bar shearing process in rolling motion, is one of the equipment of continuous rolling line indispensable. With the increasing modernization steel production and varieties, demand of the flying shear machine is increasing. Because of the implementation of sports bar shear, so on the motion characteristics of flying shear, agility and stability and reliability are very high requirements of winding control system is introduced in this paper [1]. flying shear model, the device structure and control requirements similar to industrial shearing machine. This paper takes the device as the object, according to the characteristics of the flying shear control scheme is given for material movement no stability in the process of right, ensure high quality and efficiency of industrial manufacturing of flying shear, the flying shear control has certain reference significance.

1.1 Conceptual Design Principle

The design of the SIEMENS S7-300 series PLC and SINAMIC S120 motion controller as the core, acquisition and processing by the external sensor and tension sensor of speed and tension value, at the same time using the logic control algorithm, torque and speed regulation method, to achieve accurate control of the motor which Sl20, the controller of reeling motor torque and speed setting, small signal external sensor and tension sensor collected by the signal amplifier is converted into standard voltage signal $0{\sim}10\text{V}$, analog-to-digital conversion AI/AO module through the IM174 interface module into PLC, and participate in the closed-loop control, finally realize the reeling motor tuning, Improve its stability [2]. In addition, the design supports Ethernet communication, and can configure the touch screen of the host computer on TIAV1 to realize human computer information exchange.

2. SYSTEM ANALYSIS

2.1 Control requirements analysis

Because of the shearing machine is in motion to tie the implementation of shear, so in order to ensure the quality of the rolled piece section, should make the cutter blade moves in shear, shear section should be as flat as

possible, at the same time to ensure that no wrinkle and tie was pulled off this. There are high demands on the bar tension and speed. The value of tension and the line speed is collected directly by the tension sensor and the external encoder and displayed on the HMI. At the same time on the tension and speed values are set, the actual rolling tension and speed value reaches the set value and kept constant in the range of allowable error in a certain period of time, to ensure the quality of bar and increase the efficiency of flying shear device classified as a motion control servo system in the drive system we have studied.

2.2 Object characteristics analysis

It is based on DC motor open-loop control on the speed and position signal by rotary encoder and resolver feedback to the driver, to form a closed loop negative feedback PID control, closed loop current loop, three position loop, speed and drive the internal loop regulation of the motor has a strong follow up to the set value, and then the system can achieve dynamic balance [3-5].

2.3 System safety analysis

This paper takes the control system of China intelligent manufacturing challenge as an example. The driving system uses SINAMIC S120 drive driver, and the power unit has a comprehensive protection function.

At the same time, S120 driver has powerful alarm function. It can give timely warning to most faults and faults, ensure safety problems in production process, different types of reports, different hints and solutions.

3. CONTROL SYSTEM DESIGN

3.1 Control system logic

Take-up and reel control in the way of "speed control torque limit" and use DCA diameter calculator to calculate the winding diameter and adjust the motor speed to achieve the purpose of controlling the line speed.

As shown in Figure 1, the reel is controlled by the way of "torque control speed limit". The tension of the tie is controlled by adjusting the output torque of the reel to make it stable within the allowable range of the error. The tension control logic is shown in Figure 2.

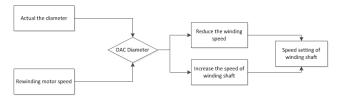


Figure 1: Linear speed control logic

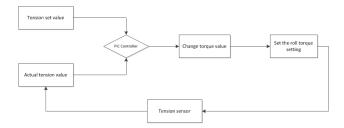


Figure 2: Tension control logic value

3.2 Control Algorithm

3.2.1 Design calculation

Line speed= x angular velocity radius; motor speed = speed (D diameter)

Line speed for the setting, so only a rolling diameter can be obtained by the motor speed setting value. With the change of radius, the motor speed setting value is adjusted accordingly in real time, so the output line speed set line speed, to meet the requirements of constant line speed. The diameter of the winding can be directly measured by DCA diameter calculator read.

3.2.2 PID control

In engineering practice, the regulator control law is proportional integral differential control widely, referred to as PID control, also known as the PID regulation, adopt incremental PID algorithm in this system. Due to differential amplification has the characteristics of interference signals in PID control, the production process has high frequency disturbance differential response, too sensitive, easy to cause the control process of oscillation. In this design, proportional integral control, PI control [6]. PIC control actual tension controller will tie the value and speed value and set value difference for integral, obtain compensation feedback to the closed-loop control circuit, adjusting the tension and line the speed stable value to change the working principle of PLC controller .

