Analysis of one-dimensional ferromagnetic rod in terms of heat losses

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Abstract: This work aims to analyze the influence of a time-varying magnetic field and its consequences in terms of heat losses on a one-dimensional metallic rod of the finite length of the ferromagnetic material in the context of Maxwell's equations and modified Ohm's law. Due to time-varying magnetic fields, conducting currents are formed, which give birth to eddy current and eventually result in heat loss known as eddy current loss. At the same time, due to the reversal in the applied magnetic field, the internal friction of the molecular magnets resists the reversal of magnetism, resulting in magnetic hysteresis. To mitigate this internal friction, a fraction of the magnetizing force is employed; this work done by the magnetizing force creates heat defined as hysteresis loss. Treating the total heat loss as the thermal loading for the problem, the differential equations governing the distribution of temperature fields, elastic fields, and electromagnetic fields are derived and solved with the help of suitable boundary conditions. The results obtained are displayed graphically using MATLAB software to illustrate the influence of wave frequency, hysteresis loss, eddy current loss, and time-dependent magnetic field on the temperature distribution of ferromagnetic material considered.

Key-words: Maxwell's equations, magneto-thermoelasticity, eddy current, hysteresis loss, time-varying magnetic field, integral transform