

Partial Discharge Pattern Analysis of Pure Mineral Oil and Nano Material Filled Mineral Oil under Superimposed Harmonics AC Voltage

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Abstract:

Transformer plays important role and expensive device in power system. It is used to step down or step up in required level, for the continuously smooth and reliable operation, transformer must be protected from anomalies condition. Transformer insulation is used for the protection of transformer and mineral oil is widely used as an insulating oil but mineral oil has disadvantages like poor biodegradability and low fire point, in this paper we are adding the nano filler material to increase the quality of mineral oil insulating properties and study the partial discharge pattern under the superimposed harmonics AC voltages. Harmonics are produced due to the use of power electronics device by the consumer which cannot be controlled in present condition.

1 Introduction

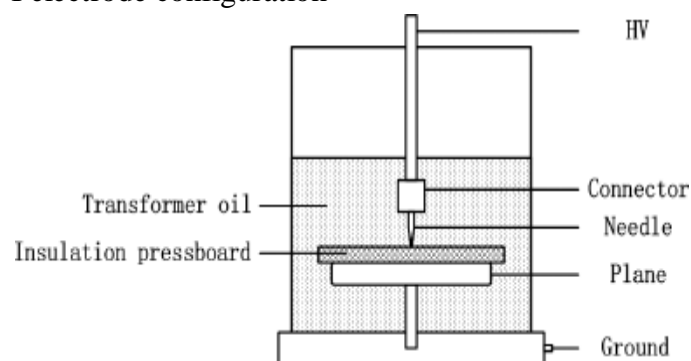
Transformer is the most expensive and important part of the transmission system. It must be more reliable all the time. So the transformer required to be insulated, transformer can be insulated by solid and liquid components. In this paper we analyse the partial discharge pattern in pure mineral oil and nano material filled mineral oil under the harmonics voltages, harmonics are produced by the power electronics device which can continuously degrade or damage the insulation properties of transformer. Partial discharge on the effect of harmonics can be discussed in many ways. By increasing individual harmonics will effect the partial discharge inception voltage [1], as superimposed harmonics increased the heat and those heat effect the partial discharge phenomenon [2], as increased of harmonics voltages we will get a small magnitude of PRPD pattern [3], superimposed harmonics increased the speed of

partial discharge (PD) activity which effect on the endurance and a lifetime of electrical insulation [4]. In this paper we studied the partial discharge pattern

of pure mineral oil and nano particle filled mineral oil under the harmonics AC voltages. This paper will also show the PRPD pattern analysis and PDIV behavior under the harmonics AC voltages.

2 experimental circuit

1 electrode configuration



In this experiment we are using needle plane configuration. Different kind of configuration can be used. Mineral oil and nano particle filled mineral oil is used as a transformer oil. It consists of 1mm thick press board and gap between the electrode is 1.5mm. Needle electrode is connected with high voltage side and the plane electrode is grounded.

Experimental circuit diagram

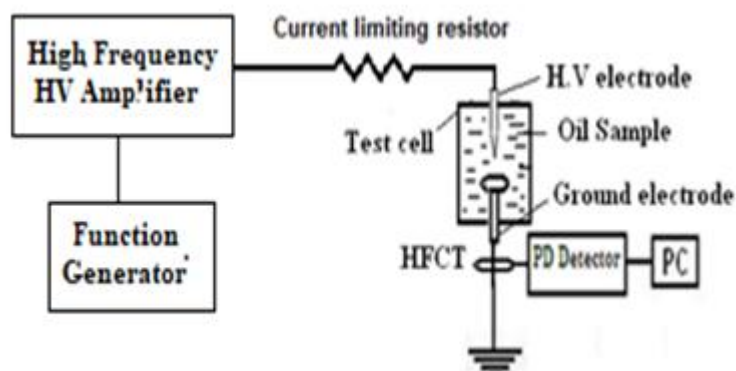


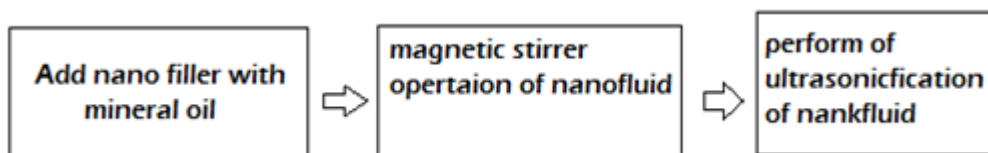
Figure1: experimental circuit diagram of needle plane electrode configuration

