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Investigating the interplay between helium ash and impurities in an aneutronic fusion plasma environment for sustainable energy production

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Abstract
In this research, the effect of helium ash on the ignition and burn condition of aneutronic fusion plasma in the spherical tokamak reactor was investigated. Since the presence of helium ash is unavoidable, we considered the ratio of helium particle confinement time to the energy confinement time ρ* as a figure of merit. Therefore, the effect of helium concentration by using zero-dimensional coupled equations of power balance and particle balance on the ignition and burn behavior of plasma was investigated. In this research, unlike our previous research, we considered a non-ideal plasma, and the constant concentrations of Be and W impurities were assumed to investigate the effect of common impurities in the environment of spherical tokamak's plasma. In fact, the functions used to calculate the radiation loss power are a new approach based on the latest atomic data and coronal equilibrium model. By numerically solving the equations and attaining the iso-curves, we concluded that the helium concentration in the burn state of the plasma is higher than the ignition state and increasing ρ* improves the stability in the plasma. The triple product curves close for ρ*>4.63 in the burn state and for ρ*>3.0 in ignition state, and there will be no possibility of plasma operational activity.

Keywords: spherical tokamak, aneutronic fusion, helium ash, impurity, power and particle balance

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