Comparison of Spacefactor, Capacitance value and Impregnated Temperature in MPP Oil Impregnated Polypropylene Film A C Capacitors

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***Abstract*-**The MPP finished capacitors may be of dry type or oil type. This paper represents the testing and analysis of the impregnated oil MPP capacitors. The different dielectric oil is used to impregnate these capacitors. The palm oil, Olive oil, and sunflower oil are the three different dielectric liquids which are used as impregnated fluid. The electrical properties of all the oils are tested according to the liquid insulation standards. The capacitor considered for the test is a MPP capacitor single element and its value is 2.0µF/400V. The capacitor to be tested was impregnated at different temperature levels. From the test results, it is found that dielectric oil type, the treated temperature level and space factor affected to the value of capacitance.

***Keywords*—metalized polypropylene, space factor, dielectric liquids, capacitance value.**

I.INRODUCTION

The MPP film is very much suitable for the construction of oil impregnated capacitors. Paper film, pp film aluminium, pp film-zinc and paper-zinc are the different combinations which were used in oil impregnated capacitors. This combination of capacitor elements impregnated using oil treatment chamber machines at different value of temperature.

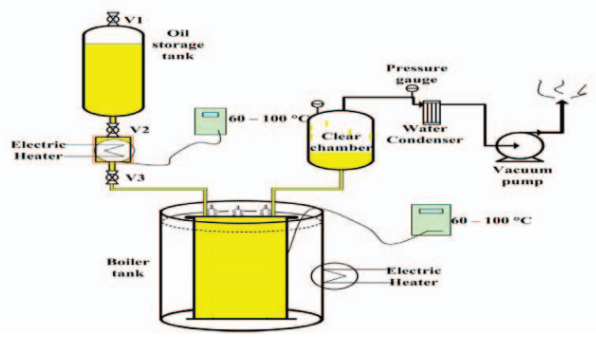

Fig. 1: Imprgnating plant

Impregnation plant shown in Fig.1 is used to fill the oil into the capacitors. The capacitor to be impregnated is loaded in the boiler tank. In mass production more capacitors are dumped in the boiler tank or impregnated chamber. Vacuum is created in the boiler tank and temperature is raised to a required value of temperature. From the theoretical point of view, the impregnation process must be done just through free ideal space, which cannot be accessible in reality. Therefore vacuum is created by two stage vacuum pumps and less than 0.15 torr specific vacuum pressure was created. Oil under high pressure and temperature flows into the capacitor tank or container and now capacitor element is fully immersed in oil. The capacitor is completely filled with oil within 2 hours. But capacitors are remains in the tank for 24 hours in the same temperature and vacuum pressure. Thermo meter is used to record the impregnated temperature. Temperature of whole process is controlled manually. Impregnation plants are available in various capacities. In mass production hundreds of fan capacitors are impregnated at a time. Similarly capacitors are impregnated with other type of oil. As already mentioned three types of oils are used. The model capacitors were impregnated with EnvirotempFR3 fluid, Palm oil and sunflower oil. Time gap of each impregnation process was 24 hours.

II. EXPERIMENTAL WORK

All manufactured capacitors will have plus or minus of some percentage of its original value. The capacitance of test capacitor unit was measured at 30oC. The two capacitor elements were tested and their thickness was about 22 mm and 23 mm. The elements are circular in cross section as shown in Fig. 2.

The space factor is high in loosely wounded capacitor element and thickness of element is more. In our case for the same value of capacitor, one element has 22 mm and other has 23 mm. The space factor is less with 22 mm thickness and its performance is very good. Same is observed from the results that capacitor with 22 mm

thickness element is more satisfied one. And also it is observed from the result that the capacitor element impregnated from Olive oil is most efficient than other capacitor which was impregnated from other two liquid dielectrics.

Fig. 2: Capacitor element ready for oil impregnation

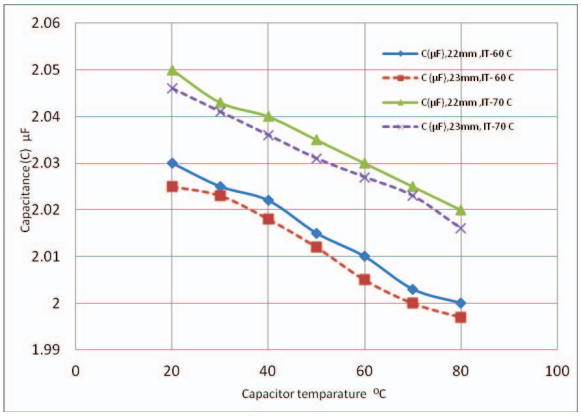

Fig. 3. Capacitor values of a sunflower oil impregnated capacitor

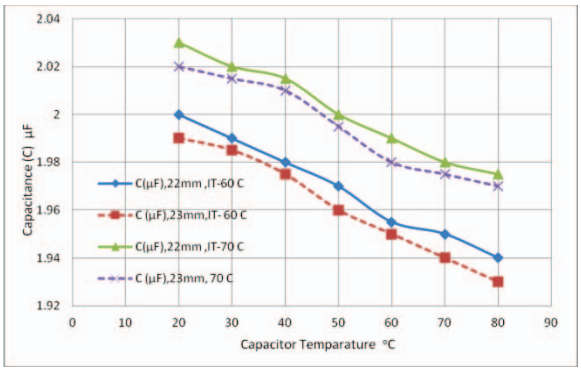

Fig. 4. Capacitor values of a palm oil impregnated capacitor.