Experimental circuit diagram is shown in above figure. Input to the high frequency amplifier feed through the function generator, and the high frequency high ac voltages are generated through high voltage amplifier {trek model}, it consists of current limiting resistor to limit over current. Here high voltage side is connected with the needle electrode. It used a needle plane electrode. high frequency current transformer (HFCT) is used for

capturing pd signals and agilent digital oscilloscope for visualization for pd signal.

Sample preparation

In this experiment we are analysing the two types of sample oil, pure mineral oil and another nano filler added mineral oil. Pure mineral oil can simply prepare by filtering processing but the nano filler added mineral oil takes a number of steps, block diagram is shown in below figure



Sample involved in preparation of nano filler added mineral oil. Here we take SiO_2 as a nano filler, 0.1% percentage of SiO_2 nano material mixed with the 1000 ml of the mineral oil. 0.1% of SiO_2 is taken by weighing machine. First nano filler is mixed with mineral oil then it goes to the second steps for the magnetic stirrer which is done for the 45 minute. In magnetic stirrer process is done for the properly mixing of the nano filler and it is heated upto the 70°C . In final steps ultrasonication of nano fluid is done it is continued for the 20 minutes. Ultrasonication process uses physical vibration to break substance apart and help dissolution of solid into liquid

RESULT AND DISCUSSION

In this test by using needle plane electrode configuration for both pure mineral oil and nano filler added mineral oil different pd pattern are taken under the different superimposed ac harmonics voltage. Here we keep the fundamental frequency constant and super imposed with different order of harmonics. In this process we superimposed harmonics and vary the voltage from 1pp to 20pp. here we get quite different wave from than original power frequency. In this process we get the different PDIV with increased harmonics its is due to the heat produced by the harmonics and electrical stress. Figure shows the relationship between the superimposed harmonics and inception voltage, the PDIV is in decreasing order as we increasing harmonic voltage frequency for the both pure oil

nano filler added oil. It is due to the increasing of temperature because of harmonics which slowly degrade the insulation property of oil. As we know the PDIV is voltage where at last a single PD pulse will be appeared, which in unwanted phenomenon.

A graph clearly shows PDIV with pure oil is comparatively more than the PDIV nano filler added pure mineral oil. It means nano filler increased the insulation properties of mineral oil.

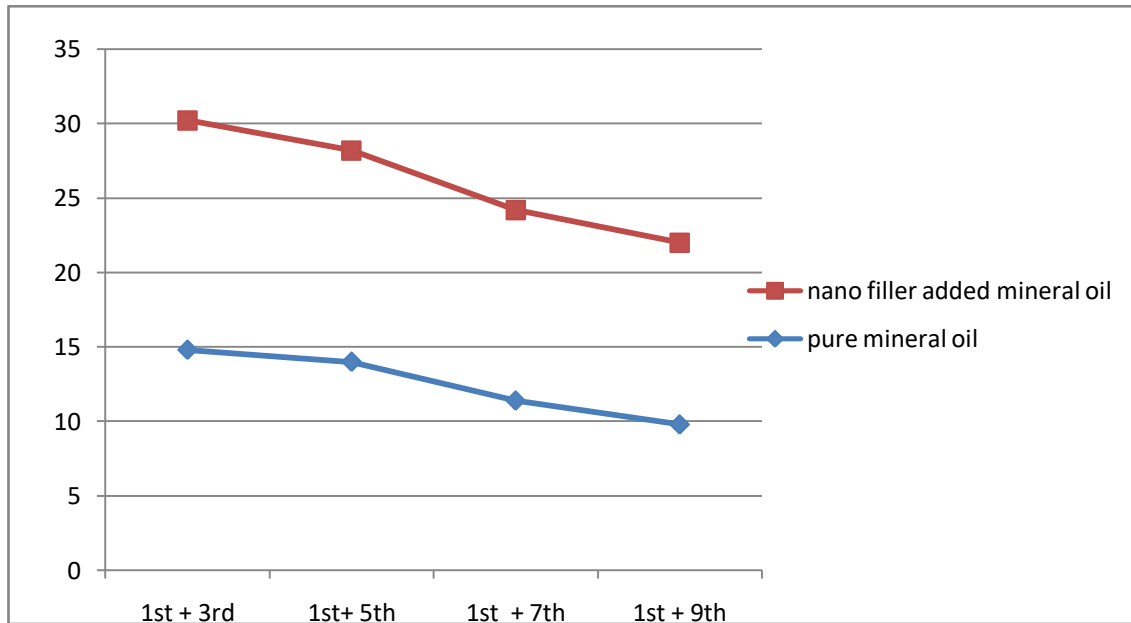
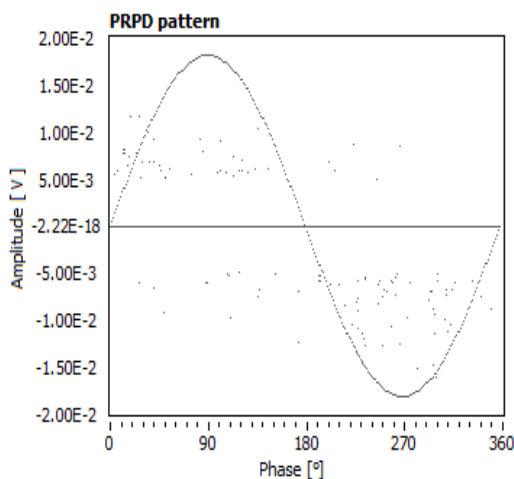


