Eddy-Current Starters for Wound Rotor Induction Motors

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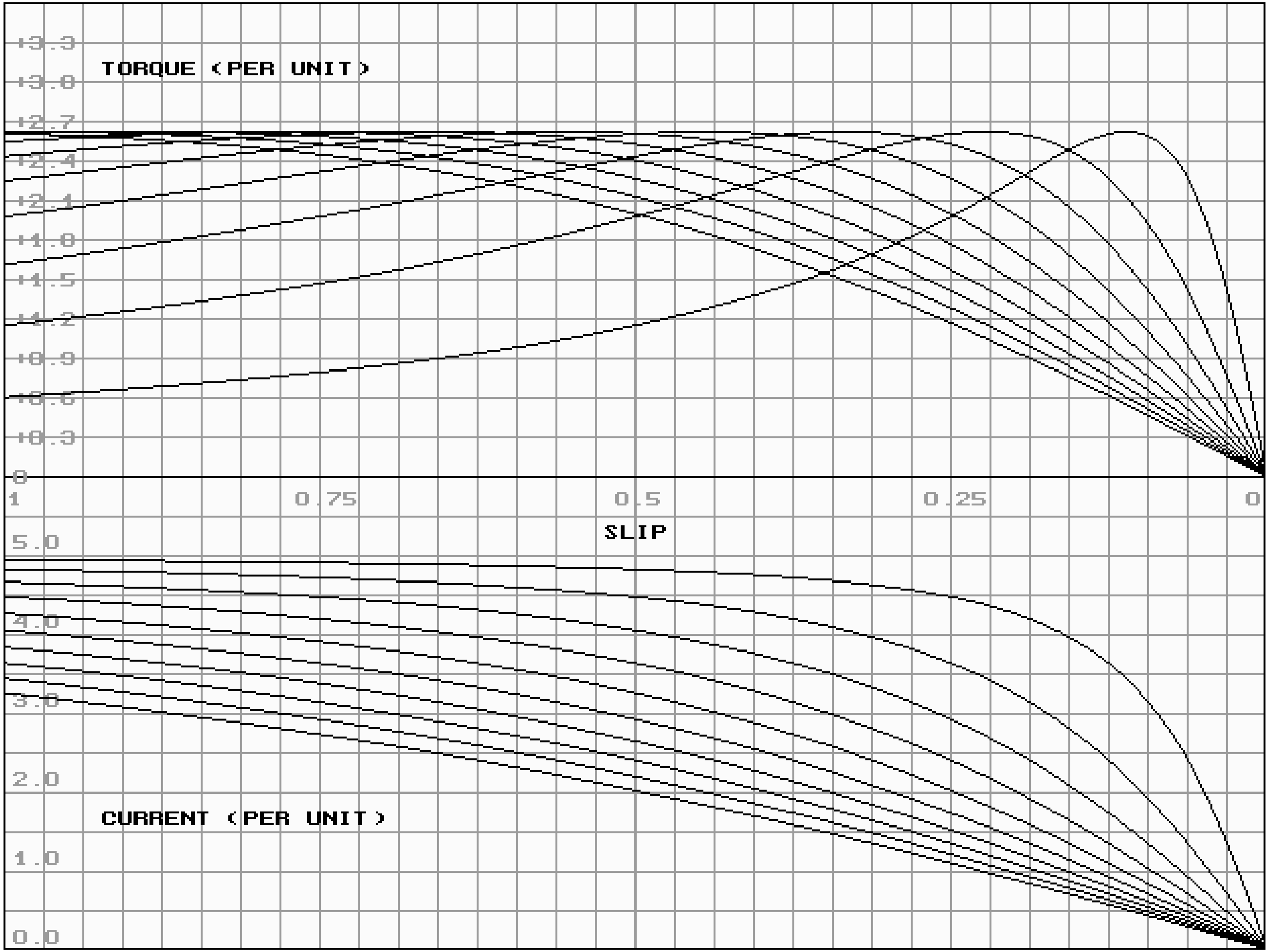
Eddy-Current Starters for Wound Rotor Induction Motors (WRIMs)

- Wound Rotor Induction Motors – Fundamentals and Requirements.
- Starting devices / methods for WRIMs.
- Theory of Eddy-Current Starters.
- Fundamental design of Eddy-Current Starters.
- Eddy-Current Power Density and Distribution: Non-linearity.
- Intricacies about Eddy-Current Starters: Optimisation.
- Current Density Spectrums.
- Leakage Effects.
- Conclusion.

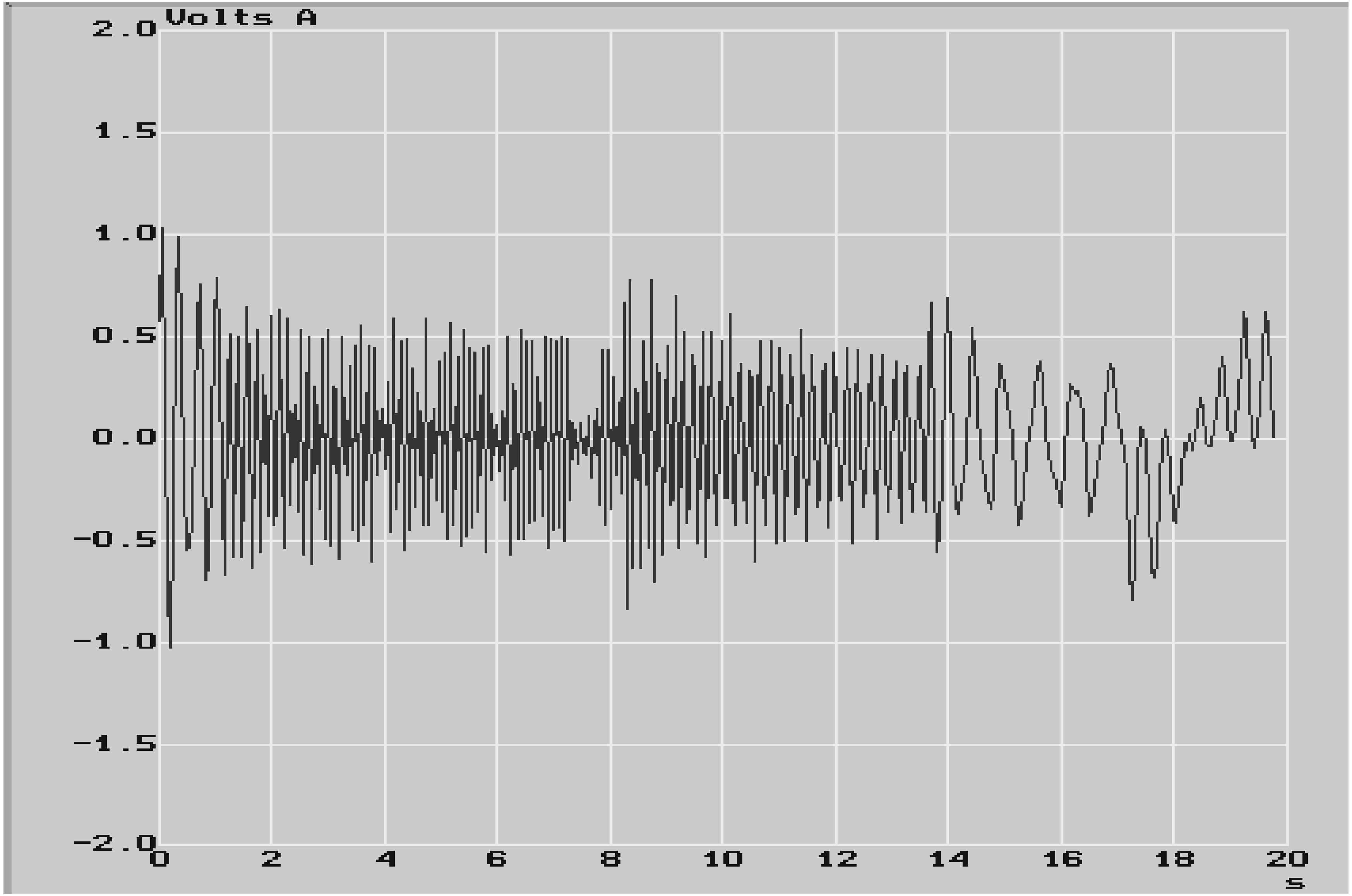
Starters for Wound Rotor Induction Motors (WRIMs)

