

Absorbent Water Battery set up in the Vat of Oil Transformers

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Abstract--At oil transformer coils made by paper insulation, the present of water in paper lead to insulation demotion and electric faults. In the vat of transformers, at ambient temperature, the water migrates from oil in the isolation paper. The water in paper is distributed uniformly.

At present times, for extracting the water from the isolate paper of coils conductors, with transformers in function, most used method consist in heating oil at 60-70 Celsius degrees, and after, when the water migrate from paper in oil, treating the oil to extract the water online in special installation outside the transformers. But, heating the oil at 60-70 Celsius degrees means to heat also the conductor's isolation with the possibility to deteriorate the paper qualities.

One solution for this problem could be to set up an absorbent water battery in the vat of transformers. So, the water inside the transformer will migrate in papers insulation coils but also in the absorbent water battery. If the quantity of coils paper is equal with the quantity on paper of battery, only 1/2 of water will migrate in paper insulation coils.

Index Terms--absorbent battery, insulation, paper, transformer, water

I. INTRODUCTION

In the vat of transformers, at ambient temperature, the water migrates from oil in the isolation paper. The water in paper is distribute uniformly. If we take a paper (Fig. 1) and put some water, we will see that in a short time, the water will be uniformly distribute in all paper. (Fig. 1 and Fig. 2).



Fig. 1. Dry paper

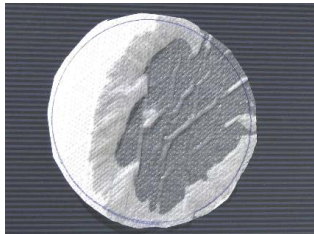


Fig. 2. Water migration in paper

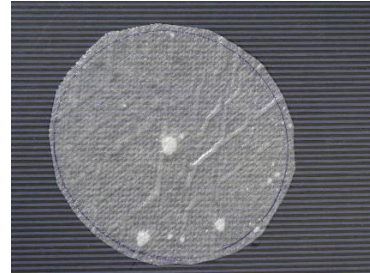


Fig. 3. Complete water migration in paper

If in other industrial applications, this quality of paper to absorb water is usfull, in transformers, the water in paper conductors insulation leads to weak the electric insulation with possibility of coils faults.

Because of this phenomenon, when is made a transformer, in the last step, the coils (Fig. 4) are dry in special oven to extract water from coils paper insulation.



Fig. 4. Coils of transformer

Also, the oil use for electric insulation of transformer, must contain minimum of water.

II. CLASSICAL SOLUTIONS TO EXTRACT WATER FROM COILS PAPER INSULATION AT TRANSFORMERS IN USE

In function, in time, in the oil of transformer appear water from outside. At ambient temperature, the water migrate from oil into the coils insulation paper.

At the present time, for extracting the water from the insulate paper of coils conductors, with transformers in function, most used method consist in heating oil at 60-70 Celsius degrees, and after, when the water migrate from paper in oil, treating the oil to extract the water online in special installation outside the transformers. But, heating the oil at 60-70 Celsius degrees means to heat also the conductor's isolation with the possibility to deteriorate the paper qualities.



Fig. 5. Coil with demotion insulated paper

In function, many times, because of external electric faults, in transformers, the temperature is high, more than 70 Celsius degrees. At this temperature, the paper demotion and his electric insulation become weak. (See Fig. 5)

Another method is to heat only the coils at 60-70 Celsius degrees to eliminate the water from paper into oil. But, also, this method goes to demotion the paper at high temperature.

The vacuum method use to extract water from paper presume special technology and big forces work on coils and vat.

III. ABSORBENT WATER BATTERY SET UP IN THE VAT OF OIL TRANSFORMERS

The principal target for oil transformers is to limit the quantity of water in coils insulated paper.

In a transformer, it is a quantity of paper Q_p and a quantity of water Q_w . The paper is use only for insulation of conductors and coils. So, the quantity of water Q_w goes uniformly only into electric insulation paper of coils Q_p .

