DESIGN OF SINGLE STAGE PNEUMATIC PELLET INJECTOR SYSTEM FOR TOKAMAK SST-1

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The objective of pellet fueling program for Steady State Superconducting tokamak (SST-1) is to develop new technologies. SST-1 will have hydrogen plasma with density 1_10^{19} particles/sec. For T_e ~3 KeV, minor plasma radius 20 cm, and considering perturbation parameters $\Delta N_e/N_p$ ~1(N_e, number of electrons in plasma, N_p, number of electrons introduced by pellet) the required fueling rate for hydrogen pellet of size ~1.4 mm is 10 per second. In first phase pneumatic gas gun development is undertaken. Second phase will include developing multi-barrel and extruder system to achieve higher pellet injection rate. Single pellet injector developed will also be used for applications such plasma diagnostics, wall conditioning with lithium pellet etc. To start with pellet of 3mm diameter and length, having mass 1.84 mg will be attempted. Pellet formation will be in a pipe cooled to a temperature of 10 K, housed in a cryostat pumped to 10^{-5} and cooled to liquid nitrogen (LN2) temperature. Heat load on the LN2 surface 32 watts and on 10 K surface holding the pellet is 2 watts. Velocity of 1 Km/sec is aimed using helium gas as propellant. Low yield strength of hydrogen pellet (2 to 4 bar @ 8 K) limits acceleration attained. Terminal velocity attained will depend on breech pressure of propellant gas supplied to the back end of the pellet via a fast (1-2 _ 10^{-3} s), high pressure valve. Factors determining pellet velocity include the propellant gas temperature, its mass and pressure, and on pellet side is its density, length and also barrel length. Experimental and theoretical study of velocity attained by pellet for a pressure range10 bar to 150 bar will be done. Freezing section is followed by pellet injection line. The injection line will have differential pumping system to isolate the test chamber vacuum from propellant gas. The size of vacuum vessels chamber are 1000 , 60, 60 liters with a gas load of 2.721 bar liter , 1.29×10^{-2} ,1.45×10^{-3} mbar liter respectively. Volume of test chamber is 60 liters. A microwave cavity of size 7cm × 8cm having central frequency 2.87 GHz based upon excitation of TM_{010} mode will measure pellet mass. For time of flight measurement photodiodes with response time less than 8 micro seconds are planned on injection line. CCD camera will take shadowgraphs of pellet. A shock sensor will register the pellet impact. Detailed design and calculations will be presented in the paper.