Validation with Zheng

Case 1

$U_p = 10\,kV$, $Q_{couple} = 0.179\ mJ/cm = 0.0179\ J/m$

$L = 3.88\,mm$

$S = 61.8\,kHz$, $\eta = 0.35$, $F = 10\,kHz$, $\tau_h = 350\,ns$

→ estimated electrode width, $w \approx 8\,cm$

- **Power:** $W = Q_h \cdot F = \eta \cdot w \cdot Q_{coup} \cdot F =$

$= 0.35 \cdot 0.08 \cdot 0.0179 \cdot 10^4 \Rightarrow$

$\Rightarrow \boxed{W = 5.012\ Watt}$

- **For Optimus value:** $\dot{w}_h^{max} = 3 \cdot \dot{w}_h$ (in W/m^3)

$$\dot{w}_h = \frac{Q_{couple} \cdot \eta}{A \cdot \tau_h} = \frac{0.0179 \cdot 0.35}{\frac{1}{2} 3.88 \cdot 61.8 \cdot 10^{-6} \cdot 350 \cdot 10^{-9}} \Rightarrow$$

$\Rightarrow \dot{w}_h = 1.493 \cdot 10^{11}\ W/m^3 \Rightarrow$

$\Rightarrow \boxed{\dot{w}_h^{max} = 4.479 \cdot 10^{11}\ W/m^3}$

Case 2

$V_p = 20\,kV$, $Q_{couple} = 1.396\,mJ/cm = 0.1396\,J/m$

$L = 6.88\,mm$ $\quad \eta = 0.35$ $\quad F = 10\,kHz$

$J = 62.7\,A/mm$ $\quad \tau_h = 350\,ns$ $\quad \Delta T_{max} = 407.7\,K$

electrode width $w = 8\,cm$

- **Power:** $W = Q_h \cdot f = \eta \cdot w \cdot Q_{couple} \cdot f =$

$= 0.35 \cdot 0.08 \cdot 0.1396 \cdot 10^4 \Rightarrow$

$\Rightarrow \boxed{W = 39.088\ Watt}$

- **fv Options value:** $\dot{w}_h^{max} = 3\,\dot{w}_h$

$\dot{w}_h = \dfrac{Q_{couple} \cdot \eta}{A \cdot \tau_h} = \dfrac{0.1396 \cdot 0.35}{\frac{1}{2} 6.88 \cdot 62.7 \cdot 10^3 \cdot 350 \cdot 10^{-9}} \Rightarrow$

$\Rightarrow \dot{w}_h = 6.47 \cdot 10^{11}\ W/m^3 \Rightarrow$

$= \boxed{\dot{w}_h^{max} = 1.9417 \cdot 10^{12}\ W/m^3}$

Case 3

$V_p = 30\ kV$, $Q_{couple} = 4.654\ mJ/cm = 0.4654\ J/m$

$L = 9.99\ mm$ $\quad \eta = 0.35$ $\quad F = 10\ kHz$

$\delta = 65.6\ km$ $\quad \tau_h = 350\ ns$ $\quad \Delta T_{max} = 894.8\ K$

electrode with $w \simeq 8\ cm$

- **Power**: $W = Q_h \cdot F = \eta \cdot w \cdot Q_{couple} \cdot F =$

$= 0.35 \cdot 0.08 \cdot 0.4654 \cdot 10^4 \Rightarrow$

$\Rightarrow \boxed{W = 130.312\ Watt}$

- **FvOptions**: $\dot{w}_h^{max} = 3 \cdot \dot{w}_h$

$$\dot{w}_h = \frac{Q_{couple} \cdot \eta}{A \cdot \tau_h} = \frac{0.4654 \cdot 0.35}{\frac{1}{2} 9.99 \cdot 65.6 \cdot 10^9 \cdot 350 \cdot 10^{-9}} \Rightarrow$$

$\Rightarrow \dot{w}_h = 1.42 \cdot 10^2\ W/m^3 \Rightarrow$

$\Rightarrow \boxed{\dot{w}_h^{max} = 4.261 \cdot 10^{12}\ W/m^3}$

Case 4

$N_p = 40$ kV, $Q_{couple} = 10.89$ mJ/cm $= 1.089$ J/m

$L = 13.08$ mm $\quad \eta = 0.35 \quad F = 10$ kHz

$\delta = 68.0$ J/m^3 $\quad I = 350 \quad \Delta T_{max} = 1542.7$ K

electrode width $w \simeq 8$ cm

- **Power**: $W = Q_h F = \eta w Q_{couple} F =$

$= 0.35 \cdot 0.08 \cdot 1.089 \cdot 10^4 =$

$\Rightarrow \boxed{W = 304.92 \text{ Watt}}$

- **For Options**: $\dot{w}_h^{max} = 3 \cdot \dot{w}_h$

$$\dot{w}_h = \frac{Q_{couple} \cdot \eta}{\Delta \cdot \tau_h} = \frac{1.089 \cdot 0.35}{\frac{1}{2} 13.08 \cdot 68.0 \cdot 10^{-9} \cdot 350 \cdot 10^{-9}}$$

$\Rightarrow \dot{w}_h = 2.44686 \cdot 10^2$ W/m^3 $\Rightarrow$

$\Rightarrow \boxed{\dot{w}_h^{max} = 7.34 \cdot 10^{12} \text{ W/m}^3}$

Case 5

$V_p = 50\ kV$, $Q_{couple} = 20.965\ mJ/cm = 2.0965\ J/m$

$L = 16.13\ mm$ $\quad \eta = 0.35$ $\quad f = 10\ kHz$

$\sigma = 70.3\ J/m$ $\quad \tau_h = 350\ ns$ $\quad \Delta T_{max} = 2329.5\ K$

electrode width $w \simeq 8\ cm$

Power: $W = Q_{HF} = \eta \cdot w \cdot Q_{couple} \cdot f =$

$= 0.35 \cdot 0.08 \cdot 2.0965 \cdot 10^4 =$

$\Rightarrow \boxed{W = 587.02\ Watt}$

F.O.: $\dot{w}_h^{max} = 3 \cdot \dot{w}_h$

$$\dot{w}_h = \frac{Q_{couple} \cdot \eta}{A \cdot \tau_h} = \frac{2.0965 \cdot 0.35}{\frac{1}{2} 16.13 \cdot 70.3 \cdot 10^{-9} \cdot 350 \cdot 10^{-9}} \Rightarrow$$

$\Rightarrow \dot{w}_h = 3.69773 \cdot 10^{12}\ W/m^3 \Rightarrow$

$\Rightarrow \boxed{\dot{w}_h^{max} = 1.1093 \cdot 10^{13}\ W/m^3}$