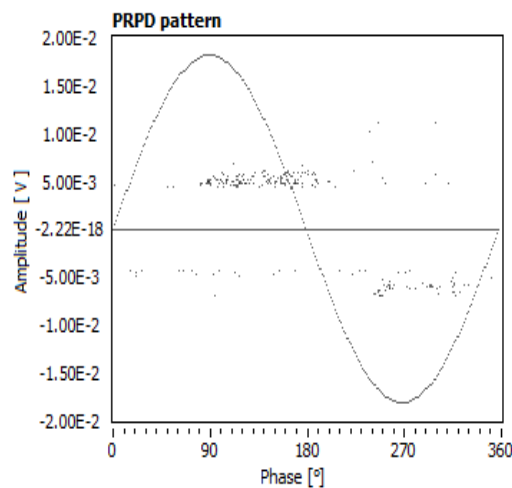
Figure: relationship between PDIV with superimposed harmonics for the pure mineral and nano filler Added mineral oil

In figure different PRPD pattern of super imposed harmonics are shown with both the pure mineral oil and nano filler added mineral oil. Those PRPD is quite like similar but slightly difference in charge between lower and higher harmonics frequency in both cases. The number of averages charges is more

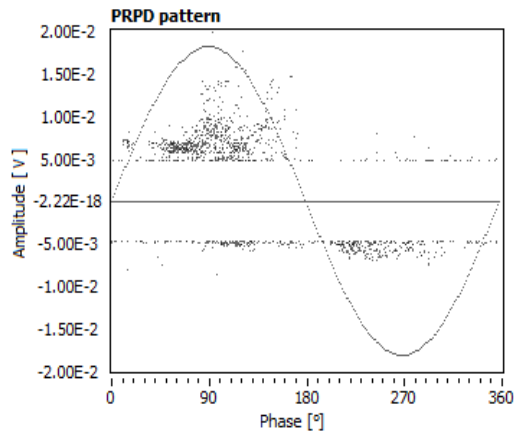
in increased harmonics frequency. comparing the PRPD pattern in between pure mineral oil and nano filler added oil, PRPD pattern clearly showing that the average charge produced in nano material added oil is very less.



