USING THE MEMBRANE/BAG RELAY - MBR

APPLICATION NOTE

Treetech

Using the membrane/bag relay - MBR

1. Introduction:

Power transformers and reactors are equipment widely used in medium, high and extra high voltage power generation, transmission and distribution systems. These assets often use some type of oil as an insulating and heat transfer medium, which may be mineral (petroleum derived), vegetable, silicone based or others.

Commonly, the windings of transformers and reactors use copper conductors wrapped with paper for insulation. The whole set is kept immersed in insulating oil during equipment operation.

Excessive water and / or oxygen in the insulating oil of these equipment has widely known negative effects such as:

- Decreased dielectric strength of insulation due to excessive moisture;
- Migration of water to the paper used for winding insulation, which increases the risk of bubble formation and accelerated degradation of the mechanical properties of the paper in the presence of high temperatures;
- Degradation of the mechanical properties of paper due to reactions between oxygen and cellulose fibers.

These factors acting individually or together endanger the lifespan and integrity of the equipment. A degraded insulation increases the risk of internal short circuits and the risk of winding deformation due to forces caused by external short circuits.

To avoid those risks, power transformers and reactors are usually equipped with a sealing system to prevent contact between ambient air and insulating oil, in order to avoid mixing moisture and oxygen with oil. These equipment undergo a large temperature variation causing oil to expand and contract, consequently resulting in large variations in oil level. The sealing system is often made up of a flexible rubber

membrane or bag to allow the oil level to vary freely without causing pressure or vacuum inside the equipment's tank.

This sealing system is illustrated in Figure 1, which shows a transformer or reactor composed of a main tank (1), inside of which are housed the magnetic core (2) and the windings (3). The main tank (1) is connected to the expansion tank (4) through the interconnection piping (5), and the whole assembly is filled with insulating oil (6). The rubber membrane (7) is installed inside the expansion tank (4), moving (7A and 7B) according to the oil level (6). The upper part of the rubber membrane (7) is in contact with atmospheric air through the air tubing (8) and the air dehumidifying device (9). On the upper part of the rubber membrane (7) rests a wheel or roller (10) which is coupled via a rod (11) to an oil level indicator (12).

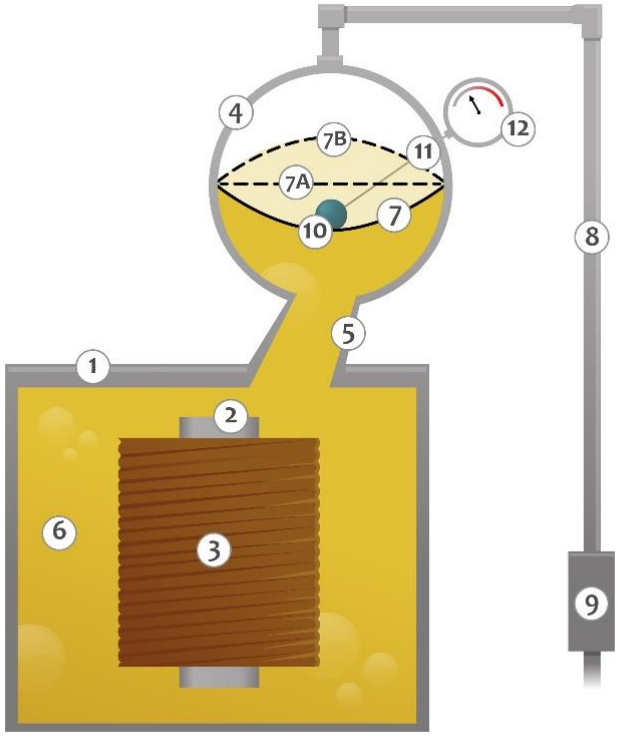

Figure 1 - Membrane sealing system

A second sealing system is shown in Figure 2 using a rubber bag instead of a membrane. This figure shows the expansion tank (1), the rubber bag (2) is installed inside, which has its upper opening connected to the air tubing (3), in order to avoid oil contact (4) with the atmospheric air. As the oil level (6) rises and falls, the rubber bag (2) collapses or extends. At the bottom of the rubber bag (2) there is a float (5) which is coupled via a rod (6) to an oil level indicator (7).

