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ESTIMATION OF STRAY CAPACITANCES OF TWIN SOURCE HVDC TRANSMISSION LINE AND ITS STORED ENERGY

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Abstract:

In Neutral Beam Injector (NBI), ions are accelerated to desired energy (from ~10 kV to ~MV range) by an electrostatic multi-aperture grid system of an ion source. Accelerated ions subsequently neutralized in a gas cell called neutralizer. To maintain the electrostatic lens configuration, grid plates are placed closely packed (~mm distance) parallel to each other. Paschen-breakdown (here it is called as grid breakdown) between the grid plates occurs routinely during system conditioning phases due to the presence of high voltage (HV) and sufficient gas (@ sub-atmospheric pressure). When grid-breakdown occur the stored energy of HVDC transmission line is dumped into the grids of the ion source at the breakdown location and possesses a danger to damage the grids by melting and even puncturing the spot.

In Twin Source [1] 120meter long transmission[2] line is designed to connect accelerator power supply system -35kV ,15 A and extraction power supply system -11kV ,35A with Plasma Grid(PG) , Extraction Grid (EG) and Ground Grid(GG) .The major contribution for the stored energy emanates from the inter conductor capacitances or stray capacitances of the HVDC transmission line. This paper discusses the methodologies for estimation of the inter conductor capacitance and thus stored energy. The exercise helped to get the optimized possible transmission line configuration to ensure low stored energy to avoid grid damage. The analytical calculations of aforesaid configuration is validated with simulation, performed on COMSOL platform and the corresponding obtained results is further confirmed from capacitances for 1m long HVDC transmission line between PG Line, EG Line and GG Line i.e. CPG EG , CEG GG and CPG GG estimated analytically are 13.41pF, 19.67pF and 8.6pF respectively. The simulated values are 19.41 pF, 18.45pF and 10.46pF respectively. The measured values are 16.86pF, 15.52pF and 9.67pF respectively. The estimated stored energy is 12.85mJ for 1m length of HVDC transmission line.

[1] M. Bandyopadhyay, R.Pandey, S.Shah, G.Bansal, D.Parmar, A.Gahlaut, J.Soni, R.K.Yadav, D.Sudhir, H.Tyagi, K.Pandya, K.G.Parmar, H.S.Mistri, M.Vuppugalla and A.K.Chakraborty, "Two RF Driver Based Negative Ion Source Experiment", IEEE Transactions on Plasma Science, 42, 624, March (2014).

[2] Deepak Parmar, V. Mahesh, A. Gahlaut, K.G. Parmar, B.Prajapati, H. Shishangiya, M N Vishnudev, M. Bandyopadhyay, R. Yadav, J. Soni, R. Pandey, G. Bansal, K. Pandya, J.Bhagora, S.Shah, Dass Sudhir Kumar, H. Tyagi, A. Chakraborty, "Design & Development of Electrical System for TWIN Source", Proceedings of Symposium of Fusion Engineering (SOFE) (2015).

Eligible for student paper award?

No

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