- Liquid resistor starters
- Traditional switched resistor networks
- Electronically switched resistors (Pulse Width Modulated)
- Vapour starters
- Saturistors
- Eddy-current starters
- Built-in implementations of rotor resistance devices: Idle-bar rotors.

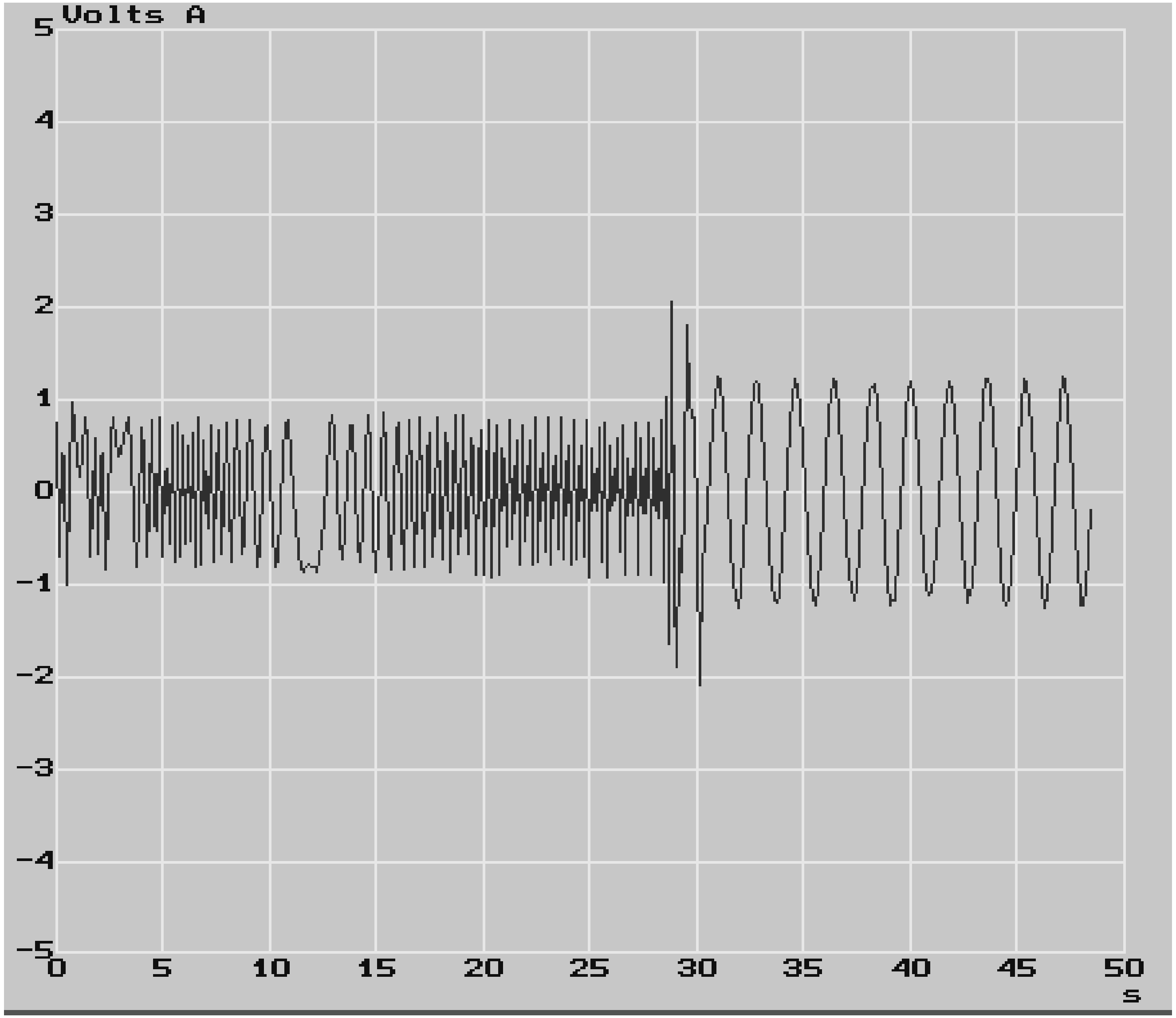
WRIM Current and Torque Versus Speed



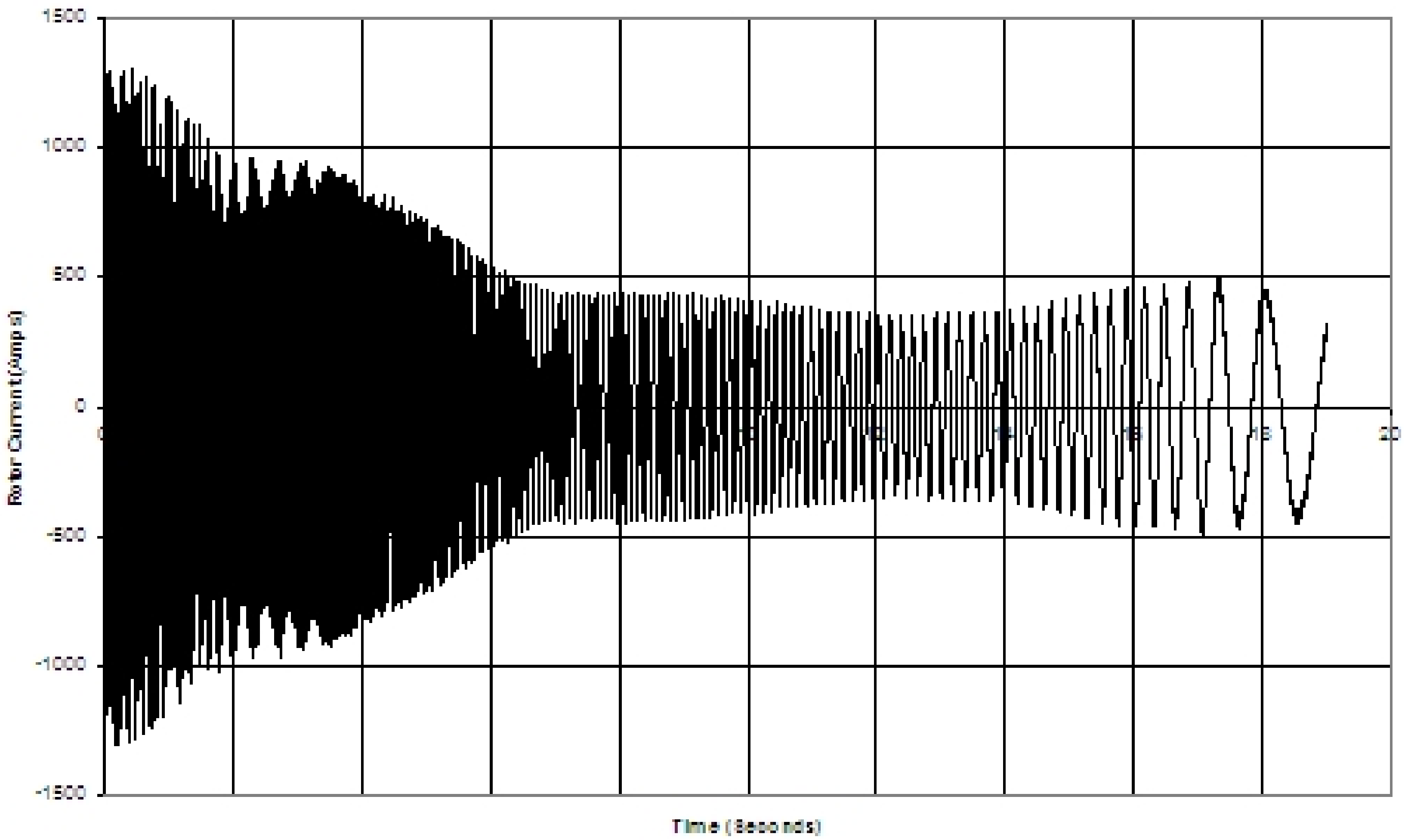
“Vapour” Starter – Two Stage



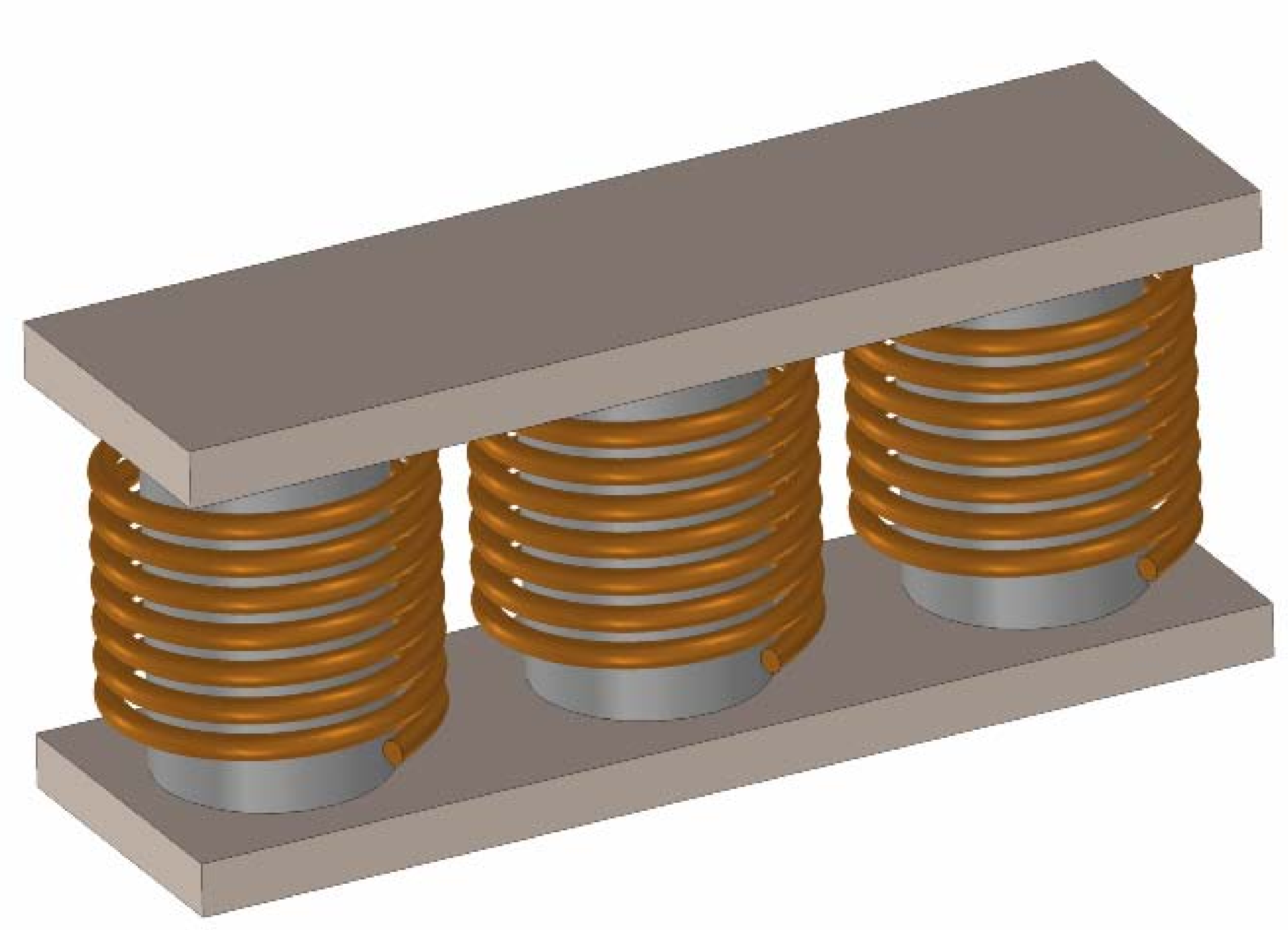
Liquid Resistor Start – Low Electrolyte Concentration