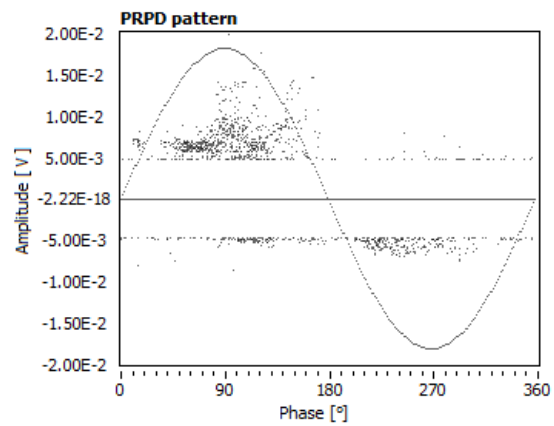
(a)



(b)

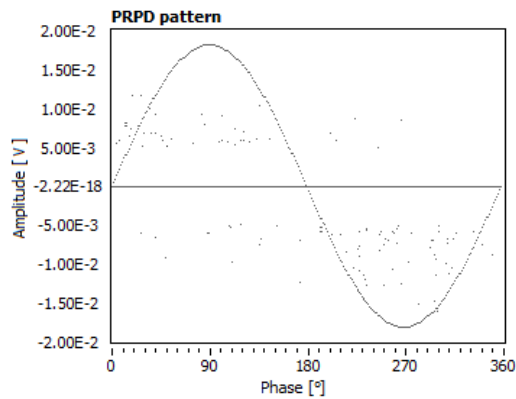


(c)

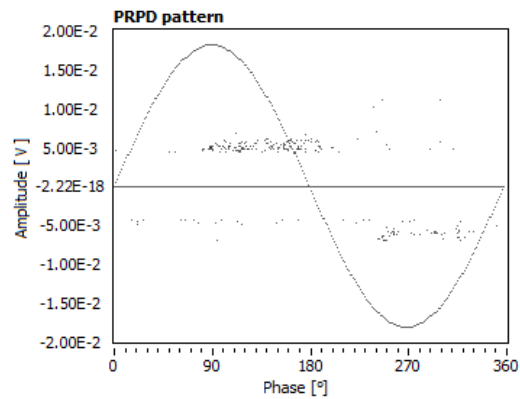


(d)

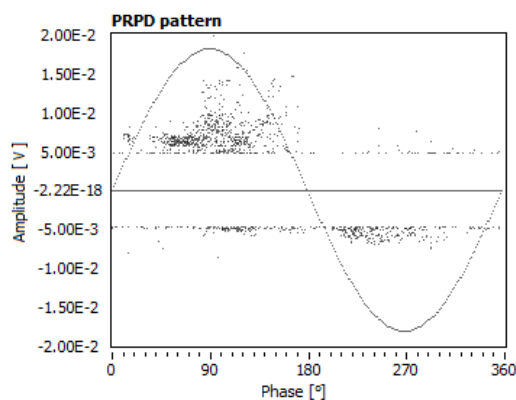
Figure3: PRPD pattern at different superimposed harmonics (a) 1st+3rd harmonics (2) 1st + 5th harmonics (c) 1st + 7th harmonics (d) 1st 9th harmonics