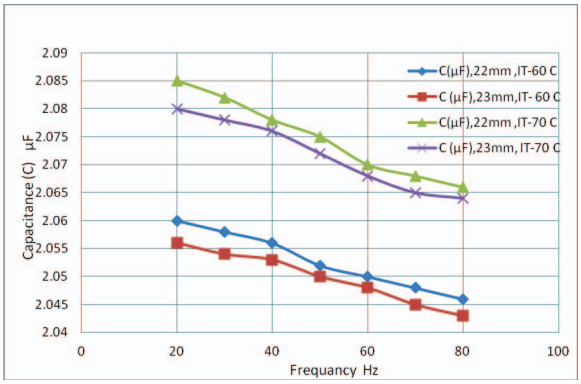

Fig. 5. Capacitor values of an Olive oil impregnated capacitor.

All the capacitors were impregnated with different dielectric liquids of element with 22 mm and 23mm thickness measured at temperature 30°C. Fig. 6.14 shows the variation of capacitance values with increase in capacitor temperature for the sunflower oil impregnated capacitor. Thick line represents capacitor values for capacitor elements of 22 mm thickness and dotted line represents capacitor values for capacitor elements of 23 mm thickness. It was observed that capacitor values decreases with increase in capacitor temperature. Impregnation process was done at a temperature of 60°C and 70°C. So Fig.3 also represents the change in capacitance value for Impregnation temperature (IT) of 60°C and 70°C. It clearly shows that more capacitor value is achieved for impregnation process at 70° C. Capacitor value increases with increase in impregnation temperature but temperature cannot be increased above permissible value.

Similar experiments were conducted on capacitor impregnated with palm oil and Olive oil. Graphs are shown in Fig. 4. and Fig. 5. respectively. It was observed that capacitance values were less in palm impregnated oil capacitor. More values of capacitance are in Olive oil impregnated capacitors. Olive oil impregnated capacitors are more efficient than other two oil impregnated capacitors. For the same value of impregnated temperature more value of capacitance was achieved in Olive oil impregnated capacitor.

From all the graphs, it was observed that values of capacitance of 22 mm thick elements are slightly higher compare to capacitor element with high thickness (23 mm).

The plots of capacitor value versus impregnating temperature of sunflower oil impregnated capacitor are shown in Fig. 6. It was observed that there is increase in capacitance value with increase in impregnating temperature. The capacitance value was not increasing much beyond impregnating temperature of 70 °C. The capacitance value was less in element with more space factor (23mm element) at higher impregnating temperature.

This shows that the element wound (or pressing of element) was not proper. This leads to drastic decrease in capacitance value with high temperature. This also results in high dissipation factor and finally catastrophic failure or results in short life of a capacitor. This was not so severe in low space factor capacitor (22 mm thickness element). The same result was observed in palm impregnated capacitor and Olive oil capacitor the results of both the capacitor are shown in Fig. 7 and Fig. 8.

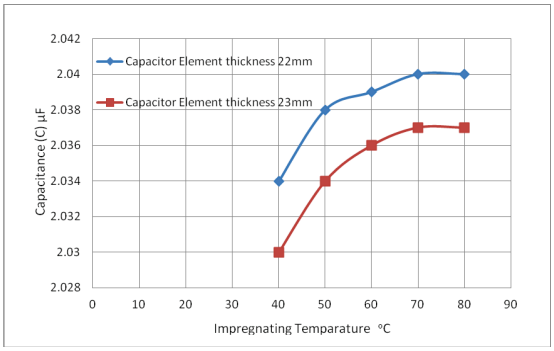

Fig. 6: Capacitance v/s Impregnating temparature of a Sunflower oil impregnated capacitor

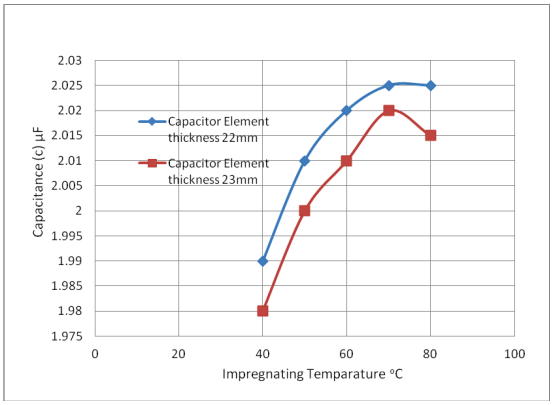

Fig. 7: Capacitance v/s Impregnating temparature of a Palm oil impregnated capacitor

The results of Olive oil impregnated capacitor are shown in the graph (Fig. 8). This graph shows the variation of capacitance for different impregnating temperatures. Large variation in capacitance value for the temperature range is in between 51°C and 69°C. It was observed that same change in both capacitors. Max value of capacitance was achieved above 70 °C.