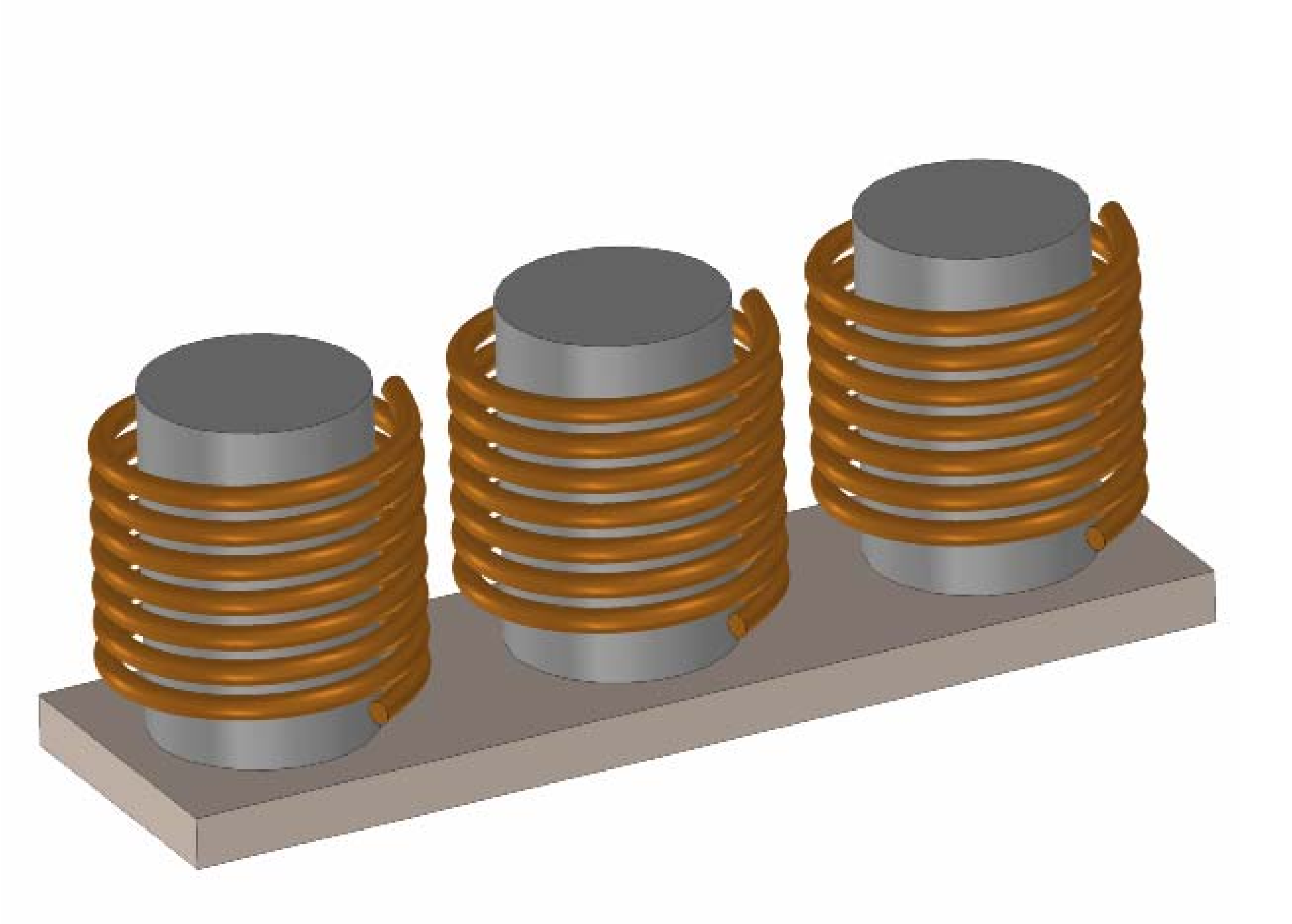
Eddy-Current Starter Start



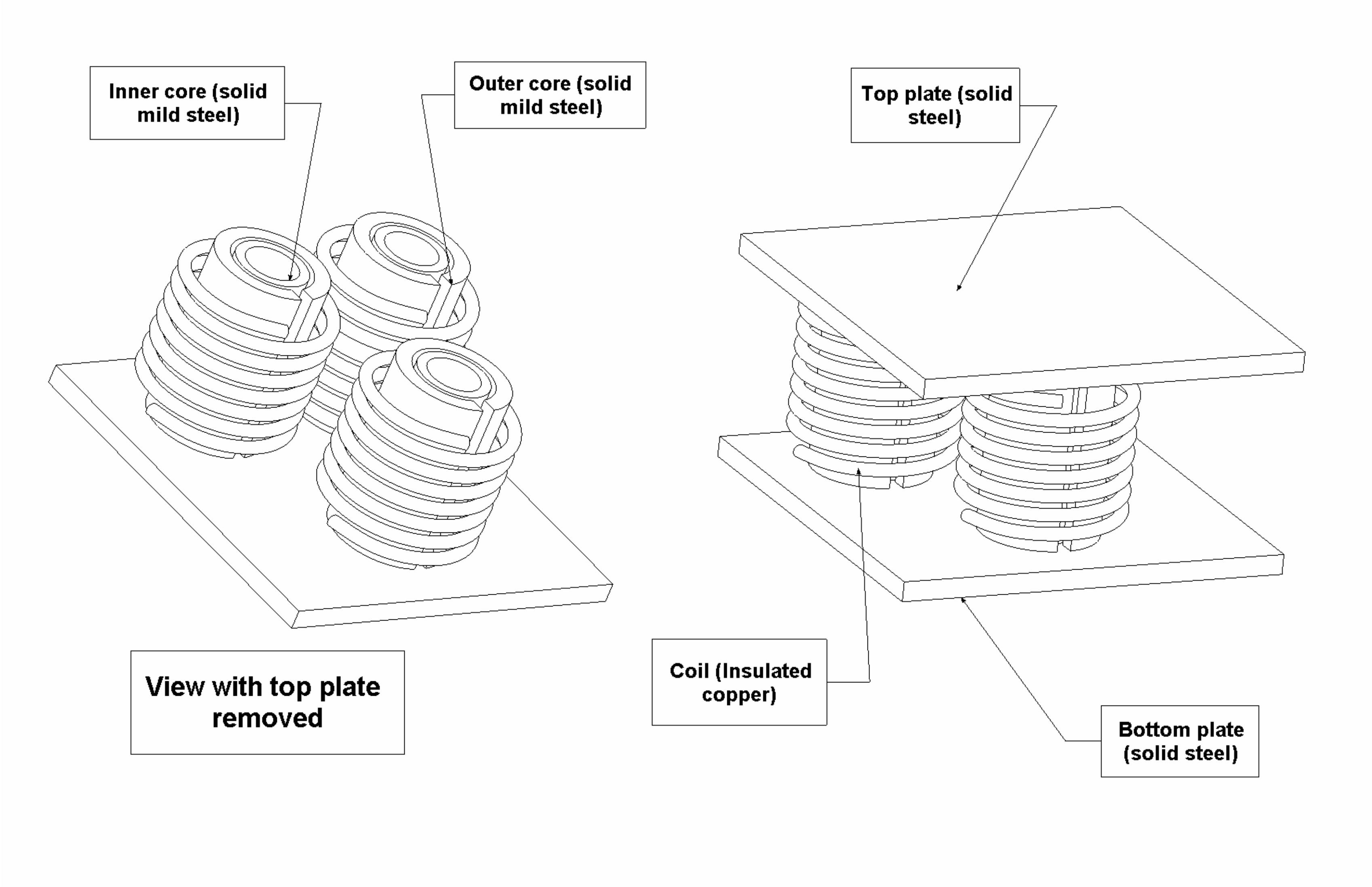
Fundamental Design



Fundamental Design (cont.)



Fundamental Design (cont.)



Eddy-Current Transfer Analysis Methods

- Thomson's classical eddy-current theory
- Rosenberg's Assumption
- Agarwal's Methods