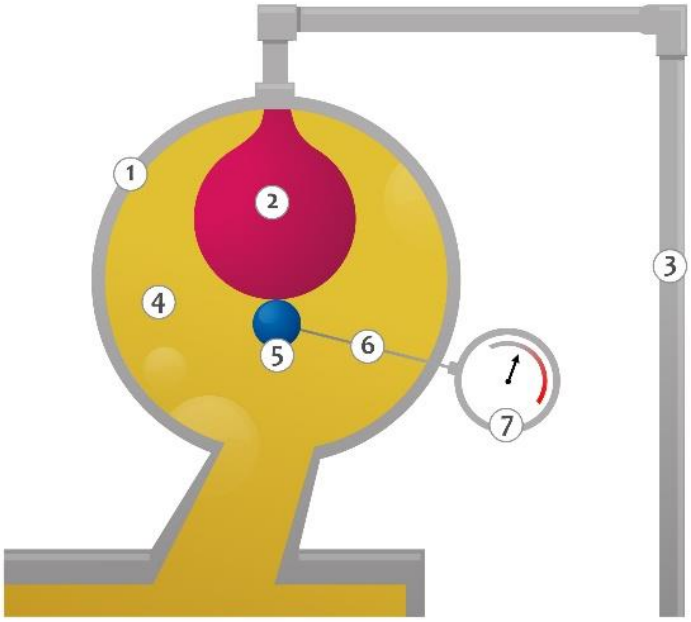

Figure 2 - Bag sealing system

As noted at description above, the perfect sealing of the transformer or reactor depends on the condition of the rubber membrane or bag. Leaks in the membrane / bag will allow contamination of insulating oil through contact between oil and air. Oxygen and moisture will endanger the integrity of the high voltage equipment.

Traditionally, rubber membrane or bag leaks are detected through the oil level indicator. The oil level indicator tends to indicate a lower oil level than found in the transformer or reactor due to membrane or bag sinking. This allows the low-level alarm contact to be activated on the oil level indicator, indirectly signaling leakage in the membrane or bag. However, this detection technique has some disadvantages, namely:

- Membrane or bag may not sink completely as expected due, for example, to rubber stiffening as it ages. In this case, membrane or bag leaks may go unnoticed for long periods, with serious consequences for the life of the transformer or reactor;
- Even if the membrane or bag sinks and the low oil level alarm is triggered, there may be doubt whether the alarm refers to a problem with the oil level or if the alarm is due to membrane or bag leakage;
- Some level indicators are not installed below the bag and some manufacturers fix the bag in certain ways that restricts the movement of the bag.

Another installation option for possible bag abnormality detection is the use of a Buchholz relay installed on top of the expansion tank to detect air bubbles in the transformer/reactor oil. The use of this device is specific to bags, it is not possible to use in case of membranes. The main feature of this type of device is the accumulation of gas inside the relay, so this device mainly depends on the point of bag failure, as not all rupture points of the bag let air out of the bag migrate to the relay / tank. The most common is that the oil migrates into the bag and the air is restricted inside it.

Despite its possible benefit, this type of device has some peculiarities in diagnosis and operation, as it cannot be operated without a vacuum or pressure pump, since opening its breather will allow air to enter the expansion tank. In new transformers it is still possible that air / transport / fill gas may be trapped at some points in the equipment, so some improper alarms may occur within a few months of operation. Shall this occur, a shutdown will be required to check the integrity of the bag and to re-commission the relay with a vacuum or pressure pump.

That being said, such equipment is not specifically developed to monitor the condition of the membrane / bag, since it may enable improper alarms and bring a difficulty of operation.

2. Monitoring of membrane or bag condition

The Membrane / Bag Relay - MBR is a system for detection of leakage in the membrane or rubber bag of the expansion tank of power transformers, reactors and other similar equipment. This system is based on a sensor that is properly installed on the membrane or inside the expansion tank's rubber bag. This sensor is connected to a control module installed inside the transformer / reactor control panel, giving alarms in case of membrane or bag rupture.

Using this sensor has the following advantages:

- Ensures that any leakage problems in the expansion tank membrane or rubber bag will always be indicated, avoiding dependence on rubber flexibility (as is with the traditional detection method);
- Provides an immediate indication of leakage in the expansion tank rubber membrane or bag, avoiding detection delays that may occur with the traditional method, caused by the membrane or bag slow sinking in the conservator;
- When the alarm is activated permanently, it provides an unambiguous indication of membrane or bag leakage, avoiding doubt as to the true nature of the problem (membrane / bag leak or low oil level in equipment);
- The membrane relay may still have an additional gain by identifying a possible moisture ingress inside the dry membrane / bag portion. In this case the MBR will possibly indicate intermittent alarms due to condensation and moisture evaporation caused by variations in the working temperatures of the monitored equipment. Condensation of water inside the bag may pose a risk to the equipment, since this water would migrate directly to the oil and paper in the event of a bag failure.

3. Installation in rubber membrane based systems

Figure 3 illustrates the application of the Membrane Relay with a rubber membrane based sealing system. In this figure we can see the MBR sensor (1) located on the upper part of the rubber membrane (2). The sensor (1) is connected to the control module (3), installed on the transformer control panel (4), through a cable (5). The wiring of the cable (5) from the interior of the expansion tank (6) to the outside is generally accomplished by means of a junction box (7) to maintain the sealing of the expansion tank (6). This junction box is not supplied with the MBR, as its physical construction will depend on the construction of the conservative tank.

