

# *Design and Application of Intelligent Pressure and Liquid Level Gauge in Capsule Oil Conservator*

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**Abstract:** Oil conservator is an important component of transformer assembly. Its function is to compensate the volume expansion or contraction of insulating oil due to temperature change and ensure that the body of oil filled equipment is always filled with oil. Capsule oil conservator is a sealed capsule that can bear high pressure installed in the oil conservator. The insulating oil is separated from the outside air through the capsule, and the water vapor is prevented from entering the capsule through the moisture absorber. During operation, the capsule is in the oil, and inhale or exhaust as the oil level rises or falls, so as to automatically balance the pressure inside and outside the capsule and ensure that the transformer body is always filled with insulating oil. The normal operation of capsule oil conservator can provide safety guarantee for transformer operation. With the increasing consumption of capsule oil conservator, customers often react that the actual oil level of capsule oil conservator is inconsistent with the pointer, resulting in the phenomenon of false oil level. In this paper, the intelligent pressure level gauge is successfully applied to the oil conservator and verified by simulation operation, which effectively solves the problem of false oil level.

## **1. Introduction**

For oil immersed transformer, the temperature of transformer oil will cause corresponding volume change due to the change of load, transformer access or removal of cooling device, temperature difference between day and night, sunlight exposure and the change of cooling water temperature in condenser. The volume of oil will increase with the increase of temperature and decrease with the decrease of temperature. Therefore, the oil level of transformer is always changing. Firstly, in order to ensure the internal pressure balance and safe operation of the transformer, an oil conservator is set at the top of the oil tank to prevent the transformer oil from damaging the transformer oil tank due to the internal pressure caused by the increase of temperature and volume. Due to the decrease of temperature, the volume of transformer oil is reduced, the oil level is reduced, the transformer body is short of oil, the leads and coils are exposed, and the electrical strength is reduced. Secondly, the setting of oil conservator also takes into account the decrease of oil level caused by weld cracking, aging of sealing surface rubber strip or poor sealing and leakage of components during long-term operation of the transformer. When the oil level decreases, the transformer oil can be supplemented in time, so as not to cause transformer failure

and affect safe operation in a short time. Third, Effect of high voltage products on gas in transformer oil (oxygen and moisture) requirements are high. There should be no or only a small amount of gas as far as possible. Keeping the oil level in the oil conservator at a certain height can reduce the contact area between transformer oil and air. With the increase of transformer voltage, it is particularly important to isolate transformer oil from air to prevent oxygen and moisture from entering transformer oil and reduce the insulation strength and aging of transformer oil Change. Therefore, the existing oil immersed transformers are equipped with oil storage devices. Oil conservator is one of the important protection components of oil immersed transformer. Its main purpose is to ensure the free change of transformer oil volume, reduce the contact area between transformer oil surface and air to the minimum, slow down the aging of transformer oil, and then undertake the function of immediate oil replenishment due to the reduction of oil level due to different reasons. Due to the structure of the transformer, it is difficult to control the entry of gas during the installation of components such as oil conservator and oil level gauge, so that a certain amount of air is dissolved in the transformer oil, so that the oxygen in the air will promote the aging of transformer oil and fiber materials soaked in oil. When the fiber material is hydrolyzed, the cellulose bond breaks, which destroys the cellulose material in the oil, accelerates the aging of the insulation, and reduces the service life of the transformer. Therefore, the oxygen content in transformer oil shall be reduced as much as possible, and the vacuum after installation or other gas shall be added during installation and manufacturing.

## 2. Capsule Oil Conservator Structure

The capsule oil conservator has a capsule inside to adjust the change of oil volume. The principle is the same as that of the metal expansion oil conservator. Due to the use of the capsule, its cost is low, which is 1 / 5 of the cost of the metal expansion oil conservator. Its appearance is a sealed container with simple structure<sup>[1]</sup>. When the capsule breaks, it only needs to be replaced from the top. It is easy to install and maintain, which is convenient for users to maintain by themselves, Loved by the majority of users and used more. With the increase of the amount of capsule oil conservator, it is often reflected from the user that the actual oil level of the capsule oil conservator is inconsistent with the indication of the oil level gauge. For example, the oil level indication meets the normal operation of the transformer, but it is found that the oil in the oil conservator is insufficient from the relay observation window, resulting in the false oil level of the oil conservator. If this phenomenon is not found in time, it will lead to the lack of oil in the transformer, Serious will cause transformer power failure.

