2D Eddy Current Analysis In Plane Of Laminated Ferromagnetic Media

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Introduction: Laminated media are intended to conduct the magnetic flux in the plane [1]. When fringing flux falls in perpendicularly to the plane, the surface for the eddy currents is no longer small. This will cause eddy current losses, which will reduce the efficiency of the application [2].

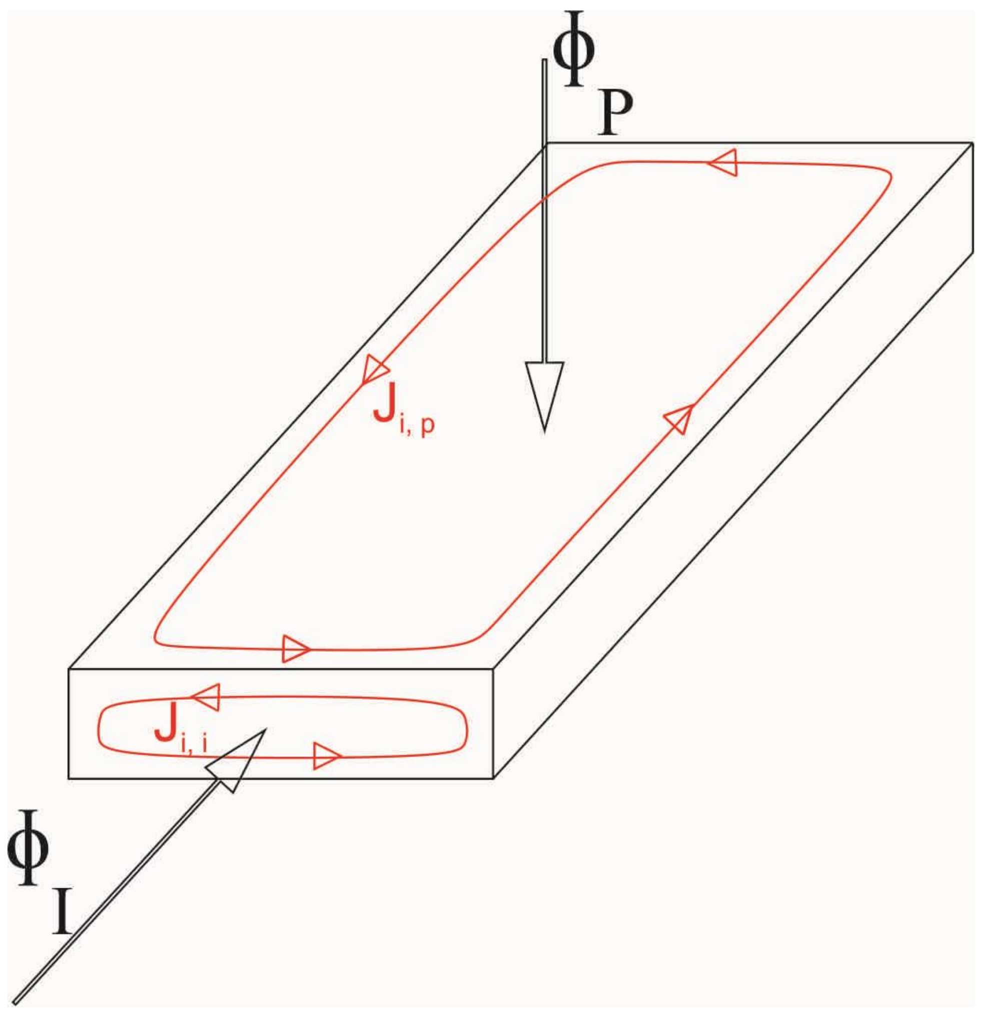

Figure 3. Induced eddy currents $J_{i,p}$ and $J_{i,i}$ in one sheet of laminated media, caused by flux Φ_p perpendicular to the plane and caused by flux Φ_I in the plane respectively

Computational Methods: In order to reduce calculation time, a 2D model and a simplified geometry with proper symmetry is used. Instead of using a homogenization method [3], all details of the laminated media are considered to become an accurate model. By this way the geometry is one fourth of a rectangular tooth in closed magnetic circuit by use of a yoke (figure2). The isolation (coating and air) between the sheets is modeled by use of 'thin low permeability gaps'. The sum of the induced eddy currents must be zero in each individual sheet, this is obtained by use of the 'single turn coil domain' with total current zero applied to each sheet.