In this design, the torque control value by friction compensation value, inertia compensation value and the value of the PIC controller and three cumulative when the line speed increases, the friction compensation increases, and inertia compensation to suppress motor acceleration and deceleration with tension fluctuation parts, and finally a PIC control system for fine-tuning the tie the linear velocity and tension remained relatively constant, improve the shear cutting work quality and efficiency.

4. OPERATION INSTRUCTION

Ensure that there is no barrier shielding gratings to meet the operation of the equipment. Boot, download the program to the device, open the HMI picture of the tension and the tie line speed value settings, click the START button to start flying shear work. In the process of running the program on the HMI screen and intuitive to see the various parameters of the winding motor and shear tie curve tension and stability line speed value in the process, when you click the STOP button to stop flying shear work. Remember that in this design, the same time only to enable a motor, when the winding motor enable, unwinding motor may not enable, and vice versa. The system flow chart as start stop control figure 3.

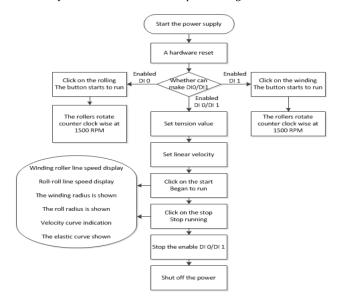


Figure 3: Control flow chart of system start-stop

5. IMPLEMENTATION EFFECT

The motor gear ratio is 50:1, the premise parameters of PIC controller are respectively PIC_KP=0.0001, PIC_Tn=250.0ms, change the winding and scroll speed, continuous recording the actual tension and tie line speed value, and compared with the set value, analyze and sum up the test data table as shown in Table 1, which Rv and Wv respectively represent the winding speed and scroll speed; error r% value set value set value 100%.

Table	1:	Test	data

- 1000 11111									
Rv/	Wv/	tension		error	Velocity value m/min		error		
rpm	rpm	Set value	measured value	σ1%	Set value	measured value	σ2%		
450.92	540.64	9.0	7.10	21.1%	1.5	1.1	26.7%		
500.55	605.24	10.0	8.20	18.0%	2.0	1.6	20.0%		
578.27	678.16	10.0	8.33	16.7%	2.0	2.01	1.0%		
800.14	900.75	12.0	16.98	41.50%	3.0	4.2	40.0%		
1100.0	1200.0	13.0	23.3	79.10%	4.0	6.5	62.5%		

When the rotational speed continues to increase, the actual tension value and line speed value suddenly increase, and the drawing piece is stretched seriously or even deformed. It is known that the critical value of the system has arrived. The HMI monitoring screen is shown in Figure 4.

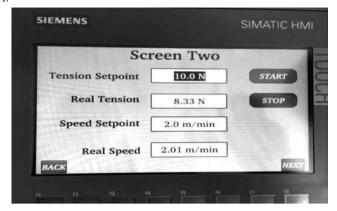


Figure 4: HMI monitor screen

Figure 4 HMI after the test, when the tension set value and speed setting value is changed, the system adjustment, the actual tension and linear velocity can quickly reach the set value in the range of allowable error and stability. At the same time, online speed change and stable process, tension still can quickly overcome the disturbance keep the system stable. When the tension changes and tends to be stable, the line speed can still overcome the disturbance quickly, and the system is stable. The HMI monitoring screen is shown in Figures 5 and 6.

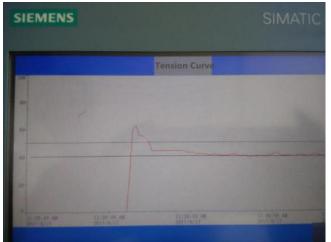


Figure 5: Monitoring chart of tension curve

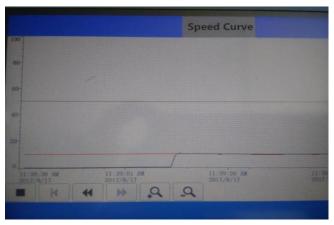


Figure 6: Speed curve monitoring chart

6. CONCLUSION

After debugging and testing results, fully verifying the industry, can make a tie with stable tension and line speed, to ensure the quality of cutting section and bar shear efficiency. At the same time the design of motion control can give learners some reference, let it quickly understand and be familiar with the motion control.

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- 2. [2018074] Science and technology research project of Jilin Institute of Chemical Technology
- $3.\ [2016033]$ Major science and technology projects in Jilin Institute of Chemical Technology

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