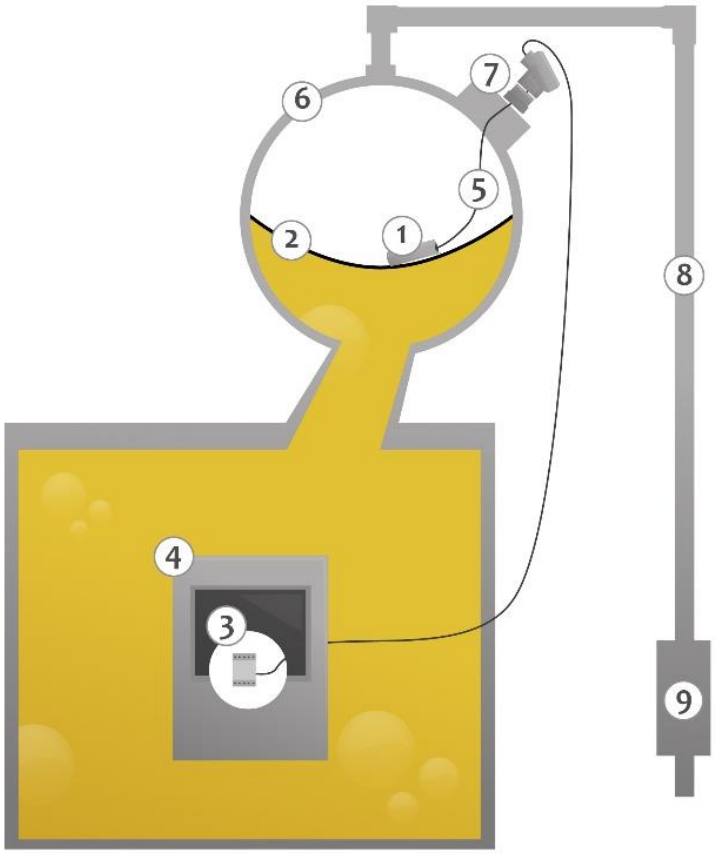

Figure 3 – MBR relay application with a membrane based system

4. Installation in rubber bag based systems

Figure 4 illustrates the application of the Membrane Relay with a rubber bag based sealing system. In this figure we can see the sensor (1) located inside the rubber bag (2). The sensor (1) is connected to the control module (3), installed on the transformer control panel (4), through a cable (5). The cable (5) path from the inside of the bag (2) to the outside is made by means of a junction box (7), located at the beginning of the air tubing (8), in order to maintain the sealing of the expansion tank (6) and the bag (2). This junction box is not supplied with the MBR, as its physical construction will depend on the construction of the conservator tank.

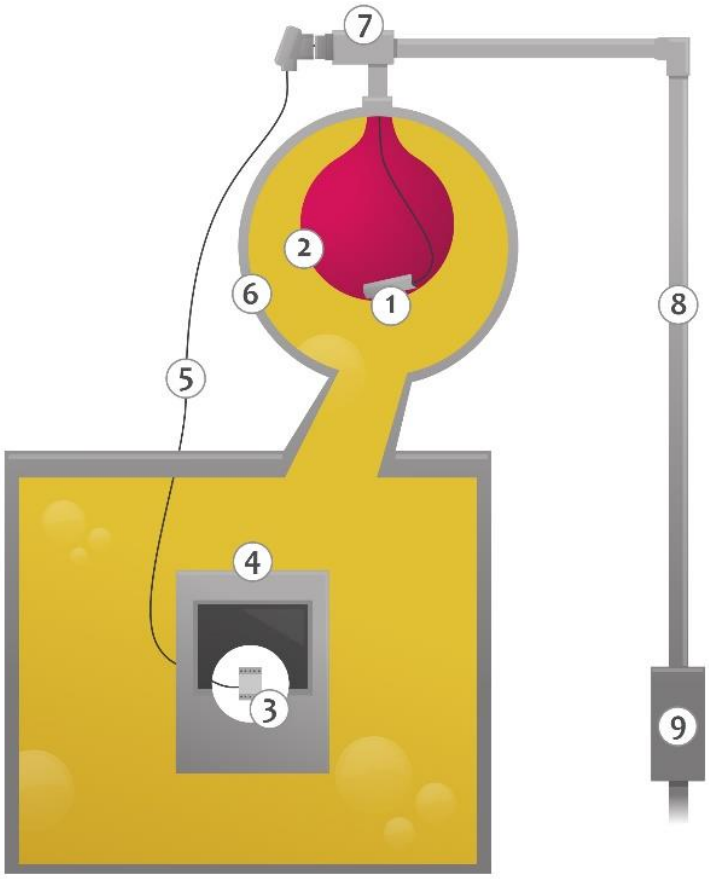

Figure 4 - MBR relay application with a rubber bag based system

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