Experimental Validation of Induction Heating of MS Tube for Elevated Temperature NDT Application

B. Patidar[1], M. M. Hussain[1], S. Das[1], D. Mukherjee[1], A. P. Tiwari[2]
[1]Atomic Fuels Division, BARC, Mumbai
[2]Reactor Control Division, BARC, Mumbai

Introduction: Induction heating is non contact type heating techniques. It is widely utilized in industries in various applications such as heating, forging, melting, welding, crystal growth etc, because of high efficiency, cleanness and easy control[1] Therefore, induction heating is preferred to heat the different size of specimens for conducting elevated temperature non destructive testing (NDT).

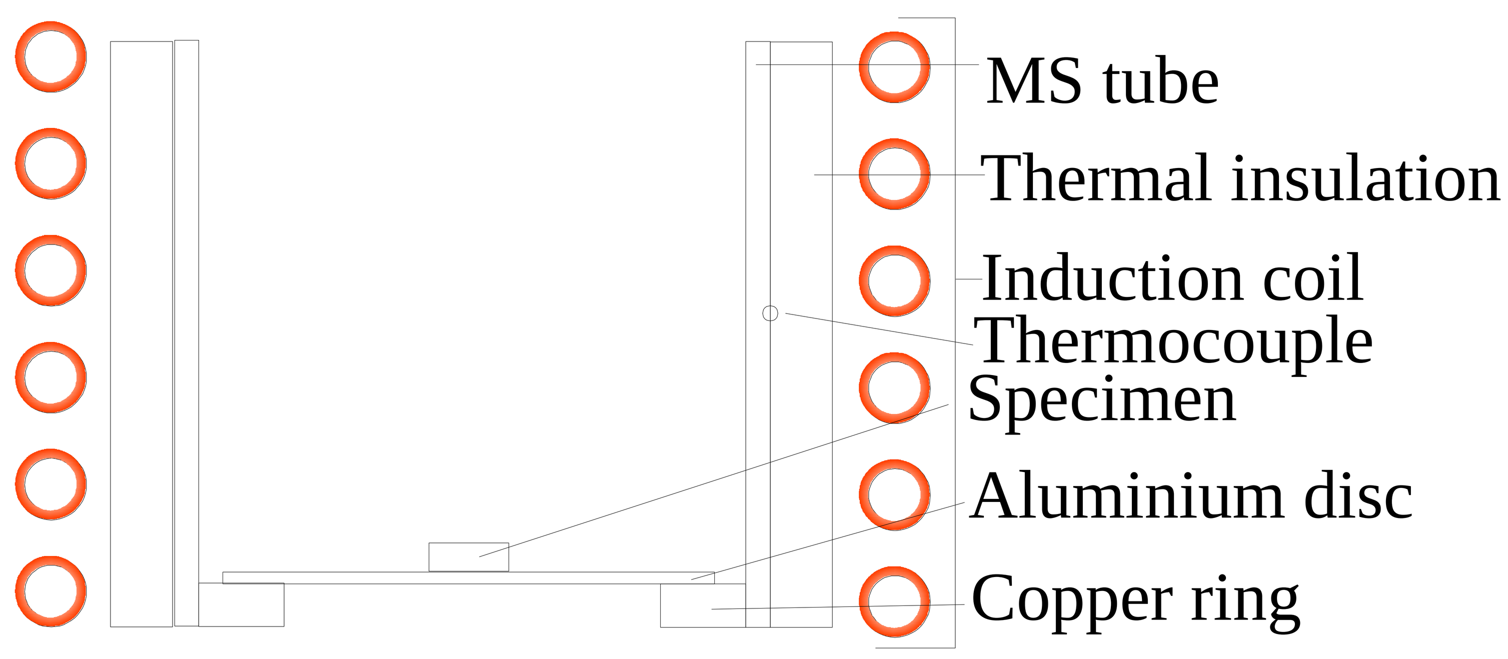

Figure 1. Schematic Diagram of induction heating system

Computational Methods: Induction heating is coupled field phenomena, i.e combination of electromagnetism and heat transfer [2][3]. Both the physics are nonlinearly coupled with each other due to temperature dependent material properties.