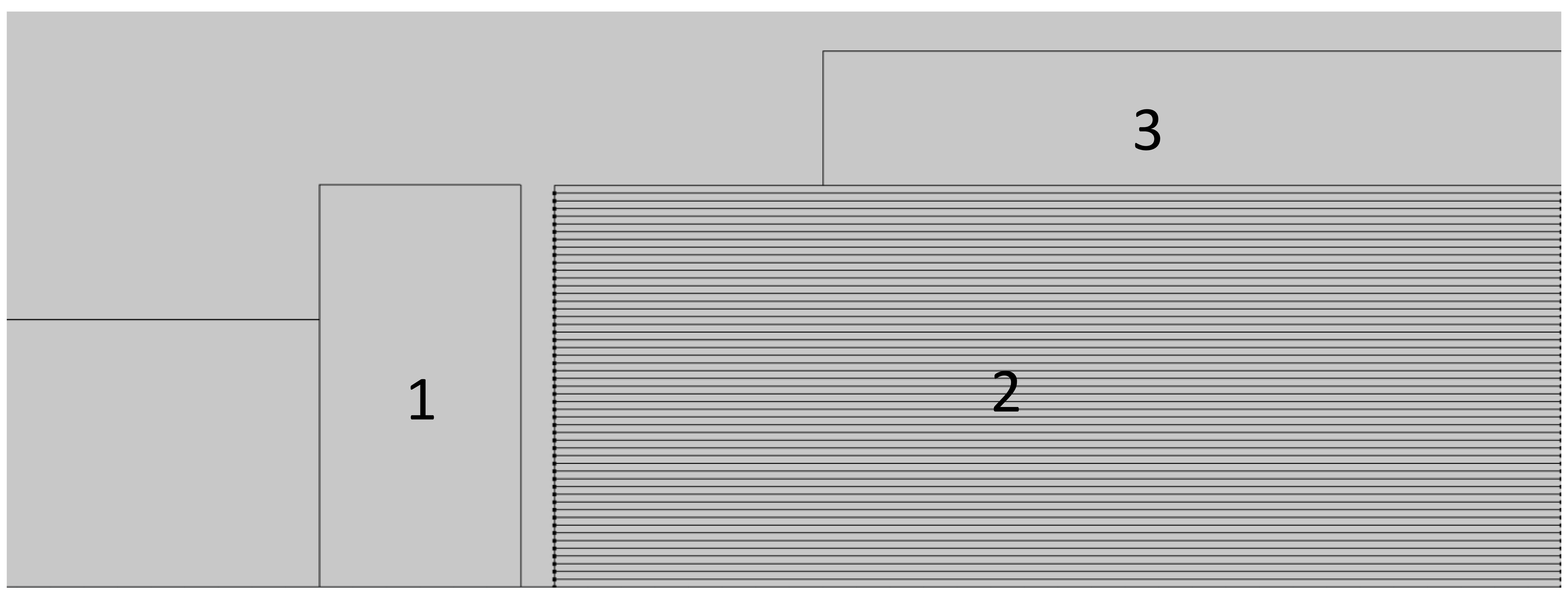

Figure 2. Geometry: (1)Yoke (2)Laminated media (3)Conductor

Results: Different frequencies are studied. At high frequencies, the losses aren't quadratic with the frequency, because the magnetic reaction field produced by the eddy currents compensating the magnetic fringing field can't be neglected (figure3). Different widths of the air gap are studied, when the air gap width increases, more fringing flux falls in perpendicularly to the sheet, which causes more eddy currents which results in more losses (figure 4 and 5).