- Poynting Vector
- Finite Difference Method
- Boundary Integral Method
- Finite Element Method
- Miscellaneous Numerical Methods

$$P = \frac{H_o^2}{2 \cdot \delta \cdot \gamma}$$

Non-linearity Issues – Current Density

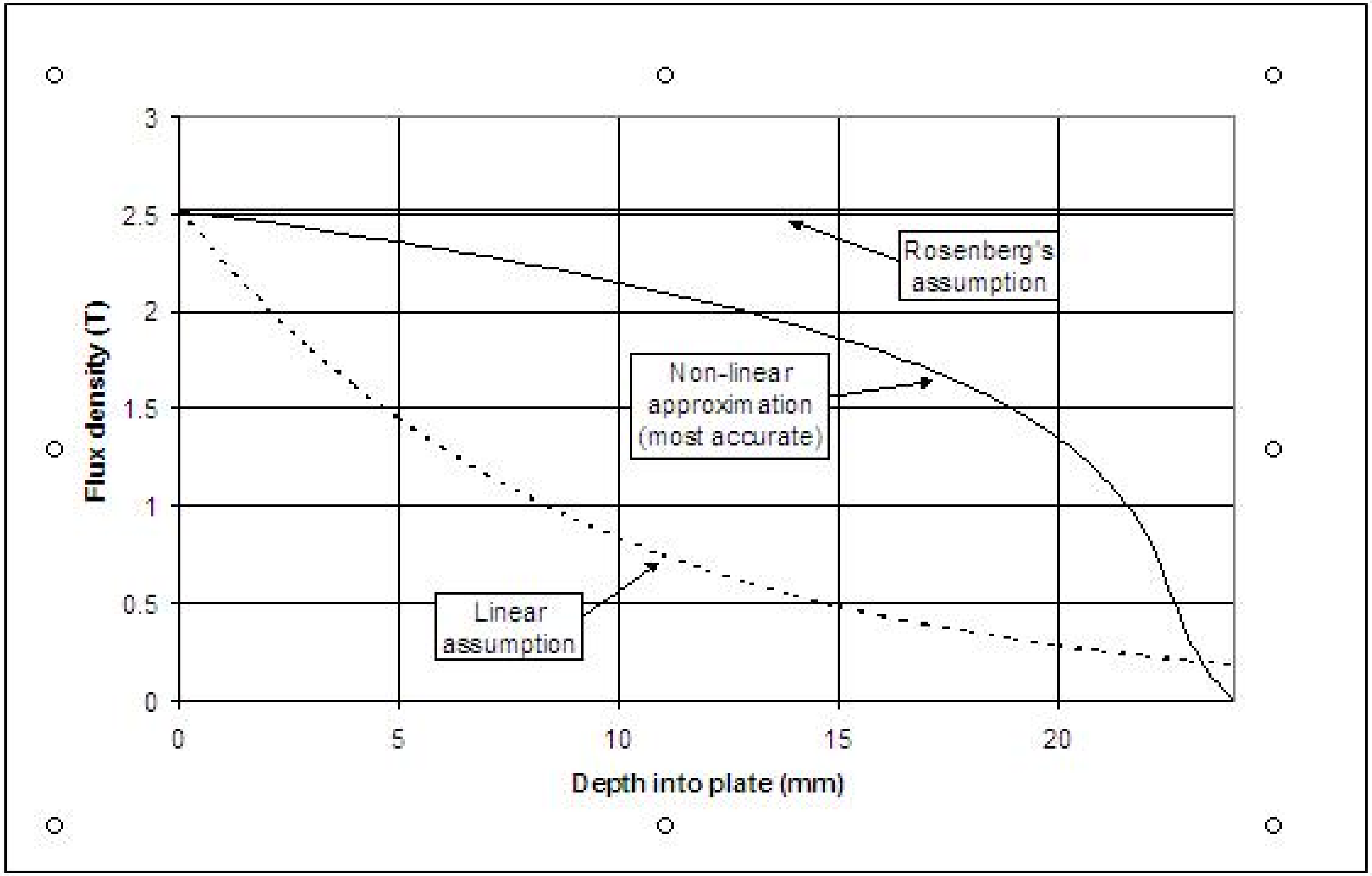
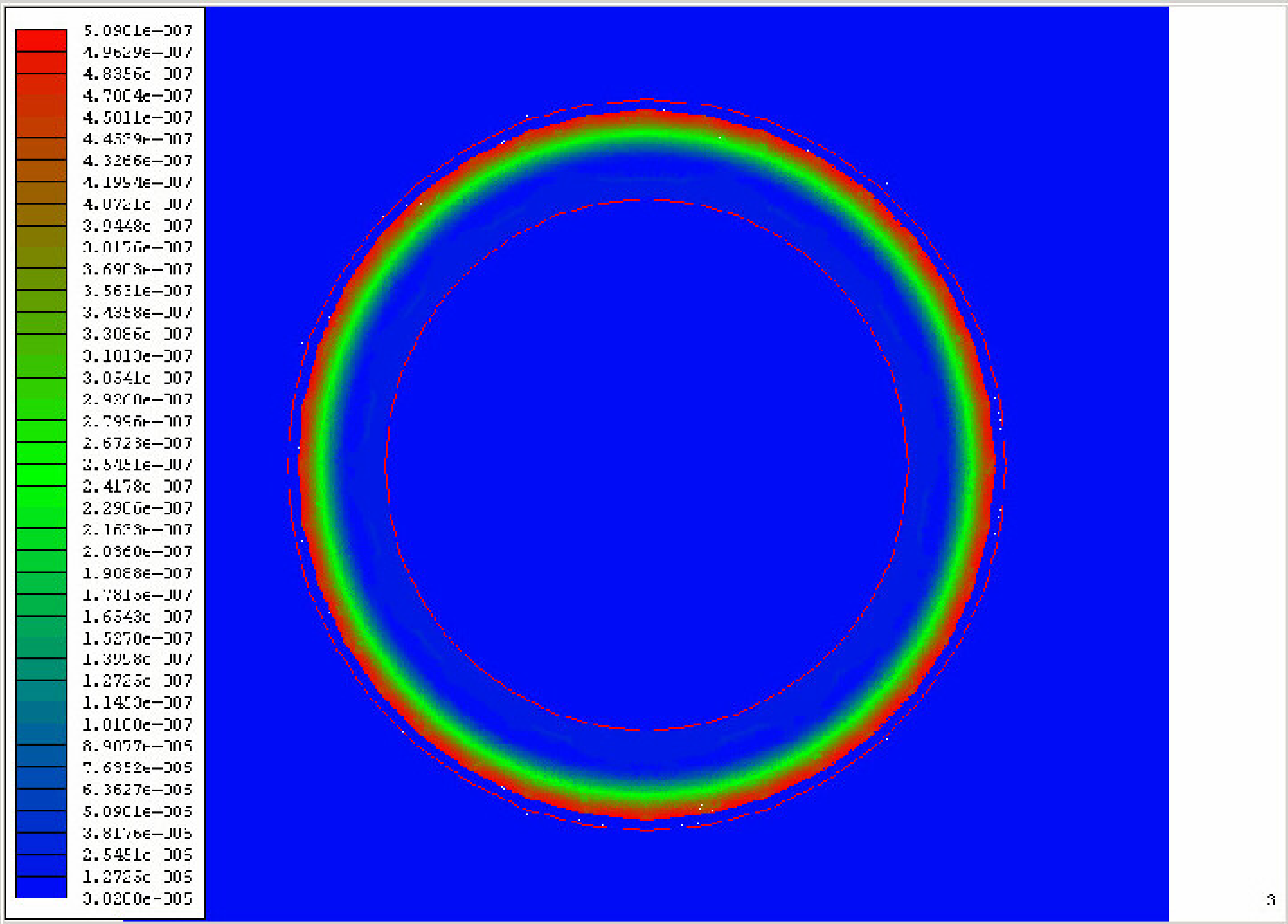