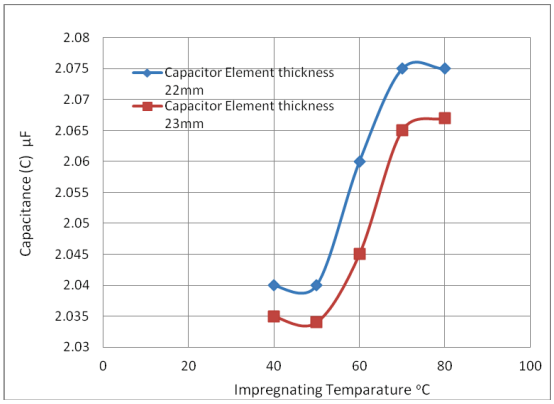

Fig. 8: Capacitance v/s Impregnating temparature of a Olive oil impregnated capacitor.

III. Experimental Results and Dicussions

In all the three cases, it was observed that more capacitance value was achieved around impregnated temparature of 70°C. More capacitance value was achieved in Envirotempo impregnated capacitor. The recommended value of temperature is 60°C to 70°C for impregnation process.

The results of all the three oil impregnated capacitor of different thickness elements are as shown in Fig.9 and Fig. 10. It was observed that the variation of capacitance value was small with the change in impregnating temperature. Good capacitance value is achieved in Olive oil impregnated capacitor compared to other oil impregnated capacitors. And from the result it was proved that the capacitance value can be increased by proper capacitor winding that means by less space factor. The element thickness can be decreased by proper winding or pressing and thus increase in capacitance value.

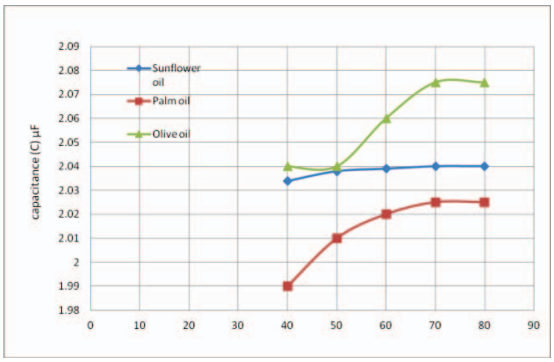

Fig. 9: Comparison of all the Three oil impregnated capacitors (22mm element thickness)

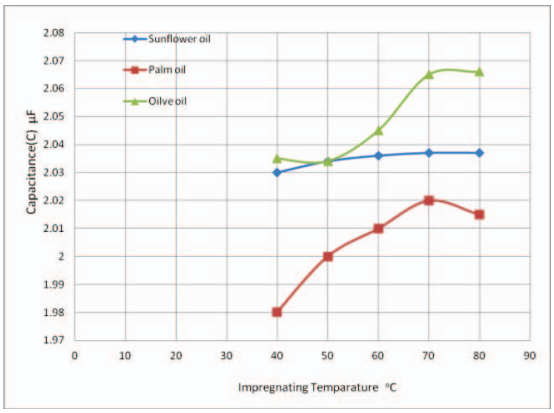

Fig.10: Comparison of all the Three oil impregnated capacitors (23mm element thickness).

Voltage level test between terminals of capacitor: AC High voltage of 2 times of rated value was applied between the terminals of capacitor for more than 15 seconds. Same test is done with DC voltage also. Both AC and DC voltages

are applied between the terminals of all the three different oil impregnated capacitors. No failure in test was observed. There is less risk of fire in capacitor with Olive oil impregnated capacitors.

Voltage level test between metal container and terminals of capacitor: High voltage capacitor body (capacitor tank or metal can) is made of steel material. So voltage test was performed between tank (container) and terminals. For this test, four times of the rated value of AC voltage was applied for 30 seconds. All the three types of capacitors passed in this test.

IV. CONCLUSIONS

By overall results, the suggestions may be given to the manufacturer that pressing or element winding process is very important process in the manufacturing stage of capacitor. Low value capacitance results due to poor pressing of capacitor elements and also results in high dissipation factor. The Thickness should be small for the given value capacitor. When the element size is small, dielectric loss is almost constant and small for the increase in temperature. Therefore an element with small size (for the same value capacitance) is recommended for oil impregnation. It is also observed that the optimum impregnating temperature is 70^{o}.

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