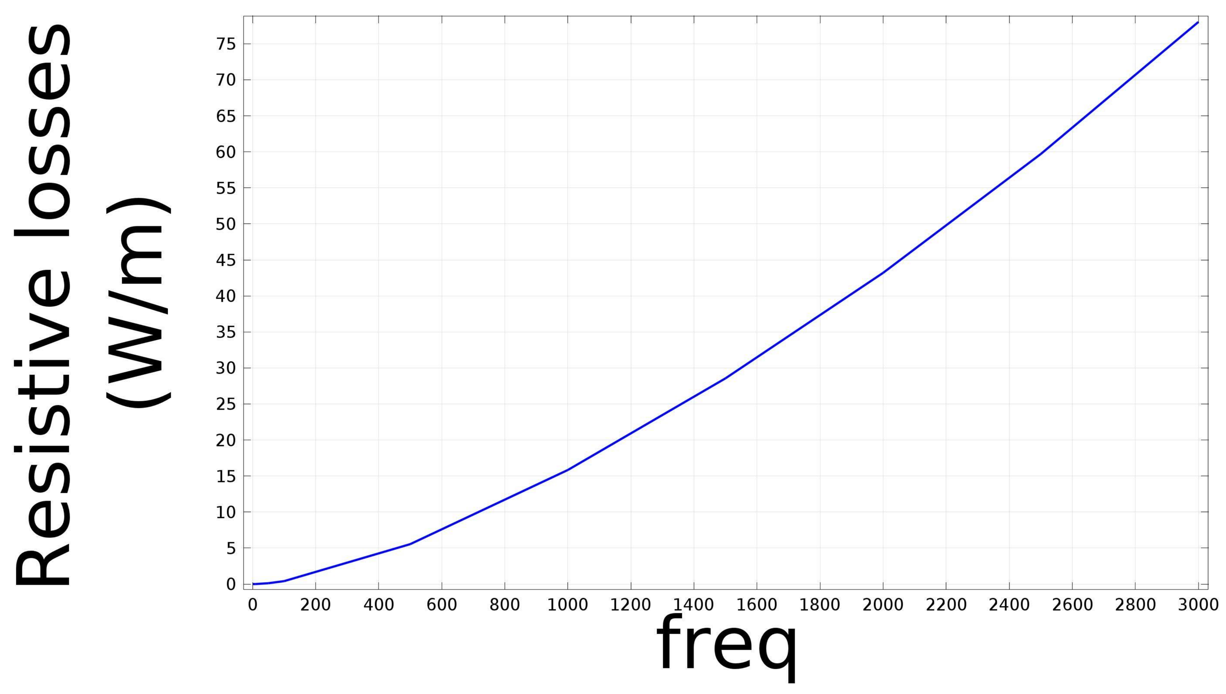

Figure 3. Resistive losses in function of different frequencies

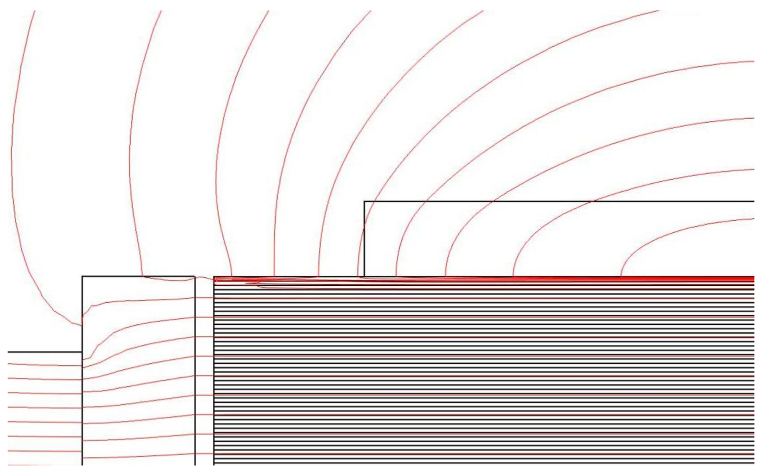

Figure 4. Magnetic field lines by 1mm air gap thickness

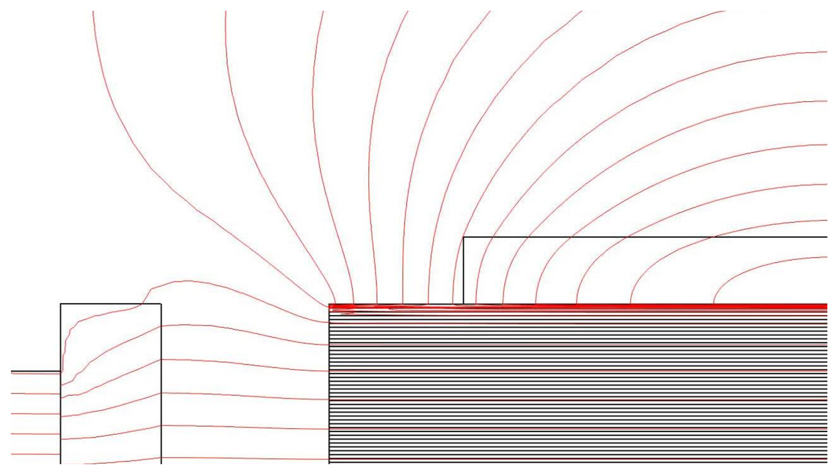

Figure 5. Magnetic field lines by 10mm air gap thickness

Conclusions: Eddy currents due to perpendicular flux can't be neglected in motor design. Reducing these eddy currents by use of new techniques/materials will increase the efficiency of the application.

References:

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