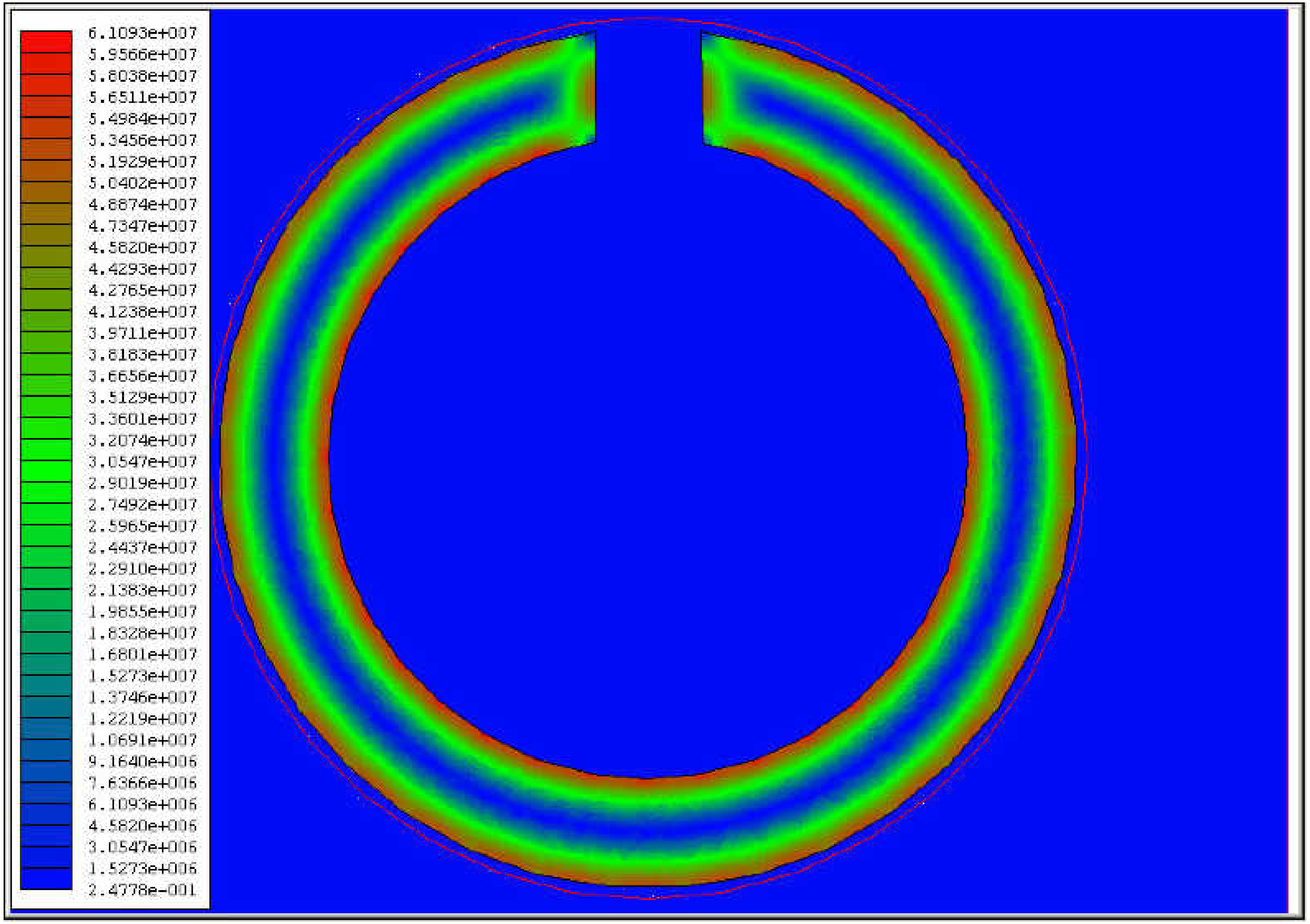
Figure 3-3 : Rosenberg's assumed magnetisation curve (with penetration depth) compared with linear assumption (inaccurate) and non-linear approximation (most accurate), for a surface peak flux density of 2.5 T.

