Better Magnetics

High Frequency Magnetics Workshop 2020
Do you want to see a city on Mars in the next 50 years?
The losses in the magnetics are the same than 20 years ago, while semiconductor losses have decreased 10x!
Four skills for one success:

- Electrical Design
- Mechanical Design
- Materials
- Building
People & Technology
Is Artificial Intelligence the key for accelerating the next revolution in PE?
Magnetics are simple
Magnetics are simple?

Choose your wires

Choose your core

Choose your considered effects

Choose your models

\[ P_v = k \cdot f^a \cdot B^b \]

\[ P = \frac{1}{T} \int_0^T k_i \frac{dB}{dt}^{\alpha} (\Delta B^{\beta\cdot\delta}) dt \]
Modelling reality

Steinmetz’s model
Modified Steinmetz
Generalized Steinmetz
Improved Generalized Steinmetz
Natural Steinmetz Equation

Preisach’s model

Ferreira’s model

\[ P_v = k \cdot f^a \cdot B^b \]

\[ p_v = \left( C_m f_{eq}^{\alpha-1} \hat{B}^\beta \right) f_r. \]

\[ P = \frac{1}{T} \int_0^T k_i \left| \frac{dB}{dt} \right|^a (\Delta B^{b-a}) dt \]

\[ P_{NSE} = \left( \frac{\Delta B}{2} \right)^{\beta-a} \frac{k_N}{T} \int_0^T \left| \frac{dB}{dt} \right|^\alpha dt \]

\[ k_N = \frac{k}{(2\pi)^{a-1} \int_0^{2\pi} |\cos \theta|^\alpha d\theta} \]

\[ P_{up} = GH_e^2 \]

\[ G = \frac{-2\pi \gamma \text{ber}_2 \gamma \text{ber}' \gamma + \text{bei}_2 \gamma \text{ber}' \gamma}{\sigma \text{ber}^2 \gamma + \text{bei}^2 \gamma} \]
No black magic

Mystery

Investigation

Modelling & sequencing

System

Unstructured data

Anomalies & patterns

Analysis & hypothesis

Artificial Intelligence
No black magic

Steinmetz’s model → Losses in magnetic core
Preisach’s model → Hysteresis loop
Ferreira’s model → AC resistance

Frenetic’s model →
- Steinmetz’s model
- Preisach’s model
- Ferreira’s model
- Magnetic design
- Human learning
How Engineers works

Universities and courses

Learning
How FAI works

Technical publications

Learning
FAI squad

Magnetic
- Core
- Wires
- Turns
- Parallels
- Gap
- Stacks
- Wires placement
- Insulation
- Cooling

AC resistance
Core losses
Magnetizing inductance
Permeability
DC resistance
Winding losses
Leakage inductance
Magnetic flux density
Electrical insulation
Temperature
Stray capacitance
Window filling
Laboratory feedback

Construction → Measurement → Big data
Final form