Triode Oscillator Design Using FEM Modeling

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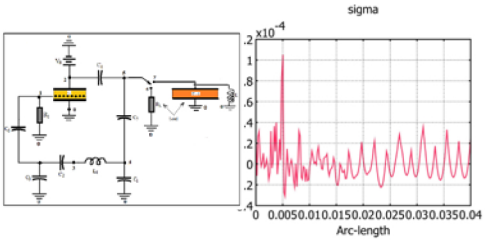
COMSOL, adding SPICE elements into its FEM, gives the possibility of a direct modeling of oscillators: triode and load are FEM described while all the other components of the circuit are just simulated using SPICE.

The modeling is not a straight application of any module but needs the previous computation of the conductivity of the beam through PDE mode.

Fig.1: oscillator circuit



Electronic equation Comsol static solution for σ Fig.2: σ with negative values

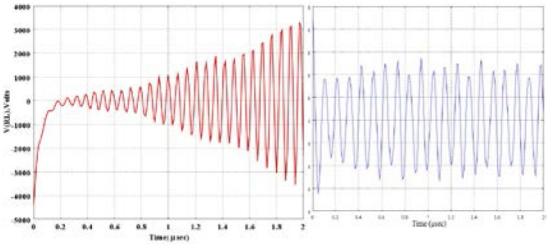
$$\begin{cases} \frac{1}{2}mv^2 = -eV \\ \nabla^2 V = -\frac{\rho}{\varepsilon_0} \\ i = \rho v \end{cases}$$

$$\begin{cases} (emes) \rightarrow -\nabla \varepsilon_0 \nabla V_{cc} = -current / \sqrt{2\eta V_{cc}} \rightarrow V_{cc} \\ (PDE) \rightarrow -\nabla \sigma \nabla V_{cc} = 0 \rightarrow \sigma\ (stored) \\ (emdc) \rightarrow -\nabla \sigma \nabla V = 0 \rightarrow V\ (to\ check\ V \cong V_{cc}) \end{cases}$$

Oscillator modeling

$$\begin{cases} (emqvw) \rightarrow -\nabla \partial(\varepsilon_0 \nabla V) / \partial t - \nabla(\sigma \nabla V) = 0 \\ (Spice) \rightarrow other\ circuit\ components \end{cases}$$

Bibliography: Marvin Chodorov and Charles Susskind, "Fundamentals of Microwave Electronics", McGraw-Hill, 1964.



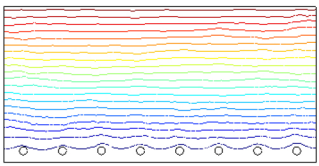


Fig.3: voltage on 50W Fig.4: voltage on the capacitance Fig.5: voltage distribution

This bench mark gives to the user of high power triodes/tetrodes the possibility to enter into their design in order to have a tube well matched to their needs, including on the thermal aspects.

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