Discharge Model of a Spark Gap Peaking Switch

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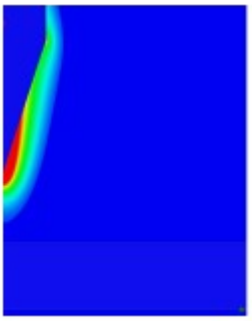
***Abstract*—Ultra-fast breakdown in gaseous or liquid dielectric serves as the basis for generation of short duration high voltage pulse in pulsed power systems. In [1 and 2] electro-dynamic model of high pressure spark gap peaking switch was discussed. Theoretical investigations leading to mathematical model of gas discharges could certainly help the understanding of the physics involved. Gas breakdown is essentially a threshold process which is consequence of the steep dependence of the ionization rate. In this paper mathematical discharge development in a gaseous spark gap switch which is subjected to 300 kV, 3 nanosecond rise time pulse has been carried out. Rate of change of volume charge density in the gaseous region is found out and this will determine at what time the rate of volume charge density has exceeded or equal to ionization charge density for the gas. This will lead us to the value of breakdown delay or the rise time of the output pulse across the connected load. Towards these objective continuity equations for positive ions, negative ions and electrons (coupled with gauss's law) are solved in conjunction with Poisson's equation.**

Keywords: Gas Discharges, Spark gap switch

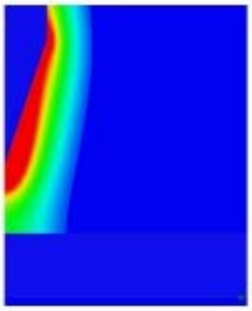
I. SOLUTION TECHNIQUE

An electrical discharge modeling is a complex problem as multiple physics are involved in the same. The approach used in this paper is Finite element to solve Poisson's equation and continuity equation simultaneously. Transient solver of Ansoft Maxwell is used in conjunction with AC conduction solver. Consistent boundary conditions have been applied to the model. The potential to the plane electrode is set to ground. The point electrode potential is defined as a sinusoid having 3 ns rise time. The top bottom and side walls have been assigned to zero normal displacement field components. The simulation is run for 5 ns and volume charge density is calculated for time steps defined.

(a) 0.5ns



(b) 3ns



(c) 5ns

Figure 1.(a), (b), (c), Shows the development of charges at different time instants

REFERENCES

[1] Parekh M.G., Bindu S, Mangalvedekar H .A., "Electromagnetic modeling of high pressure spar k gap peaking switch" 16t h E ML 2012,Beijing,China.

[2] Bindu S, Mangalvedekar H .A., Parekh M.G., "Electro-dynamic simulation of high voltage peaking switch" I EE E transaction on plasma science., vol. 40, Issue 11,page s3093-3099.

[3] "Gas discharge physics" by Yuri P Raizer, Springer Verlag Publication