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Effect of metallic particle contamination in different types of Oil

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Abstract:- *AC breakdown test are usually used for quality check of mineral oils during transformer operation.Transformer oil is one of the most essential components for conventional oil immersed transformers as it acts both as electrical insulation and thermal coolant.The dielectric strength of the oil and more specifically the level of oil contamination determine the dielectric safety margin of the transformer insulation system. In addition, transformer oil may be used in power transformers for decades without changing. Insulation oil in power transformers serves as a heat transfer medium and as an insulating liquid.The oil board insulation system is still of big importance for the insulation of electrical power equipment such as HV transformers, current and voltage transformers, power circuit breakers and oil filled cables.The influence of particles on the voltage breakdown in insulating oil and other liquids has been recognized for many years.In this work an effort has been made to study breakdown voltage(BDV) in transformer oil with different electrode configuration with and without particle contamination.*

Keywords- *Insulating oil,oil breakdown,particle contamination,AC breakdown test,Breakdown voltage*

I. Introduction

Transformer oil is one of the most essential components for conventional oil immersed transformers as it acts both as electrical insulation and thermal coolant. For more than one century, power transformers are filled with mineral oil serving as a heat transfer and insulating medium[1]. AC breakdown test are usually used for quality check of mineral oils during transformer operation. In highly purified liquid dielectrics,breakdown is controlled by similar phenomena to those for gases. Unfortunately liquids are easily contaminated and may contain solids, other liquids in suspension and dissolved gasses.The effect of these impurities is relatively small for short duration pulses. In commercial liquids, solid impurities cannot be avoided and will be present as fibers. Insulating liquids drive their dielectric strength from the much higher density compared to Gases.Oil based insulation system is still of big importance for the insulation of electrical power equipment such as HV transformers, Currents and Voltage transformers , power circuit breakers and oil filled cables.The advantage of oil based insulation is the reliability over many years.

AC breakdown voltage tests usually used for quality check of mineral oils during transformer operation. [2].Particles influence both AC and DC voltage breakdown in insulating oil.The break down process starts with a microscopic bubble, an area of large distance where ions or electrons initiate avalanches. Insulating liquids drive their dielectric strength from the much higher density compare to
gases[3]. Particle concentration and motion is influenced by AC and DC stresses in different ways. Particles may be drawn into are expelled from high stresses region [4].

II. Experimental procedure

The transformer oil is filled in the vessel of the testing device. Two standard test electrodes with a typical clearance of 2.5 mm are surrounded by dielectric oil.A test voltage is applied to the electrodes and is continuously increased up to the break down voltage.At certain voltage level break down occurs with an arc leading a collapse of test voltage.After ignition of arc the test voltage is switched off automatically by the testing device.After the transformer oil test is completed, the insulation is stirred automatically and the test sequence is performed repeatedly (typically 5 repetitions).As a result BDV is calculated as mean value of the individual measurements. In this work ,breakdown voltage of oil with and without contamination is studied. The oils used are caster oil, mineral oil and vegetable oil.

III. Results and Discussion

Experiments are conducted with and without contamination. Contamination considered for experimentation are 1/10th ml of moisture ,$1/10^{th}$ mg of conducting metal particles .The test are performed repeatedly for 5 times and average breakdown voltage(BDV) is calculated. The average BDV is without contamination, with moisture and with metallic contamination are tabulated below for both vegetable oil, mineral oil and caster oil.

Different oils	BDV without contamination	BDV with moisture	BDV with particle contaminati on
Caster oil	23.2 KV	10.8 KV	16.2 KV
Vegetable oil	45.8 KV	14.6KV	16.6 KV
Mineral oil	29.2 KV	22.8 KV	21.4 KV