In order to clarify this problem, we have investigated the site and visited users for many times, and mastered the first-hand data. Firstly, analyze the structure of the oil conservator to see if the oil level is inaccurate due to structural defects<sup>[2]</sup>. A capsule is added to the inner wall of the capsule oil conservator. The capsule is connected with the atmosphere through the connecting pipe through the moisture absorber. The bottom surface of the capsule floats closely on the internal oil surface. When the oil surface changes with the temperature, the capsule also compresses and expands to play the role of breathing. In order to accurately indicate the oil level of the oil conservator, the oil level gauge is designed with a float floating on the oil surface. When the oil level changes, the float swings up and down to drive the connecting rod rotating mechanism to display on the panel. The oil level gauge is equipped with the highest and lowest oil level alarm devices. When the oil level is too high or below a specified value, the alarm can be transmitted remotely through the data line, Easy to observe and control. Structurally, the oil level gauge is designed according to a very common principle, and the rotating mechanism is manufactured by a professional manufacturer. There are no defects in the design and manufacture of the oil level gauge, and there are no problems

in the structural design of the capsule. It is necessary to analyze the causes of the problems from other aspects<sup>[3]</sup>. Through the inquiry of oil conservator data at home and abroad, no special place is found, but the shape of oil conservator capsule is different. The problem of inaccurate oil level indication of metal expansion oil conservator is less reflected. Why? Then it analyzes the working principle and refueling process of the metal expansion conservator. Although the metal expansion conservator has two kinds of internal oil and external oil, and their structures are different, the oiling process is the same.

### 3. Research on the Problem of False Oil Level

Is the inaccurate indication of the oil level gauge related to the refueling process of the capsule conservator? Through the understanding of the workers' on-site operation process, almost all refuel the oil conservator according to one method, that is, open the exhaust plug on the upper part of the oil conservator, fill oil from the bottom of the transformer or from the oil filling pipe of the oil conservator<sup>[4]</sup>. After the oil filling level is higher than the indication of the oil level gauge, close the exhaust plug, and then drain the oil to the scale indicated by the oil level gauge. By analyzing the above operation process and structure, making a comprehensive and systematic research on the oil conservator, the deeper causes of inaccurate oil level gauge are found out, and it is preliminarily determined that the main causes of inaccurate oil level in the oil conservator are as follows. 1) From the design point of view, the design size of the capsule diameter of the oil conservator is larger than the inner diameter of the cabinet wall, causing the wrinkled part of the capsule to press the float below the oil level, resulting in inaccurate indication of the oil level gauge and unable to reflect the actual oil level. During the installation process, the inner wall of the oil storage tank is not cleaned, foreign matters jam the rotating mechanism of the oil level gauge, and the rotating mechanism fails. When the oil level is insufficient or high, the pointer does not change, resulting in false oil level<sup>[5]</sup>. 2) The volume design of oil conservator is unreasonable, and the volume of oil conservator is not designed strictly according to the expansion coefficient of transformer oil, resulting in high oil level in summer, increased oil volume overflowing the oil conservator, low temperature in winter, reduced transformer oil volume and reduced oil level, and the oil in the oil conservator returns to the oil tank, resulting in no oil in the oil conservator and displaying oil shortage alarm, which should be started from the design point of view, Ensure that the volume of the oil conservator does not overflow when the temperature is the highest and can meet the normal oil level display of the transformer when the temperature is the lowest, so as to ensure the normal operation of the transformer<sup>[6]</sup>. 3) When filling oil, the air in the oil conservator must be removed. After the oil is discharged from the vent plug on the top of the oil conservator, close the vent plug to make the capsule and the cabinet wall in a vacuum state, and then drain the oil to the oil level indication scale, so as to ensure that the oil level accurately indicates the oil level<sup>[7]</sup>.

### 4. Characteristics of New Pressure Type Liquid Level Gauge

Through a lot of investigation and research, the causes of false oil level are found out. To solve these problems, the author adds an intelligent pressure level gauge at the oil injection and discharge port of the oil conservator. The transformer oil in the oil conservator changes with the temperature, which causes the change of oil quantity, and then affects the change of pressure in the oil conservator. The pressure type liquid level gauge can be used to measure the liquid level, density and pressure of liquid, gas or steam, and then convert it into 4 ~ 20mA DC current signal output. It can also communicate with handheld terminal or rsm100modem for parameter setting, process monitoring, etc. Connect the 4 ~ 20mA DC current signal of the pressure and liquid level gauge to the single circuit digital display instrument, the display instrument can realize remote display, and

set parameters to convert the oil level in the oil conservator into digital 0 ~ 10 display. At the same time, high and low oil alarm signal output can be set and connected to the RS-485 data transmission interface of the computer.

## 5. Advantages of New Pressure Type Liquid Level Gauge

(1) Accurately reflect the oil level of the oil conservator. The new pressure type liquid level gauge detects the change of the internal pressure of the oil conservator and will not be affected by the folding of the capsule to wrap the float of the mechanical oil level gauge, so as to avoid inaccurate indication of the mechanical oil level gauge. (2) It has the characteristics of remote monitoring. The digital display instrument can realize the digital observation in the central control room, which is convenient and intuitive. At the same time, it is set with high and low oil level alarm, which can find the oil level problem of the oil conservator in time. (3) It has the function of communication network. It can be connected to the computer through RS-485 data transmission interface to realize the remote control of the computer<sup>[8]</sup>.

## 6. Conclusion

Through simulation operation, it is proved that the new intelligent pressure level gauge can truly reflect the oil level change in the oil conservator during transformer operation. In this way, the problem of false oil level is avoided and the safety of transformer operation is improved.

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