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Plasma Facing Components Technologies in SST-1

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SST-1 Tokamak was successfully commissioned in 2012 and the first plasma was achieved in June 2013 with poloidal limiters having SS 304L as vessel wall material. Due to plasma wall interactions, high-Z impurities released from the vessel wall which in turn cools the plasma by radiation loss. In order to reduce this effect, in 2nd phase of SST-1 refurbishment PFC components were installed in the system. PFCs were integrated inside SST-1 vacuum vessel which is designed to withstand an input heat load of 1.0 MW/m². Graphite was chosen as Plasma facing material considering its good thermal properties, low atomic mass. Cu-Zr & Cu-Cr-Zr alloys plates embedded with SS 304L piping were used as back plate materials for proper heat conduction. Each and every component was tested at their functional conditions to verify its functionality and to ensure operation conformity. Approximately 3800 tiles were mounted on 132 numbers of copper alloys back-plates. The total surface area of the installed PFCs exposed to plasma is about 40 m² which is nearly 50% of the total surface area of stainless steel vacuum chamber (~75 m²). The volume of the vessel with the PFCs is ~ 16 m³. Gas-to-gas heat exchange method was adapted to heat nitrogen gas which is pressurized using dedicated gas blower system to bake the PFC components. All PFC components passed through temperature of 250 °C for 8 hours flat top and working pressure of 4 bar under UHV conditions in validation testes. Strict metrology and QA/QC plans were structured and executed to integrate the PFC components inside the vacuum vessel. During pump down of SST-1 main vacuum vessel, PFCs were baked at 250 °C for nearly 10 days to remove the absorbed water vapours. At this condition, this main vacuum vessel was maintained at 150 °C. In addition, initially hydrogen discharge cleaning was carried out followed with subsequent helium discharge cleaning to remove other surface impurities. With all PFCs and diagnostic integrated to the system, a base pressure of 4.5 × 10⁻⁸ mbar was achieved.

This paper represents SST-1 post PFC Plasma-scenario, PFC requirement inciting factors, PFC architecture and lay-out details, PFC components experimental validations, metrology plan with QA/QC and final installation of PFC with the vacuum vessel.

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