Design of Control Software on Mining Isolation Switch Breaking Test Motor Mechanism

Wang yukun1,2, Zhang Hong-kui1,2, Li Zhi-fu1,2, Liu Hao1,2, Gao Xin3, Ma Long3

1CCTEG Shenyang Research Institute, Fushun Liaoning 113122
2State Key Laboratory of Coal Mine Safety Technology, Fushun Liaoning 113122
3TAIYUAN HUITHE SCIENCE & TECHNOLOGY CO., LTD, Jinzhong, Shanxi, 030600
Email: zhang651779986@126.com

Abstract. In order to improve the controllability and stability of the isolation switch breaking test for mine and to improve the intelligence level of the test and inspection device, the software program of the motor mechanism control system was developed based on PLC. Based on the analysis of the present situation of the operation mechanism of mine isolation switch breaking test, the demand of mine isolation switch breaking test control system is put forward. Based on cx-one 4.2 software and ladder diagram language, the control software program of motor mechanism is developed. The practical application shows that the software runs well and lays a foundation for the development of intelligent inspection technology.

1. Introduction

In China most of the coal mining of coal seam gas, methane, dust and other flammable gas content, low permeability and complex geological structure, easy to cause coal and gas outburst, combustible gas explosion, such as production safety accidents, therefore, the security level of our country mining electrical equipment is much higher than similar foreign equipment. On the national security as the policy guidance, progress under the background of mining technology and mining equipment, coal mine production safety situation improved year by year. But the crisis mine production safety accidents has not completely ruled out, mine production safety situation is still grim, safety performance is still the foundation for the development of the mining equipment industry.

Mine isolating switch is mining flameproof vacuum electromagnetic starter, mining flameproof electric cabinet, mine flameproof multi loop combination switch and mine flameproof double circuit switching controller is important components of electric equipment in mines, such as mining products safety sign in An Biao country center management system for the controlled components, and play a subsection of fault current in the power system of coal mine, electrical isolation and no load commutation, happen in the contactor branch circuit, welding and other problems will not work with the main power grid to cut off the case, need to reliably breaking mine isolating switch, full load and overload current protection equipment and personnel safety, accident prevention. National standard GB/T5590-2008 "low-voltage electromagnetic starter" mine and coal industry MT/T 971-2005 "cantilever type machine Electrical control devices, "such as breaking ability of mining isolation switch request. Mining isolation switch performance is directly related to the mine safety production situation, so study on mining isolation switch testing inspection technology has very important theoretical and practical significance.
2. Operation mechanism

Mine isolating switch (as shown in figure 1) action early need outside to provide power to overcome the spring dead point, late rely on their own operating mechanism to make the action. Breaking test with development has experienced the manual operating mechanism, pneumatic mechanism and motor three stages. Manual mechanism driven by testing personnel through the drive controller and the rope for mine isolating switch action, another person cooperate to finish the main control loop current breaking test. Breaking test must in full after the current mining isolation switch action, compliance to the two experiments the demand is higher, test the success rate is low, at the same time with safety accidents. Pneumatic agencies, relying on air compressor pressure to provide operating force, has realized the automation of the whole process of breaking test, but need to convert electrical energy can store - the release of gas, operating mechanism structure is complex, the cumulative exercise tolerance, test process is not controlled, energy utilization rate is low. Motor mechanism driven directly by the flange mining isolation switch breaking test spindle rotation is complete, has the advantages of simple structure, good stability and high energy utilization rate.

3. Software requirements

Control system software is used to mine isolation switch breaking test effectively drive motor mechanism, realize the no-load closing and load reasonable control in the process of breaking. Control system has the movement Angle, direction of movement, movement speed, the origin position confirmation, some parameters such as dynamic step length and operation mode of setting function, can also according to the superior test system requirements set action delay time.

3.1. Action pattern demand

According to mine isolation switch breaking test operation and system commissioning requirements, software operation mode can be divided into automatic mode and manual mode and three point move mode, automatic mode to be used with the superior joint test experiment system, manual mode for single brake/closing operation, point Angle adjustment in the process of dynamic model for system debugging.

3.2. Movement direction demand

According to national standard GB/T 5590-2008 "low-voltage electromagnetic starter mine", the MT/T 111-2011 "mine explosion-proof type low voltage ac vacuum electromagnetic starter" and MT/T 971-2005 "cantilever type machine Electric control equipment "and other relevant standards, which has the function of reversing mine isolation switch breaking test process for 180 s electricity an interval, the positive and negative to the three times, a total of 6 times. Control system software must have two direction, the function of the three final position, namely, positive action, reverse action and three origin action.
3.3. Action point of demand
Due to the different types of mining isolation switch Angle different, GHK - 400/1140 v mining isolation switch operating Angle is about + 72 °, GHK - 120/1140 mine isolation switch operating Angle is about plus or minus 45 °. As a result, the action of control system software can be installed Angle must be a continuous value, and the largest interval must be greater than mine isolating switch Angle motion.