If inside the transformer we put another quantity of paper Q_p and the total quantity of paper will be $2Q_p$, the same quantity of water Q_w goes in quantity of $1/2Q_w$ in paper coils and $1/2Q_w$ in suplimentary paper.

So, using this method, the quantity of water inside the paper coils Q_w is reduce with 50% in transformer use.

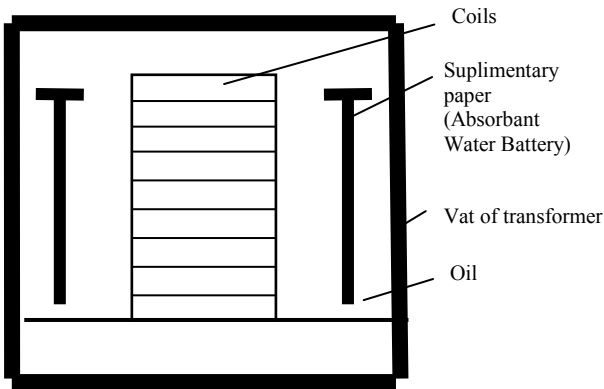


Fig. 6. Suplimentary paper put inside the vat of transformer

The Absorbant Water Battery is made by insulated paper set up on carton cylinders. (See Fig. 7). The choice of cylinders shape for battery is necessary for a large surface for paper-oil contact and also to have the oil circulation inside the cylinders for cooling the transformer. The carton cylinders must have many orifices to assure a good contact oil-paper.

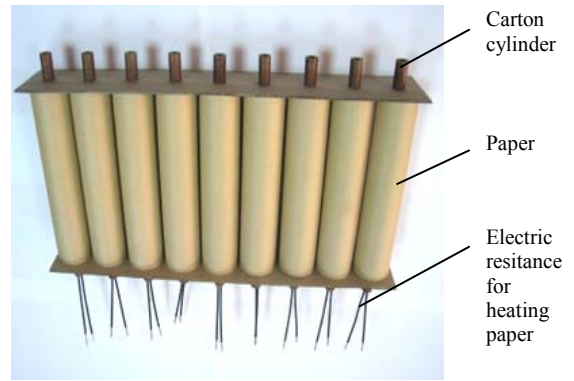


Fig. 7 - Absorbant Water Battery

For heating paper, time to time, it is use an electric resistance to extract the water from battery.

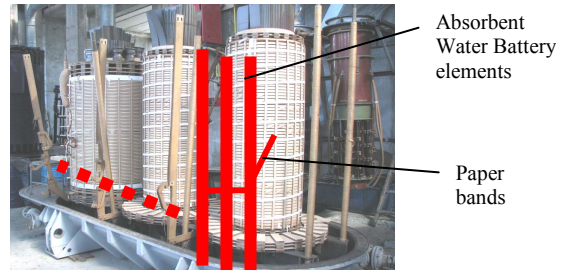


Fig. 8. - Transformer with Absorbant Water Battery

The Absorbant Water Battery is set up nearby the vat of transformer. (See Fig. 8). Because it is necessary a large quantity of paper, the battery it is made by many elements who surround the vat of transformer. To assure an uniformly water distribution between the paper of battery and coil insulation, the battery is conected at coils by paper bands.

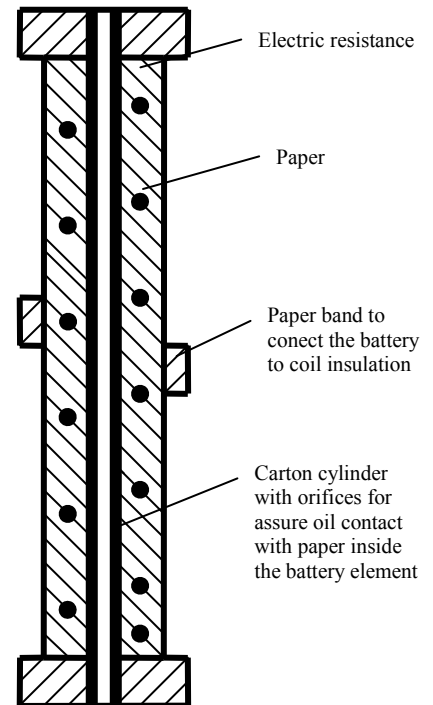


Fig. 9. Battery element

After a time of transformer function, the quantity of water increase inside the vat of transformer. So, to extract the water, is heating at 60-70 Celsius degrees only the battery. In this way, it is protect the paper insulation of coils by heating it at high temperature.