$$\delta = \sqrt{\frac{2}{\omega \cdot \gamma \cdot \mu}}$$

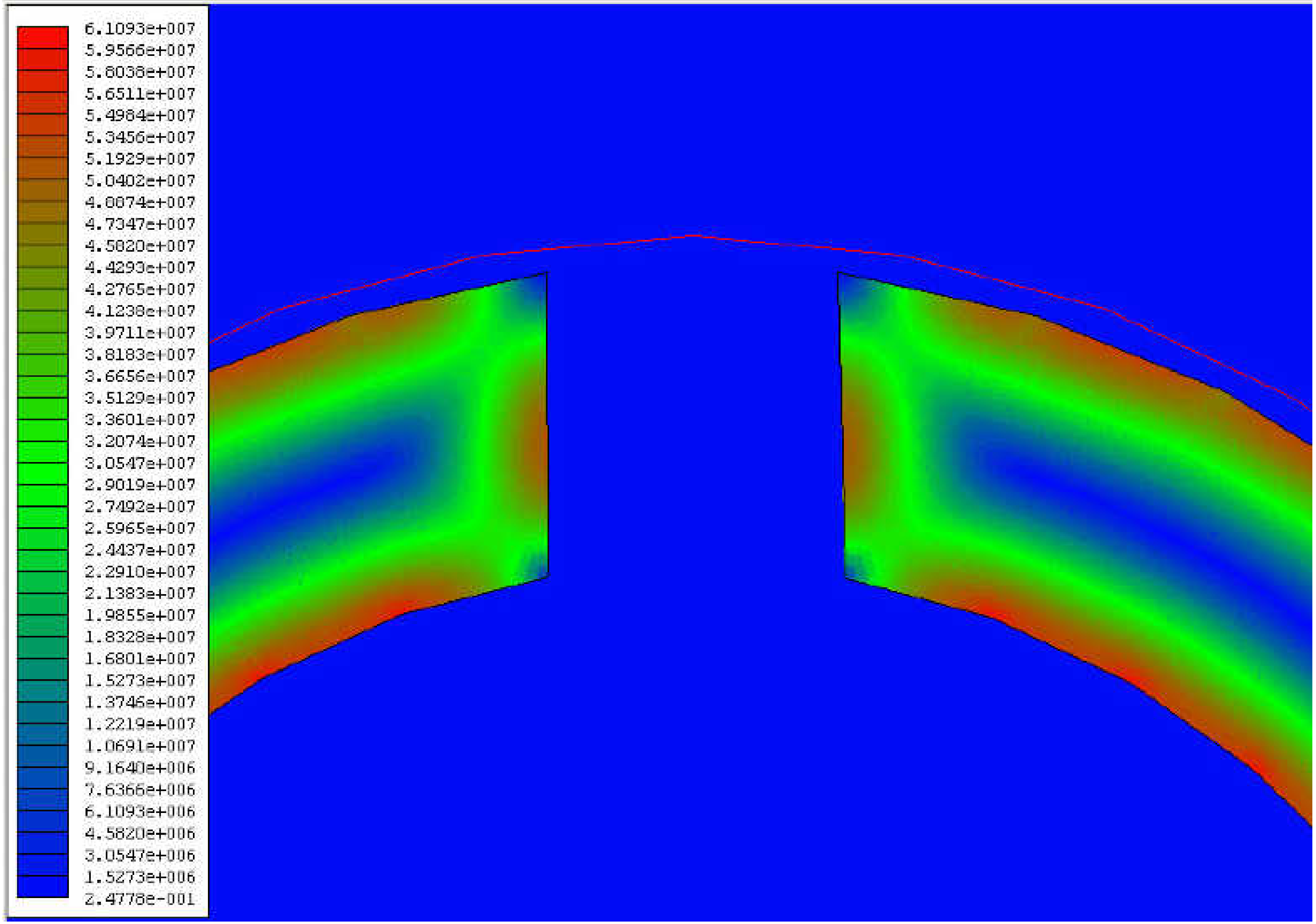
Current Density Spectrum 2



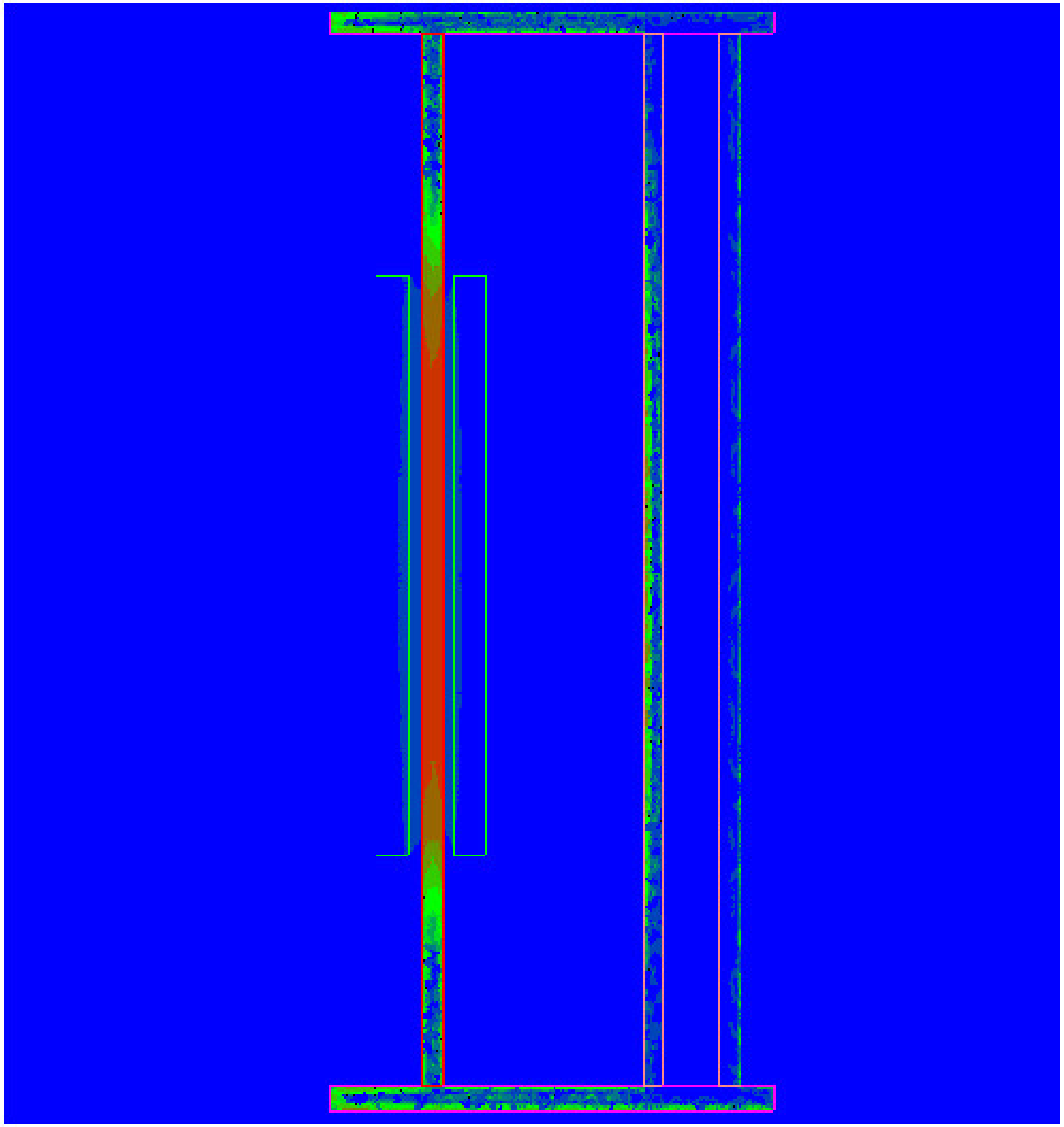
Current Density Spectrum



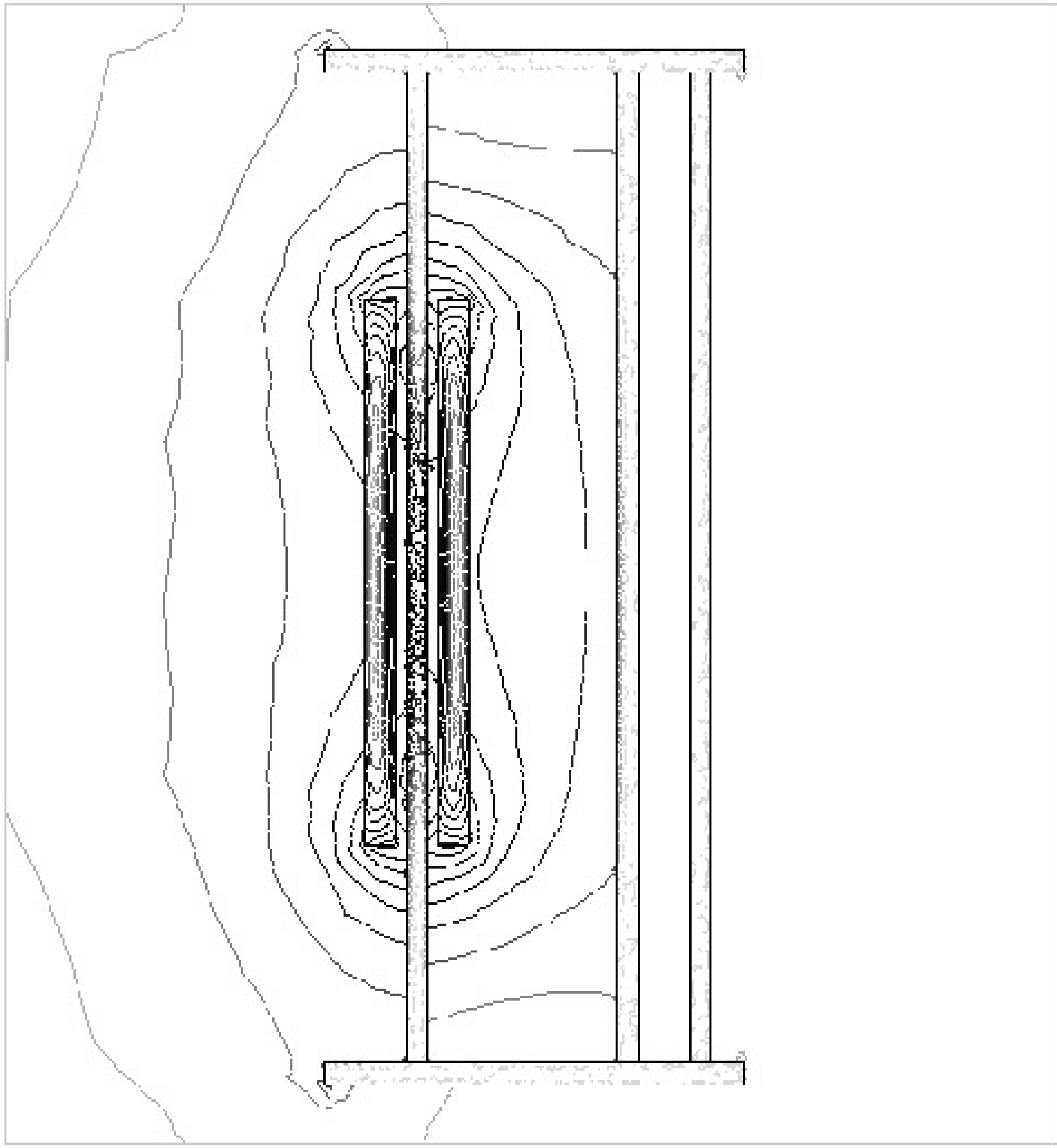
Current Density Spectrum (cont.)



Current Density Spectrum (cont.)



Leakage Effects



Conclusion - Practicality

- Simple: No moving parts
- Low Maintenance: As above
- Variations of Impedances with Tappings
- Smooth, (almost) Stepless variation of resistance with motor speed
- Heat energy is distributed mainly in the iron core
- Good for smaller (up to 800 kW) small to medium loads
- Not ideally suited for long runup times
- Ideal retrofit where supply can accommodate some additional current
- No control functions – just impedance variation with tapping setting
- Not a pure resistance – has an inductive component
- Good low-maintenance replacement for low and medium load torque applications with short to medium runup times.