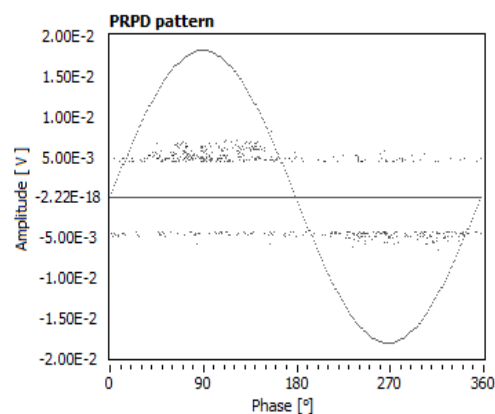
A



B



C

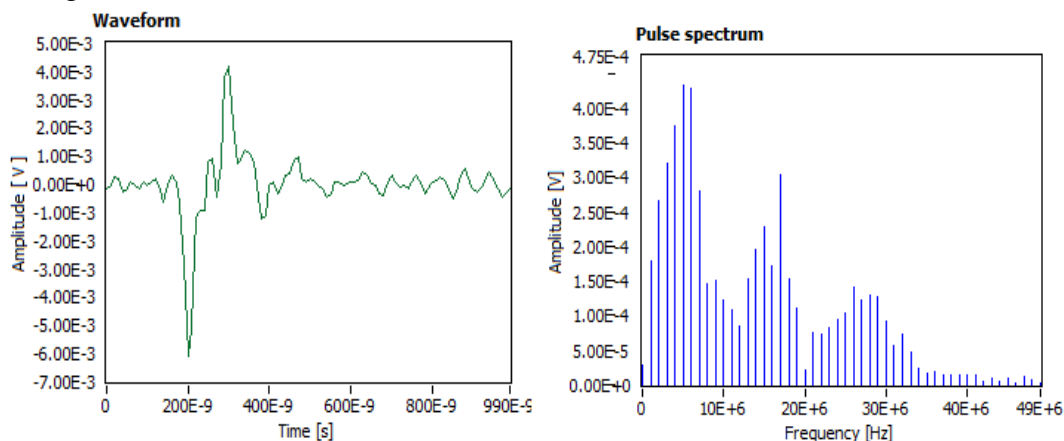


D

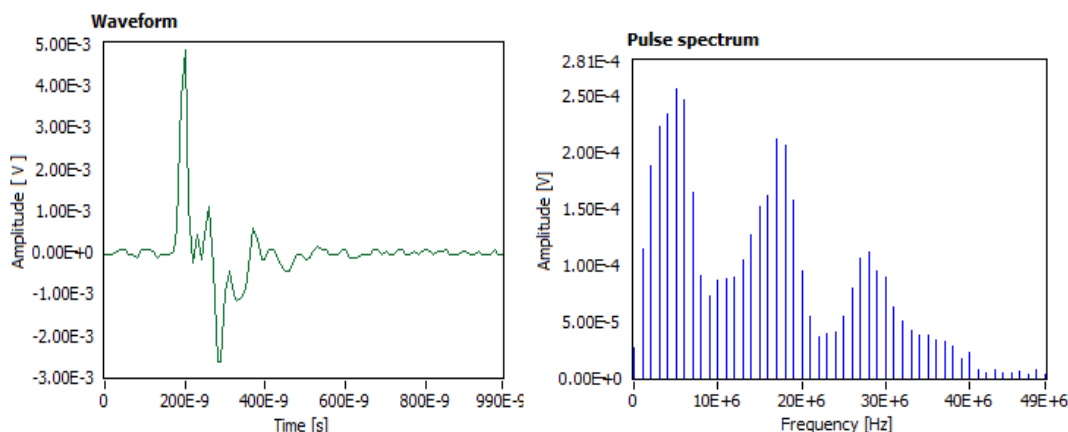
Figure3: PRPD pattern at different superimposed harmonics (a) 1st+3rd harmonics (2) 1st + 5th harmonics (c) 1st + 7th harmonics (d) 1st 9th harmonics

The time frequency domain analysis is shown in below figure at different superimposed harmonics order. In case of partial discharge analysis it is important to understand the time and frequency domain analysis of each superimposed harmonics of pd pulses. It gives the condition of mineral oil. In

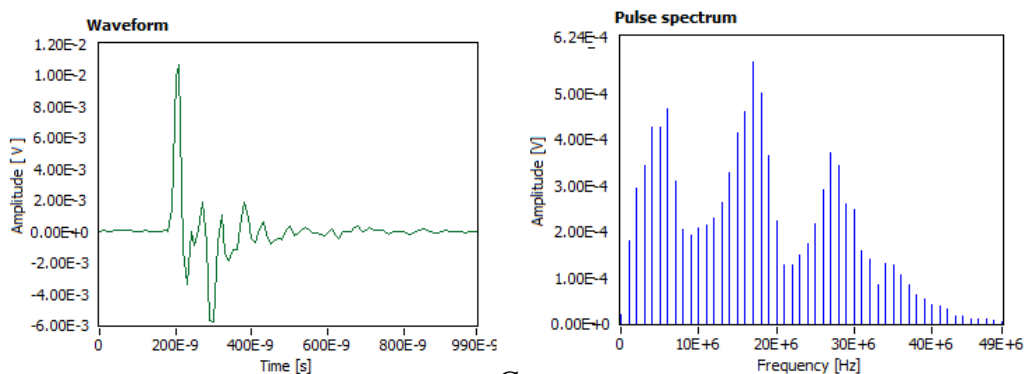
below graph the graph is plotted between the amplitude against time and amplitude against frequency of PD pulses at different superimposed harmonics.



