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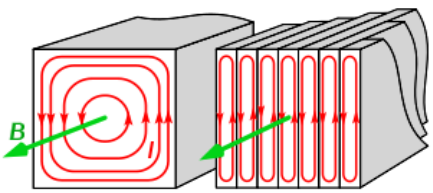
LAMINATED CORES:
A QUICK INTRODUCTION TO DESIGN

At low frequency applications, laminated cores are commonly used to reduce eddy currents. The material employed for this construction is electrical steel, that allows to slice a solid core unlike ferrite materials, that are very brittle.
The objective of this APP Note is to introduce laminated cores, explaining why they are used instead of solid cores when eddy currents must be low and some of the difficulties that magnetic designers can find when this core construction is needed.

WHAT ARE EDDY CURRENTS?

Eddy currents are closed loops of current set up in a conductor in response to a changing magnetic field, and these currents are perpendicular to the plane of the magnetic field.



HOW CAN EDDY CURRENT LOSS BE REDUCED?

The eddy current losses per unit mass can be calculated using the following expression:

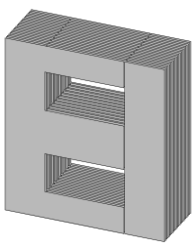
$$P = \frac{\pi^2 B_p^2 d^2 f^2}{6k\rho D}$$

Where:
- *Bp*: magnetic field peak (T)
- *d*: conductor thickness (m)
- *f*: frequency (Hz)
- *k*: constant (1 for laminated cores)
- *ρ*: material resistivity (Ω · m)
- *D*: material density (kg / m^3)

From this expression, it can be seen that eddy current losses can be reduced:

- Using a **high resistivity material**.
- **Reducing the thickness** of the core.

Laminated cores are based on the last option, where is divided the core in thin slices, electrically insulated, oriented in parallel to the magnetic flux.



DIFFICULTIES IN THE DESIGN PROCEDURE:

The design of magnetic elements using the laminated cores construction can be a difficult labor, by cause of:

- It is necessary a **huge number of stacks** for having the desired core properties so, for having the optimum design, a lot of number of iterations are needed.
- The **lack of information** due to the electrical steel manufacturers normally not making laminations, and vice versa, so magnetic designers do not have all the information about the core.

CONCLUSIONS

The magnetic element design procedure using laminated cores could be a difficult labor due to the huge number of possible combinations in the number of stacks and the lack of information given by the manufacturers. Because of this, sometimes it is a challenge to have a valid design with few iterations and, if the optimum one it's wanted, too much time may be necessary, which entails a high cost of the magnetic element. Frenetic, thanks to its artificial intelligence, can study all the possible combinations and compare it with real measurements for having the optimum design in no more than a few hours.

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