3.4. Delay time demand
Mining isolation switch breaking test should be carried out under the condition of full load current, otherwise the inspection have no actual meaning, after switching to the superior test system after a certain time delay test line, full load test current can be created. In order to improve the mining isolation switch breaking test success rate, control system software must be able to set up the delay time.

4. Control system design

4.1. Software design
Mining isolation switch breaking test motor control system software based on cx - one 4.2 runtime environment for development, development interface is shown in figure 2. Cx - one contains is suitable for the network, frequency converter, transformer, temperature controller, and the installation of the servo drive applications, and is suitable for the PLC programming software. Using a standard USB connection to a USB port CPU units can be realized, significantly reduced the amount of time the startup and commissioning.

The idea of modular design for mine isolating switch breaking test control system software program compile, debug, PLC as control core of the software, is used to control the instruction to send, parameter Settings and data processing, etc. System main program for the realization of system initialization, the system state, calls the breaker subroutine, etc., the main program flow is shown in figure 3.
Breaking subroutine execution first determines mining isolation switch movement patterns, movement direction and speed of movement and movement, and then wait for delay time, after time delay arrival start sending action instruction in action, while detecting mine isolation switch whether to reach the finish line position, such as motor brake to the finish position, otherwise continue to action. Breaking a subroutine processes as shown in figure 4.

Fig.4 Flow chart of breaking subroutine

Using ladder diagram language of system software program for editing, and realize the mining isolation switch breaking test and reliable control of the process, part of the program is shown in figure 5. System connected with each function to avoid mutual influence error, system in strict accordance with the time order, guarantee the accuracy of the data of the absolute, every port receives the data independence, unified handling, ensure the data is not mixed under the premise of guarantee higher processing efficiency.

Fig.5 Part of software programs
4.2. Control interface
Mining isolation switch breaking test motor control system software interface of the main objects including forward Angle setting, reverse Angle setting, origin Angle setting, delay time setting, action speed setting, inching step length setting, action direction setting, action mode setting, etc., through the realization of agency action parameter setting for mine isolating switch points off the reasonable control of the process. Mining isolation switch breaking test motor device and control system software interface is shown in figure 6. Positive Angle set is used to set the motor body is rotating Angle, set the range of 0 ~ 180 °, set the precision to 1 °, click the Angle value set. Origin Angle set is used to set the motor organization origin Angle, set range to 180 ~ 180 °, set the precision to 1 °, click the Angle value set. Delay time setting is used to set the motor body, action time and the higher the action time of the test system of delay time, set the range of 0 ~ 1000 ms, set the precision to 10 ms, click the delay time value set. Point set is used to set the motor dynamic step length agency manual single action point of view, set the range of 0 ~ 90 °, set the precision to 1 °, click the Angle value set. Action pattern set is divided into automatic mode and manual mode and dynamic model of three points, is used to set the motor agency action mode, click the icon set.

Fig. 6 Mining isolation switch breaking test motor control system software operation interface

5. Conclusion
Combining mining isolation switch breaking test condition, developed the fault test and control system software programs. Through long-term practical running shows that the software design is reasonable, good stability and meet the requirement of mine working condition of isolating switch breaking test, and provide test equipment for the development of intelligent detection inspection technology support.

Acknowledgement
This work is supported by Liaoning Natural Science Foundation(No 20180550951) and Innovation Foundation of the China Coal Technology & Engineering Group Corp (No 2018MS016) under Grant.

References
[1] Aimin Liu, Jiajue Li, Yongxiang Li et al. Motion Control System Simulation of Cylindrical Linear Induction Motor used in Circuit Breaker Operating Mechanism. ICAL 2009, shenyang, 460-464, 2009.
[2] Yongxiang Li, Xin Lin, Jianyuan Xu. Design of a Novel Permanent Magnet Brushless DC Motor-Driven Operating Mechanism for High-Voltage Circuit Breaker and Its Dynamic Simulation. Power System Technology, vol. 1, 185-189, 2010.D. Z. Cheng, Controllability of switched bilinear systems, IEEE Trans. on Automatic Control, Vol.50, No.4, 511-515, 2005.
[3] YAN Qun. Design and analysis of insulation structure of solid insulation switchgear. Mechanical Research & Application, No.5,77-80,2009.
[4] Xiao-yu Wang, Xin Lin, Jian-yuan Xu, Yong-xiang Li. Research on the Control Technique of the Permanent Magnet Linear Servo Motor Operating Mechanism of High-voltage Circuit Breaker. ICAL, Shenyang. 465-470, 2009.

[5] WEN Kang-zhen, WEN Yuan-fang, DUANMU Lin-nan, et al. The error of ANSYS solution of electrostatic field produced by sharp electrode. Insulators and Surge Arresters, No.2, 14-16, 2009.

[6] GENG Wei, LU Yong. The cause analysis and treatment of a inner discharge case caused by moistened 35kV switchgear. Electric Switchgear, No.4, 65-66, 2008(4).