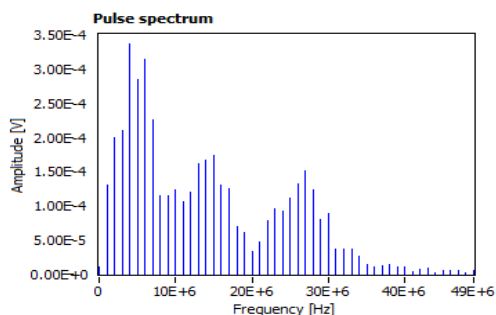
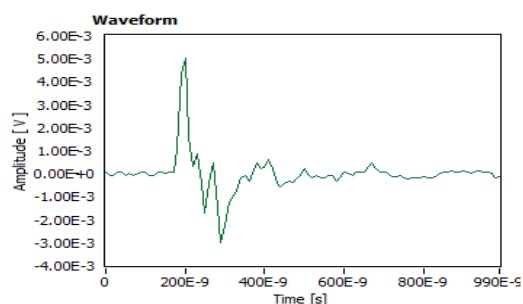
A



B

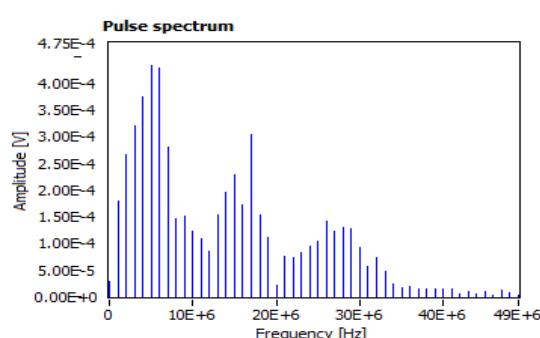
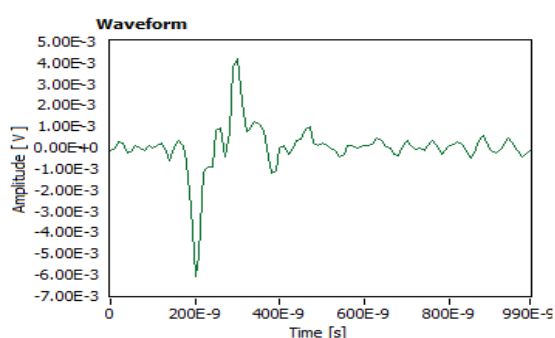


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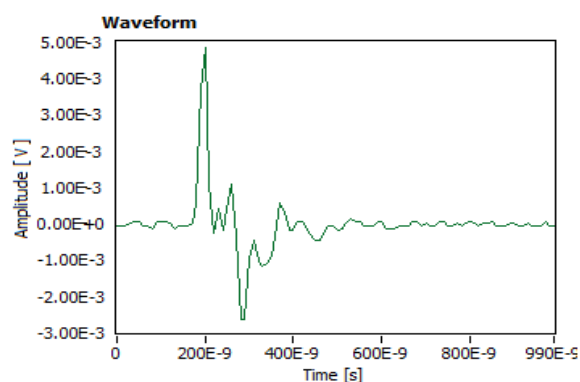
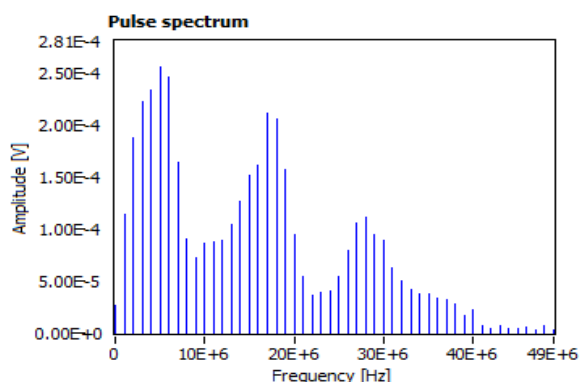


