2006 핵융합 기초 #6 (Stacey, Fusion)

6.2 A D-T particle flux of $3\times10^{21}\ \mathrm{m^{-2}s^{-1}}$ strikes the surface of a stainless steel first wall. The average particle energy is $200\ \mathrm{eV}$. Calculate the rate of impurity production in a tokamak with major radius $R=5\,\mathrm{m}$ and plasma radius $a=1\,\mathrm{m}$. (Use Fe sputtering yields)

6.3 The density of stainless steel is $8\ \mathrm{g/cm^3}$. Calculate the thickness and mass of wall eroded away in one full year of continuous operation for Problem 2. (Use $A=55$ amu for stainless steel.)

6.4 Assume that a tokamak reactor plasma discharge terminates disruptively once every 1000 pulses and that the plasma internal energy goes to 10% of the total wall area in 10 msec. For a tokamak with $R=5\ \mathrm{m},\ a=1\,\mathrm{m},\ n=2\times10^{20}\ \mathrm{m^{-3}}$ and $T=20\ \mathrm{keV}$, what is the thickness of stainless steel wall evaporated in 1 yr?

6.7 The actual impurity concentration allowable with ignition is less than that shown in Figure 6.2.3 because of transport losses. Use the empirical scaling law $\tau_E\left(\sec\right)=5\times10^{-21}n\left(\mathrm{m^{-3}}\right)a^2\left(\mathrm{m}\right)$ to estimate from the power balance the maximum allowable concentration of Fe consistent with ignition in a D-T plasma at $T=10\ \mathrm{keV}$ and $a=1.5\,\mathrm{m}$.

6.9 Estimate the threshold energy for deuterons for physics sputtering of carbon and of tungsten.

2006 핵융합 기초 #6 (Harms, Principles of Fusion Energy)

13.2 Using the sputtering data for D^+ at 100 eV bombarding Fe in Fig.13.6, evaluate K in Eq.(13.13). Sketch the sputtering-curve predicted by this equation, and discuss any differences with Fig.13.6. Compute the time it would require for a flux of 10^6 $deuterons\cdot cm^{-2}\cdot s^{-1}$ at $100\ eV$ to sputter away 10% of the thickness of a 1 cm iron wall.

13.3 Consider a deuterium plasma at $T_e = 10\ \text{keV}$ containing 1% oxygen. Estimate the emitted radiation power using a weighted sum of the powers from the individual species.

13.4 Estimate the percentage of iron impurity in a d-t plasma that would cause the ideal ignition temperature to double.

13.5 Evaluate impurity effects on the Lawson criterion.