Van de Graff

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1) Volume and mass of SF6

$L := 54 \cdot 2.54$ [cm] Length of tank

$r := 12 \cdot 2.54$ [cm] radius of tank

$\rho gas := 6.164 \cdot 10^{-3}$ [g/cm3] density of SF6 at 1 bar and 20 degC

$pabs := (14.7 + 12) \cdot .0689$ [bars] Absoulute tank pressure

$pabs = 1.84$

$V := L \cdot \pi \cdot r^2$

$m := pabs \cdot \rho gas \cdot V$ $m = 4539$ [g] of SF6

$\frac{m}{454} = 9.999$ [lbs] of SF6

Calculate the density at STP of SF6 using its molecular weight (146) and assuming it is a perfect gas:

$\frac{146}{22400} = 0.006518$

2) Max power the target can take by radiative cooling

$\sigma := 5.67 \cdot 10^{-12}$ [W/cm2-degK] Stefan-Boltzmann constant

$\varepsilon := .8$ Emmisivity and absorptivity (guess)

$d := 1.5 \cdot 2.54$ [cm] Target diameter

$Tenviron := 300$ [degK] Environment temperature

$Tmelt := 273 + 180$ [degK] Target (Li) melting point

$Pmax := \varepsilon \cdot \sigma \cdot \left(Tmelt^4 - Tenviron^4\right) \cdot 2 \cdot \frac{\pi \cdot d^2}{4}$ $Pmax = 3.5$ [watts]

The max current is approximately 100 uA, which will deposit in the target:

$\left(550 \cdot 10^3\right) \cdot \left(100 \cdot 10^{-6}\right) = 55$ [watts] max power

Thus radiative cooling won't work.

3) Maximum power the target can take by conduction to a room temperature heat sink.

$\kappa Li := 85$ [W/ (m-degK)] Heat conductivity

$\kappa Silicone := .5$ [W/ (m-degK)] Heat conductivity

$\kappa 304Stainless := 16.$ [W/ (m-degK)] Heat conductivity

$\kappa Copper := 400.$ [W/ (m-degK)] Heat conductivity

$Area := \pi \cdot .02^2$ [m^2] Area of target

$Tenviron := 300$ [degK] Heat sink temperature

$Tmelt := 273 + 180$ [degK] Lithium melting point

$$\sigma := \left[\left(\frac{.0015}{\kappa Li \cdot Area}\right) + \left(\frac{.0005}{\kappa Silicone \cdot Area}\right) + \left(\frac{.050 \cdot .0254}{\kappa 304Stainless \cdot Area}\right)\right]^{-1}$$

$$Pmax := \sigma \cdot (Tmelt - Tenviron)$$

$Pmax = 175$ [watts] This is more than sufficient, so glue the Li target to the inside of the target cup.

4) Reaction energetics

$mp := 938.27945$ [Mev] Proton mass

$mLi7 := 6533.88453$ [Mev] Li7 Nuclear mass

$mBe8 := 7454.90885$ [Mev] Be8 Nuclear mass

$Tpkin := .440$ [Mev] Proton kinetic energy

$$Ecm := \left[mp^2 + mLi7^2 + 2\ (mp + Tpkin) \cdot mLi7\right]^{\frac{1}{2}}$$ [Mev] CM energy

$Ecm - mBe8 = 17.6399$ [Mev] Must be on resonance 17.640 Mev $\Gamma$=10.7 Kev

$$E\gamma\_in\_cm := \frac{Ecm^2 - mBe8^2}{2 \cdot Ecm} \qquad E\gamma\_in\_cm = 17.619$$ [Mev] Emitted $\gamma$ in cm

Notice that a proton kinetic energy of 440 keV is just enough to hit the CM resonance energy. The proton will need a little more than this (run at 550 keV) to get through surface contamination on the Li target.