Breakdown voltage (BDV) with and without contamination

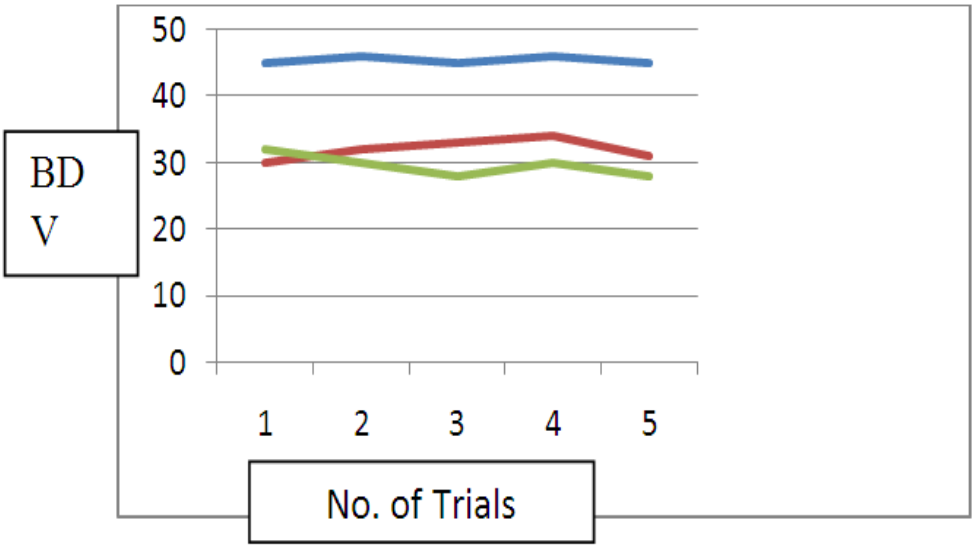


Fig 3.1 Variation of BDV in defferent types of oil without contamination

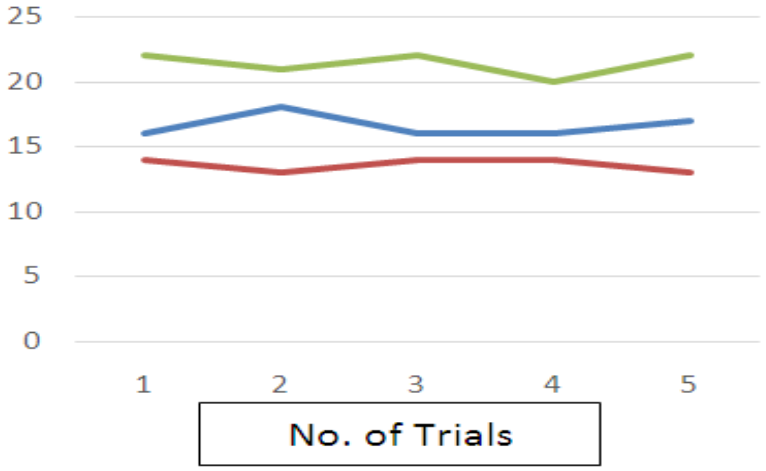


Fig 3.2 Variation of BDV in different oil with moisture

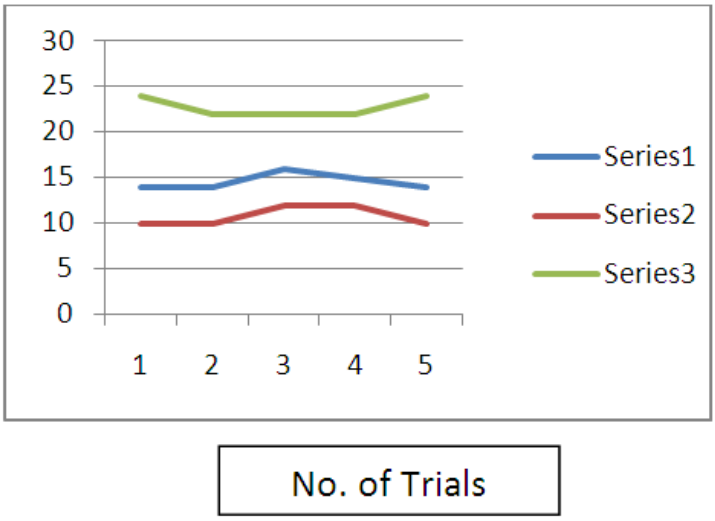
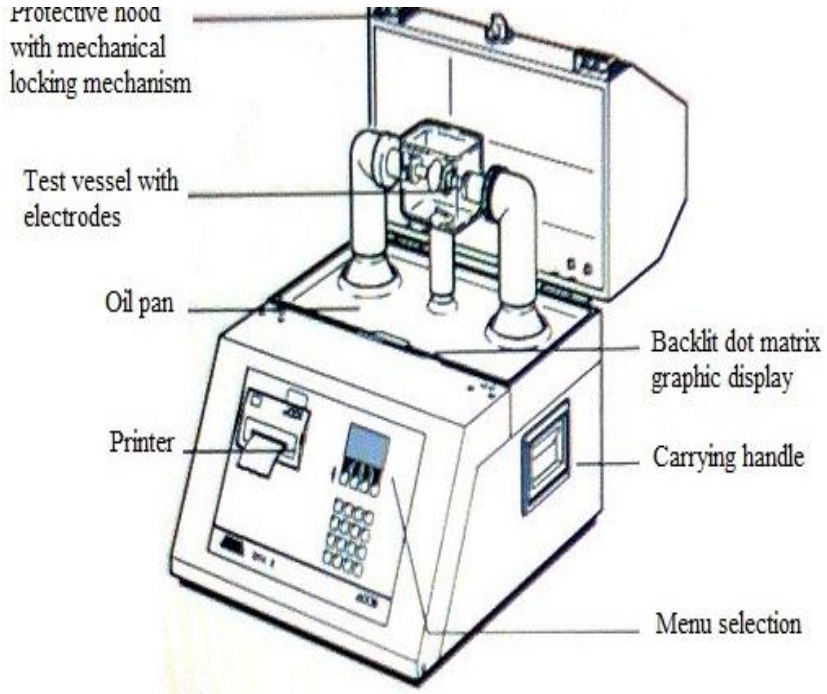


Fig 3.3 Variation of BDV in different oil with metallic particle contamination

Series 1: vegetable oil
Series2: castor oil
Series 3: mineral oil

IV. Measurement setup



V. Conclusion

From the experimental results, it is observed that the BDV of vegetable oil is good when compared with castor oil and mineral oil without contamination. With metallic particle contamination and moisture, BDV of mineral oil is better when compared to vegetable oil and castor oil. Hence from the experimental results, it can be concluded that BDV characteristics of mineral oil under contamination is good. The BDV characteristics of vegetable oil is good without contamination.

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