Study on Control Cabinet of Automatic Filtration System for Insulating Oil of UHV Substation

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ABSTRACT

Ultra-high voltage substation has a large demand for insulating oil, but the impurities in the oil are required to be regularly filtered out before and during use. However, the existing insulating oil is operated by manpower and it has some defects. For example, it needs a large amount of labor but with low efficiency, and it is difficult to precise control temperature and quality of the oil. This paper introduces a control cabinet for transformer oil filter. It is mainly used in the process of transformer oil filter to achieve the monitoring of liquid level, oil temperature and flow rate, at the same time, to achieve the automatic control of oil filter.

INTRODUCTION

In recent years, Our country has made great progress in electrical control cabinet* designing[1]. The electrical control cabinet also has its set of fixed specifications, which is usually composed of various relay, contactors, circuit breakers and traditional low-voltage electrical appliances and frequency converters, touch screen, PLC, A / D converter and other modern intelligent control equipment[2].

The control cabinet receives signals and communication through the oil level sensor, the temperature sensor and the flow sensor, and sends a control signal through signal communication with the solenoid valve. In the process of monitoring and controlling of oil filter, data collection, signal processing and stable and efficient control is the key. Based on the selection of Industrial - grade Efficient Monitoring Sensors and communication network module to obtain high quality and high precision field signal output, we need to research high precision measurement algorithm and establish efficient and reasonable parameter control model, so then we can filter out the interference signal effectively, and achieve the high stability and high-quality output control command signal[3,4]. Therefore, in order to meet the automatic filtration requirements of UHV transformer oil, the control cabinet model needs to be studied. A control cabinet for automatic opening and closing of the solenoid valve for substation is proposed.
THE CURRENT PROBLEMS OF TRANSFORMER OIL AND THE PURPOSE OF TRANSFORMATION

In the construction of UHV substation, in order to improve the quality of transformer oil to meet the requirements of the project, it is necessary to filter the transformer oil\[^5\]. Construction party usually uses the inverted tank filter oil circulation method. Inverted tank filtration method have two ways: direct and centralized. Among them, the direct inverted tank filter oil method is between the tank and empty cans placed independently, the empty tank is connected to other tanks. The use of this method requires frequent start-up of the oil filter, and the liquid level, oil temperature, and flow rate can not be accurately monitored and controlled, requiring full-time metrologist management. And centralized inverted tank can be filtered on the basis of the filter tank connected to each tank through the pipeline, only by controlling the two position three-way valve to achieve the valve opening and closing, in order to control the various tanks of the oil filter, without the need to frequently start the oil filter and also reduced labor, but the liquid level, oil temperature and flow rate monitoring problem remains unresolved.

Therefore, through the study of the transformer oil control cabinet, in the oil filtration process we can not only solve the problems of large oil quantity, long processing time, frequent switching, frequent testing, low efficiency, etc. in the UHV Transformer Station, at the same time, we can accurate monitor liquid level, oil temperature and flow rate during filtration. So that we can achieve the liberation of the scene staff and realize automatic, fast and continuous detection of transformer oil. In addition, we display the working process in real-time, so we can improve the control precision and work efficiency of the filter oil.

DESIGN OF INTERNAL MODULE OF CONTROL CABINET

The Overall Structure

Control cabinet mainly uses CPU chip control system, and in its internal storage it executes sequence control, logic operation, timing, arithmetic and counting operation instructions, and it controls a variety of production equipment by processing analog or digital input and output signal. The vacuum oil filter based on CPU is used to realize the automatic detection and real-time display of the oil level through the oil level sensor and the A/D converter chip. It can be calculated and analyzed according to the measured liquid real-time level, and can determine a series of control, such as solenoid valve start and stop order. And it has the advantage of being able to communicate with the PC and the characteristics of high control precision, convenient control, strong anti-interference etc. The oil level sensor is a part which utilizes the change in capacitance between the sensor housing and the sensing electrode caused by the entry of oil into the container and turns this change into a current change to detect the position (height) of oil in the container.
As shown in Figure 1, the control panel is composed of communication module (including RS485 and wireless sensor network), power module, memory module, key circuit, display circuit and CPU.

**Design of Internal Modules**

Core board: It collects data from the level sensor, flow rate sensor, and oil temperature sensor and place the data in the register. Then it executes the stored instructions to complete the corresponding calculations. Finally, it transmits the results to the output. And it can respond to the typing information on the touch screen (such as the switchover of manual and automatic, filtering oil time, the control of oil speed and so on).

Communication module: It includes wired communication RS485 communication and wireless communication module. The communication module is used to connect the sensor and CPU as well as the CPU and external control devices. The choice of communication mode needs us to consider the economy and transmission distance.

The economy is to consider the construction cost and the workload of site construction, consider the comprehensive economic benefits of communication network construction and the cost of operation and maintenance in operation and maintenance.

And the transmission distance is to consider the geographical and geomorphological environment of the region, and the existing communication environment.

Memory module: It includes ROM (read-only memory) and RAM (random access memory). ROM is used for the storage system and its internal parameters are immutable. The storage contents of RAM can be changed by the user, such as the setting value of the oil filter time and the control of oil speed.

Power supply module: The power module of the control cabinet provides the required power for each module. It converts ac power to dc output through the rectifier circuit of the power supply board and the stabilized chip. And it transforms these voltages and supplies them to each concentrator module. In addition, the system designed the lithium battery as a backup power to power the external power failure.
CONTROL CABINET OPERATING PRINCIPLE

Figure 2. Main interface of automatic oil filtration control system for multi tank.

As shown in Figure 2, the user can observe in the monitoring interface to the real-time state of oil filter system works such as: manual/automatic state of oil filter, valve state, oil temperature, inverted tank filter oil times, remaining time, instantaneous flow, cumulative flow, date and time etc. In addition, the main interface has the start and stop button as well as the button entering the parameter setting interface. The system configuration software is adapted for use in environments from double tank to multi-tank.

Figure 3. Automatic filter system control system parameter settings interface.

As shown in Figure 3, clicking the button on the monitoring operation interface to enter the "parameter setting" window, you can set the flow rate hysteresis, flow rate limit, delay time, inverted tank filter oil start sequence, inverted tank filter oil time setting and so on. The delay time represents the length of the settling time required from the trigger threshold to the state switch. The inverted tank filter oil start sequence is used to initialize the valve position for resetting. And the inverted tank filter oil time setting is used to set the time for the oil filter.
As shown in Figure 4, when the control cabinet begins to perform, it is judged first whether to manually control the oil filter or automatically control the oil filter. If choosing manually controlling the oil filter, we can use a control button to select the valve opening and closing and control the process of oil filter according to the current state of the filter. And if choosing automatically controlling the oil filter, we need to set the flow and time of this filter, then filter oil in set time, and finish the filter when the time is over.

CONCLUSIONS

This paper introduces the control cabinet for the control of the high pressure transformer oil filter, which is mainly used to solve the shortcomings of the large amount of human labor in the process of inverted tank filter oil, the time taken to filter oil, and the difficulty of controlling the oil temperature. This paper introduces the overall structure of the control cabinet, the internal function modules and the working principle of the control cabinet. The control cabinet simplifies the operation of the transformer oil filter, saves the labor force, realizes the transformer oil filter automation, and improves the efficiency of the oil filter. And it has a broad application prospect.

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