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Novel Approach of Pulsed-Glow Discharge Wall Conditioning in ADITYA Upgrade Tokamak

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In ADITYA Upgrade, glow discharge wall conditioning (GDC) is performed for long hours after the tokamak plasma operation using H gas to control Oxygen and Carbon containing impurities. This leads to high retention of H gas on Graphite limiter and Stainless Steel (SS) vessel. Subsequently, high H outgassing rate requires increased pumping time and high H recycling during plasma discharges affect the plasma performance in respect to H fueling control of the plasma. Intermittent He GDC for shorter duration can be used to decrease the H retention mainly in graphite. However, the removal of Helium from the limiter and wall is more difficult than H due to its properties of non-reactive, hard-to-trap, vacuum pumping limitation etc. A new approach involving Pulsed Glow Discharge Wall Conditioning (P-GDC) has been introduced in Aditya-U tokamak to reduce the residual H concentration in SS vessel and graphite limiters. It has been observed earlier with continuous GDC that the impurity removal rate is usually high in initial few seconds of GDC operation. The initial high reaction rate is due to the reaction of working gas ions with loosely bound outer most monolayers species. The removal rate then decreases exponentially as hard bonded O and C containing impurities come out slowly. Moreover, the released impurity gases are re-implanted in the wall materials partially deeper in presence of continuous GDC that they have been in its absence. Thus overall impurity removal rate decreases exponentially with time in presence of continuous gas GDC. Initiation of the glow discharge needs filling of H gas at high pressure ~ 10-2 mbar and ~1 kV voltage in Aditya Upgrade. In case of pulsed GDC the gas needs to be injected in pulsed mode and the discharge needs to be initiated during every gas. Therefore in P-GDC, to facilitate the fast initiation of discharge, a source of free of electrons has been introduced in the vessel. A fast feedback pulsed gas-fueling control system and electrons emission system has been developed to initiate glow discharge in each gas-feed pulse at various operating pressure 1 x 10-4 mbar and above. The different P-GDC experiments have been carried out with H, He, Ar as working gases and the results are compared with traditional continuous GDC. The design, development, operation and results of Pulsed GDC has been described in this paper in details.

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Author: Mr JADEJA, Kumarpalsinh (Institute for plasma Research)

Co-authors: Mr ARAMBHADIYA, Bharat (Institute for Plasma Research, Gandhinagar, India); Mr GUPTA, Chetnarayan (Institute for Plasma Research, Gandhinagar, India); Mr KUMAVAT, Devilal (Institute for Plasma Research, Gandhinagar, India); Mr ACHARYA, First Name : Kaushik (Institute for Plasma Research, Gandhinagar, India); Dr GHOSH, Joydeep (Institute for Plasma Research); Mr PATEL, Kaushal (Institute for Plasma Research); Mr PATEL, Kiran (Institute for Plasma Research); Mr KALAL, Madan (Institute for Plasma Research, Gandhinagar, India); Mr CHOWDHURI, Malay (Institute for Plasma Research, Gandhinagar, India); Ms SHAH, Minsha (Institute for Plasma Research, Gandhinagar, India); Mr CHATTOPADHYAY, Prabal (Institute for Plasma Research, Gandhinagar, India); Ms RAJPAL, Rachana (Institute for Plasma Research, Gandhinagar, India); Mr TANNA, Rakesh (Institute for Plasma Research, Gandhinagar, India); Ms MANCHANDA, Ranjana (Institute for Plasma Research, Gandhinagar, India); Mr KUMAR, Rohit (Institute for Plasma Research, Gandhinagar, India); Mr BHATT, Shailesh (Institute for Plasma Research, Gandhinagar, India); Mr GHOSH, Soumen (Department of Physics, University of California, San Diego, CA, USA); Mr AICH, Suman (Institute for Plasma Research, Gandhinagar, India); Mr KELLA, Vara Prasad (Institute for Plasma Research, Gandhinagar, India)

Presenter: Mr JADEJA, Kumarpalsinh (Institute for plasma Research)

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