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Particle Control and Fueling of CFETR

The tritium self-sufficiency is one of the most challenging feasibility and attractiveness issues in the development of fusion systems, which is also the main science mission of CFETR. The tritium burning rate is the key which can be improved by the increased particle confinement time and central fueling. Our study has been engaged in the research of central fueling technology and particle transport physics, and has achieved a number of innovative results: 1) Developed a new model evaluates the impact of various factors on the tritium self-sufficiency of CFETR, and provided key inputs to the engineering design, while clarifying the key role of realizing central fueling and improving particle confinement performance; 2) Built a workflow of core-edge integrated modeling which can explore fueling, wall recycling, pumping and impurities simulations for CFETR. Thus, we study the impact of particle control on burnup fraction in detail; The results shows that burnup fraction can be effectively increased by i) a higher pedestal density; ii) a higher $n_{e,sep}/n_{e,ped}$ controlled by higher recycling; iii) deeper pellet penetration and longer particle confinement time. Based on our analysis, for pellet penetration deeper than r/a=0.7, f_{burnup} of CFETR can be higher than 3%. This is a lower limit for the required TBR (>1) to match the achievable TBR for tritium self-sufficiency. 3) Successfully developed the a compact torus central fueling system for large and medium-sized tokamak, i.e. EAST. The conventional fueling methods (PI & SMBI) are difficult to achieve central fueling. Compact Torus (CT) is thought to be a technology with the potential for central fueling.

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