D

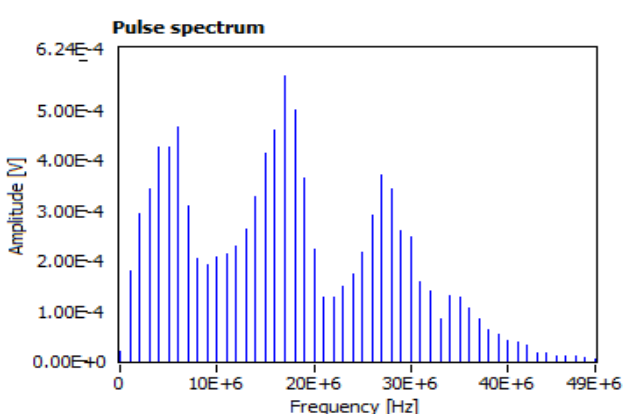
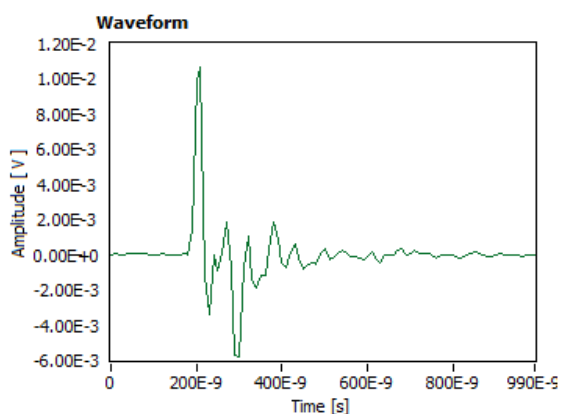
Figure: time and frequency domain analysis of PD pulses of pure mineral oil (a) 1st+3rd harmonics (2) 1st + 5th harmonics (c) 1st + 7th harmonics (d) 1st 9th harmonics



A



B



C

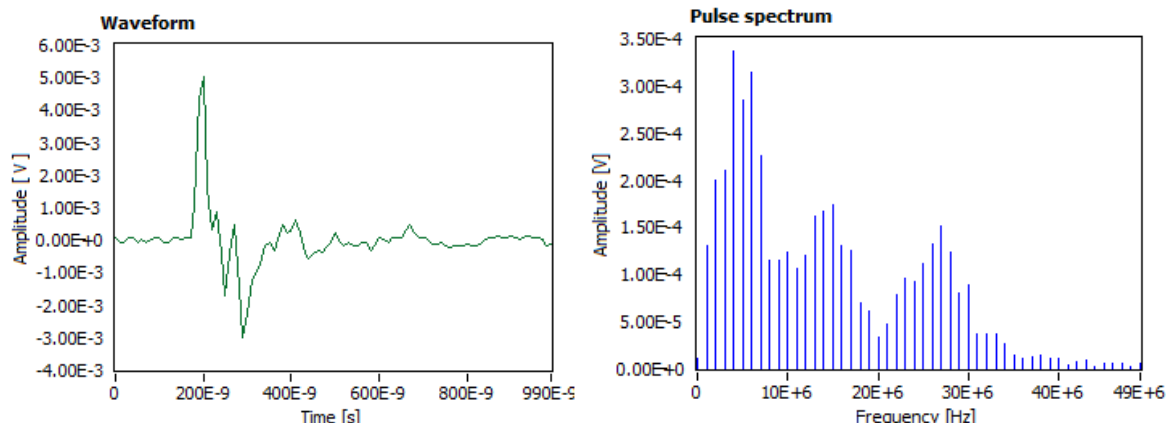


Figure: time and frequency domain analysis of PD pulses of .1% nano filler added mineral oil (a) 1st+3rd harmonics (2) 1st + 5th harmonics (c) 1st + 7th harmonics (d) 1st+9th harmonics

Above figure shows the typical time and frequency domain analysis of pd pulses using needle plane electrode configuration from 1 kv to up to 18kv at different superimposed harmonics with pure mineral oil figure and nano filler added mineral oil figure . Right side of the figure shows the pd signal and its times spectrum and left side shows the pd signal and its time spectrum. As we seen there is not much more changes in with added nano filler mineral oil and pure mineral oil. As we added nano filler amplitude of pd pulses is slightly in decreasing order.

CONCLUSION

In this paper we analyse and compare partial discharge pattern of mineral oil and nano filler added mineral oil under the ac harmonics voltages. The experiment concluded that the nano filler added in mineral oil had positively impact, it had significantly increase the partial discharge inception voltage{PDIV} and also continuously decreased producing of average charge number. Which means practically used of nano filler added mineral oil used can help in insulation properties on mineral oil .

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