Electromagnetism
$$\frac{1}{\mu(T)}\nabla^2 A - J_s + j\omega\sigma(T)A = 0 \quad (1)$$
$$Q = \frac{{J_e}^2}{\sigma(T)} = \sigma(T)(j\omega A)^2 \quad (2)$$

Heat transfer
$$K(T).\ \nabla^2 T) + Q = \rho c_p(T)\frac{\partial T}{\partial t} \quad (3)$$

Convection heat loss
$$Q_{conv} = h.(T - T_{amb})\ \mathrm{W/m^2} \quad (4)$$

Radiation heat loss
$$Q_{rad} = \epsilon\sigma_b.\left(T^4 - {T_{amb}}^4\right)\ \mathrm{W/m^2} \quad (5)$$

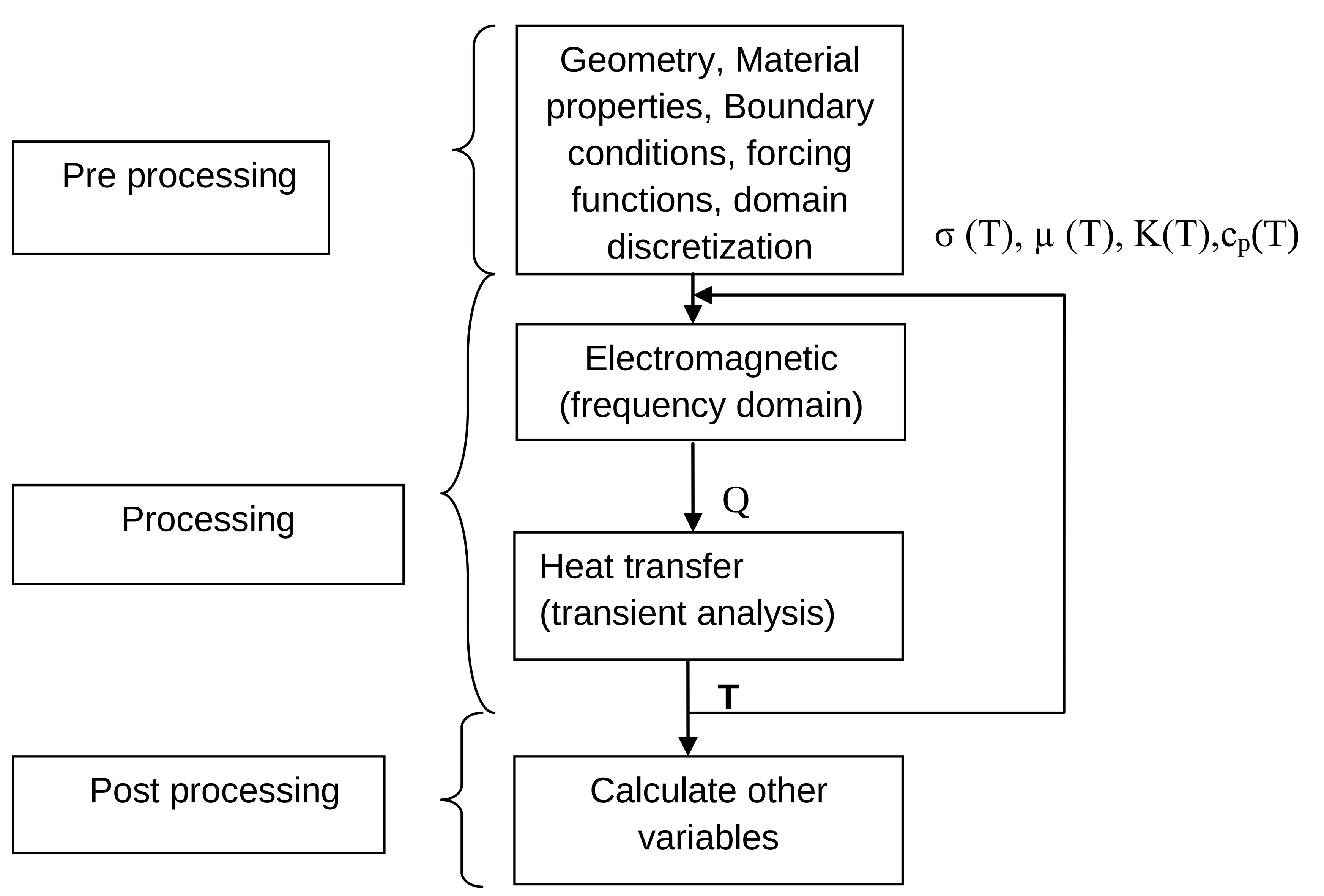

Figure 3. Simulation procedure

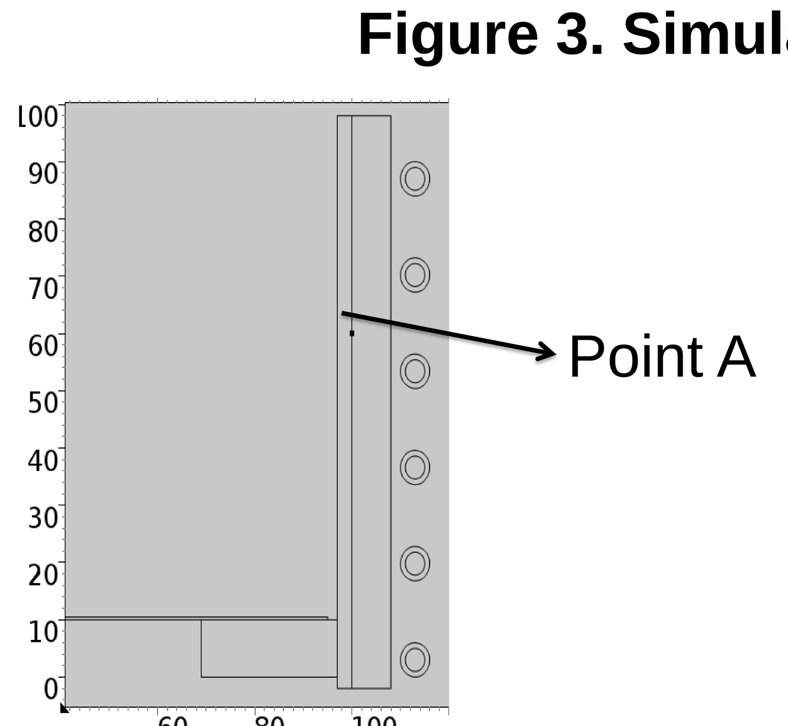

Figure 2. Geometry

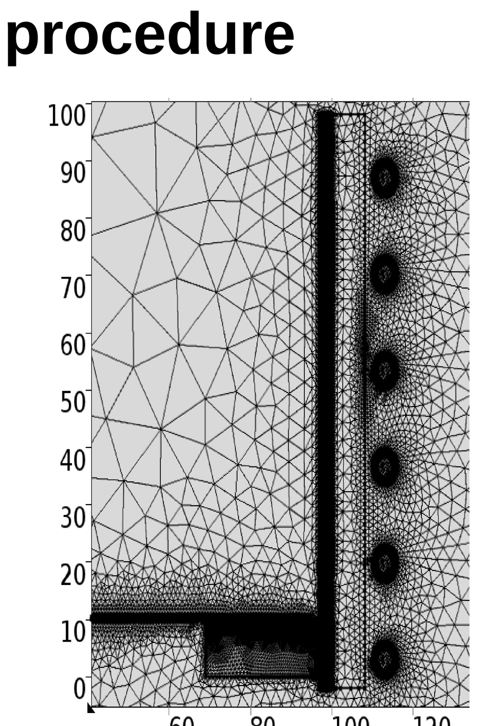

Figure 3. Meshing

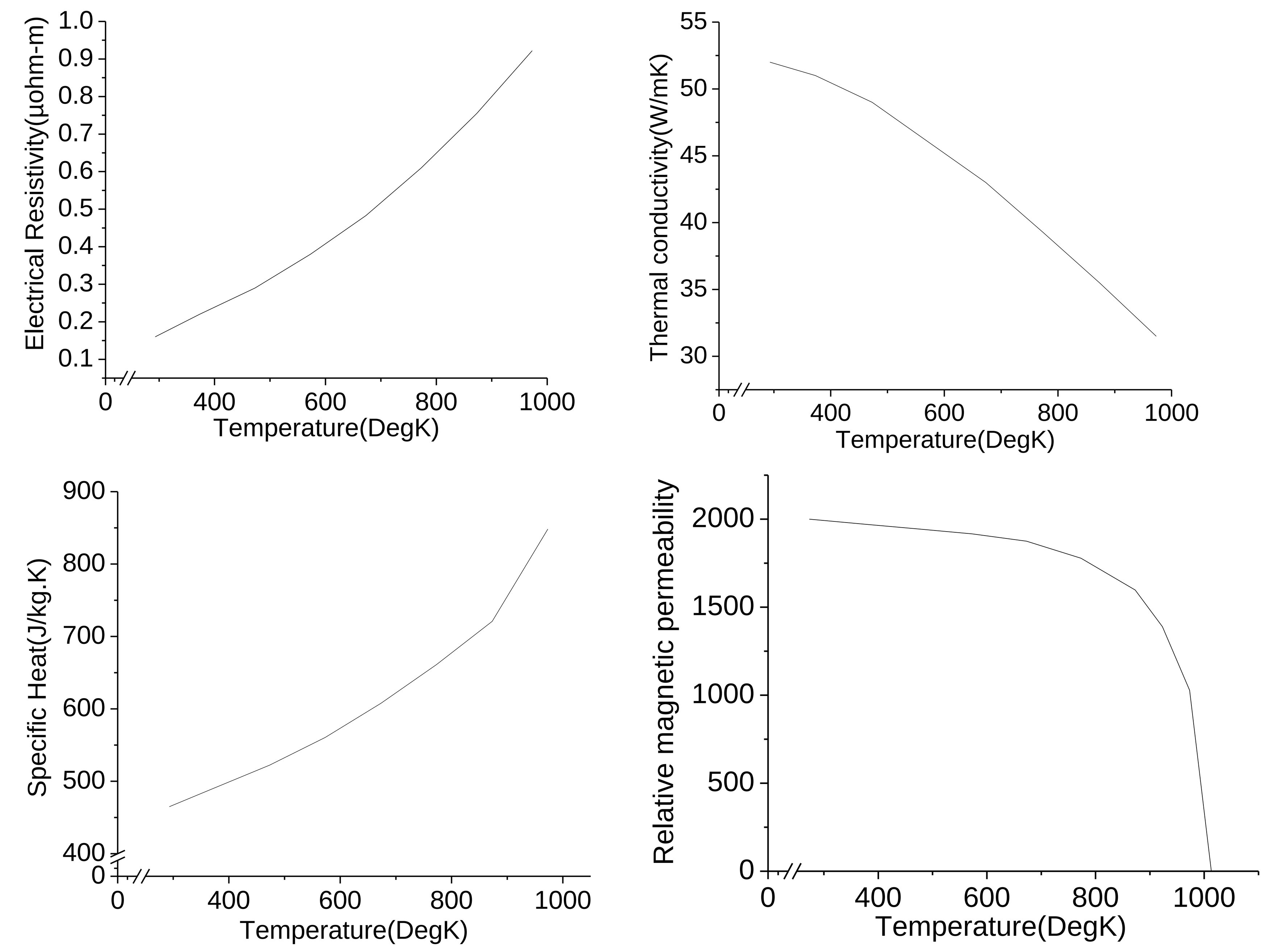

Figure 5. Mild steel physical properties

Table-I

Sr.No.	Boundary condition	Description
1.	Outer boundary	A=0
2.	Asymmetry axis	$\frac{\partial A}{\partial n} = 0$
3	Induction coil current	0 to 270 sec=49.93 A 270 to 1110 Sec=94.31 A

Table-II

Sr.No.	Boundary conditions	Description
1.	Initial temperature	312 DegK
2.	Convection coefficient(h)	10 (W/m^{2}K)
3	Emissivity(MS surface)	0.32
4	Emissivity(copper and Al)	0.04