The steps to extract the water from the vat of transformer are:

1. Heat the battery at 60-70 Celsius degrees to migrate water from the battery paper in oil
2. Treat online the oil who contain the water extract from the battery
3. Stop the heating of battery and the oil treatment
4. Wait a time need to migrate the water from the conductor paper in the battery by paper bands (The water in paper is distributed in uniform way)
5. Start again the process with step 1. The number of steps will be determinate function of the water contain in the transformer.

Avoid heating the coils paper, and extract the water by battery way, the paper insulastion of coils remain for a long time without demotion.

The Absorbant Water Battery could be easy set up in the vat of new transformers and also set up in the vat of repair transformers.

IV. COSTS OF ABSORBENT WATER BATTERY

For a transformer 110/20kV - 25 MVA, it is necessary for insulation coils about 500 Kg of paper. So, for the Absorbant Water Battery it is necessary minimum the same quantity of 500 Kg paper.

All cost for an Absorbant Water Battery in weigh of 500 Kg it is about 5000 \$.

All cost for a new transformer 110/20kV - 25 MVA on market it is about 500 000 \$.

So, the cost for an Absorbant Water Battery it is about 1 % of the total transformer costs.

V. COMPLEMENTARY TECHNOLOGY SOLUTION FOR USING ABSORBENT WATER BATTERY

The Absorbant Water Battery could be set up in a special box outside and connect by piplines at the vat of transformer. (Fig. 10)

For oil circulation, it is necessary a pump for oil.

This supplementary oil circulation, could be an advantage for cool the oil also in the box of battery.

It is also necessary more space nearby the transformer for battery.

In this techological solution, it is the possibility to change the Absorbant Water Battery with a new battery by stop the oil pump and isolate the battery box.

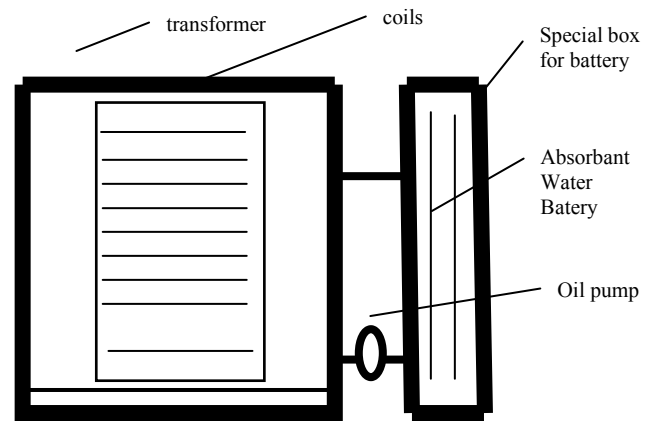


Fig.10 - Transformer connect to Absorbant Water Battery Box

The battery could be made without electric resistance.

Another inconvenience of this solution is that between the battery and the paper coil it is no possibility to connect them by paper bands.

VI. CONCLUSION

1. The Absorbant Water Battery set up in the Vat of Oil Transformers it is a new solution to avoid the water to migrate all in the insulation coils paper.
2. By extract the water only from the Absorbant Water Battery, it is protect the insulation paper of coils.
3. The Absorbant Water Battery could be easy set up in the vat of new transformers and also set up in the vat of repair transformers.
4. The cost for an Absorbant Water Battery it is about 1 % of the total transformer costs

REFERENCES

- [1] Ioan Rusu, "Absorbant Water Battery set up in the Vat of Oil Transformers", *Romanian Patent Office, Deposit f 2007 0597*, 2007