The research of full automatic oil filtering control technology of high voltage insulating oil

Gangjun Gong\textsuperscript{1,}\textsuperscript{a)}, Tong Zhang\textsuperscript{1,}\textsuperscript{b)}, Guozeng Yan\textsuperscript{2,}\textsuperscript{c)}, Han Zhang\textsuperscript{1,}\textsuperscript{d)}, Zhimin Chen\textsuperscript{1,}\textsuperscript{e)}, Chang Su\textsuperscript{1,}\textsuperscript{f})

\textsuperscript{1} Beijing Engineering Research Center of Energy Electric Power Information Security, North China Electric Power University, Beijing 102206, China.

\textsuperscript{2} AC Engineering Construction Company of State Grid Corporation of China, 100052, China.

E-mail: \textsuperscript{a)} gonggangjun@126.com, \textsuperscript{b)} Corresponding author: Jocany@126.com, \textsuperscript{c)} 2686952245@qq.com, \textsuperscript{d)} 280170073@qq.com, \textsuperscript{e)} 18010052640@163.com, \textsuperscript{f)} suchang@ncepu.edu.cn

\textbf{Abstract.} In this paper, the design scheme of automatic oil filter control system for transformer oil in UHV substation is summarized. The scheme specifically includes the typical double tank filter connection control method of the transformer oil of the UHV substation, which distinguishes the single port and the double port connection structure of the oil tank. Finally, the design scheme of the temperature sensor and respirator is given in detail, and the detailed evaluation and application scenarios are given for reference.

1. Introduction

If the quality of the transformer oil is not up to standard, it will cause partial discharge of insulating oil, and will accelerate the aging process of the transformer insulation, and also directly affect the safe operation of the whole power grid. At present, the transformer oil filter using manual operation, there is a large workload, low efficiency, easy to misuse and other deficiencies. With the development of UHV project, it is urgent to study a fully automatic oil filter control system for transformer oil to meet the requirement of UHV engineering.

2. Overall Design of Double Tank Oil Filtering System

The double tank oil filtering system consists of oil tank, empty tank, respirator, two-position three-way solenoid valve, flow sensor, temperature sensor, oil filter, sub controller, and condition monitoring and control module. The instantaneous flow monitoring of the transformer oil in the process, and the instantaneous flow as the switching criterion, while monitoring the total flow and the total flow as protection criterion, the formation of double control criterion, the double protection function, improve the stability and safety of the system. According to the different connection schemes of oil tank, the system is divided into single interface connection and dual interface connection scheme.

2.1 Single Interface Connection Scheme

The single interface connection scheme is shown in Fig.1. Only through the bottom of an oil tank is connected with the interface of oil pipeline, and add the ‘T’ type of mouth fittings, which are respectively connected with the two two-position three-way solenoid valves, two-position three-way
solenoid valve is connected with the oil filter, through state monitoring and control module of flow, temperature and other parameters of the real-time monitoring, and as a criterion control valve position switch, complete the work cycle of oil filter. Through the bottom interface as the oil outlet and the oil inlet, the process of oil filling and oil extraction is completed. A single interface reduces the oil tank and the external environment contact interface, while the installation of respirator in the tank, filter the air of impurities such as water, is conducive to maintaining tank sealing, enhanced tank sealing effect, ensure the quality of transformer oil.

During refueling, when the oil tank is filled to a certain amount, the oil gravity creates a reverse pressure on the oil in the oil inlet pipe, as shown in Fig. 2. Therefore, the power requirement of the oil filter is higher, the overall adaptability of the system is reduced, and the energy consumption is larger. For the high power oil filter in the field, the automatic oil filtration system with single interface connection can be considered.

2.2 Dual Interface Connection Scheme
In order to enhance the adaptability of the system, the project proposed a double interface connection, as shown in Fig. 3. Make the bottom interface of tank as an oil outlet, and the top interface of tank as an oil inlet, connecting pipeline respectively and connected with the two and two-position three-way solenoid valve, and then the two position three way solenoid valve and oil filter is connected through the switch valve, complete cycle oil filter work. Thus, the problem that the power requirement of the oil filter machine is higher in the single pipe connection scheme is solved. Application of double interface connection, can use the function of transformer oil gravity, transformer oil tank in the auxiliary injection and extraction, the liberation of the requirements on power oil filter system to
reduce energy consumption, improve the overall adaptability of automatic oil filtering system, is conducive to the promotion of the system.

3. Scheme Design of Cluster Oil Filtering System
The design scheme of cluster filter oil is promoted by double tank scheme. It also consists of oil tank, empty tank, respirator, two-position three-way solenoid valve, flow sensor, temperature sensor, oil filter, sub controller, and condition monitoring and control module. The instantaneous flow monitoring of the transformer oil in the process, and the instantaneous flow as the switching criterion, while monitoring the total flow and total flow as a standby switch optional criterion, the formation of double control criterion, the double protection function, improve the stability and safety of the system. According to different oil tank connection schemes, the cluster oil filter design scheme is divided into single interface connection and double interface connection scheme.

3.1 Single Interface Connection Scheme
Cluster type oil filter design scheme of single interface connection scheme is the addition of one-way solenoid valve for each tank except No. 0 empty tank based on double tank scheme, solenoid valve opening and closing state controlled by the module control, each only allowed a single solenoid valve is open. As shown in Fig. 4. The principle, advantages and disadvantages are same as that of double tank, so no longer details.
3.2 Dual Interface Connection Scheme
Cluster type oil filter design scheme of dual interface connection scheme is the addition of one-way solenoid valve for each tank except No. 0 empty tank based on double tank scheme, solenoid valve opening and closing state controlled by the module control, each only allowed two one-way solenoid valve belongs to the same tank a single solenoid valve is open. As shown in Fig. 5. The principle, advantages and disadvantages are same as that of double tank, please refer to double tank as they are similar.

4. Design Scheme of Temperature Sensor
In order to improve the applicability of the system, the temperature sensor is converted into a stud, and a set of special hardware fittings are designed for the temperature sensor, as shown in Fig. 6. The sensor is fixed on the upper fixed with bolts and fittings, and other means to keep the whole sealing fittings, probe into the internal pipeline, to monitor the temperature of the liquid flowing through the flange fittings, access filter oil pipeline. This design avoids the installation of the temperature sensor in field drilling package, saving construction time, and avoid the potential fire risks and other issues caused by uncontrollable error of site construction, drilling result. If the probe fails, it can be replaced with the whole metal fittings, and the probe can be replaced independently. The flexible workpiece is flexible and convenient to use and has good applicability.
5. Design Scheme of Respirator

There are two kinds of breathing apparatus design in this system: centralized scheme and split scheme. Centralized breathing apparatus is designed to be relatively cost effective, and if the respirator is damaged, all tanks will be affected, so the risk is more concentrated. But because of the low number of respirators used in centralized design, the failure rate is relatively low. As shown in Fig. 7.

![Figure 6. Schematic diagram of temperature sensor and fittings](image)

![Figure 7. Design scheme of centralized respirator](image)
The design of split breathing apparatus is more expensive, and each oil tank respirator is exclusive. It can maximize the risk caused by respiratory failure and enhance the reliability of the system. However, due to the larger number of ventilators used, the rate of failure is higher in theory than in the centralized scheme. As shown in Fig. 8.

6. Conclusion
In this paper, we summarized the related control technology of transformer oil automatic oil filtration system and the connection way of different requirements. The application scenarios and advantages and disadvantages of various schemes are analyzed in detail. It is important to improve the transformer oil automatic oil filter system.

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