Figure 6. Experimental set up

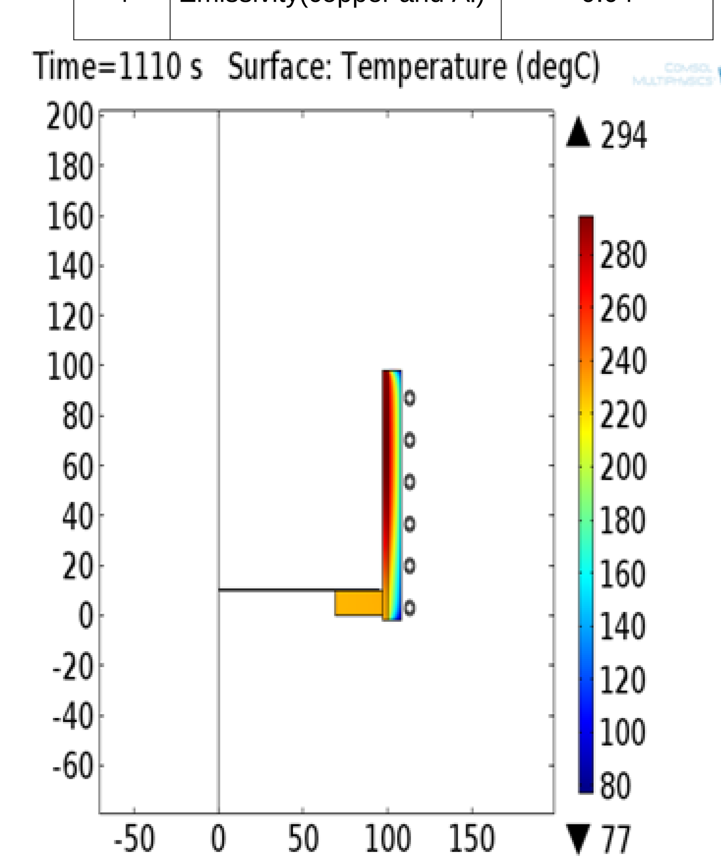

Figure 7. Temperature profile

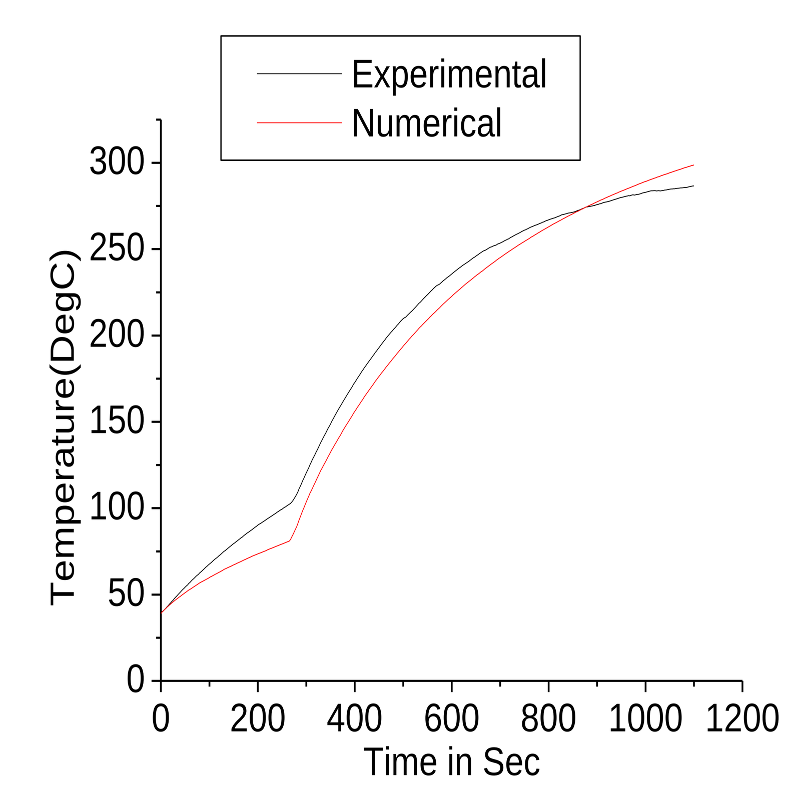

Figure 8. Numerical and experimental validation

Conclusions: . Numerical and experimental results are in good agreement. This analysis can be applied for design and optimization of induction heating process.

References:

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