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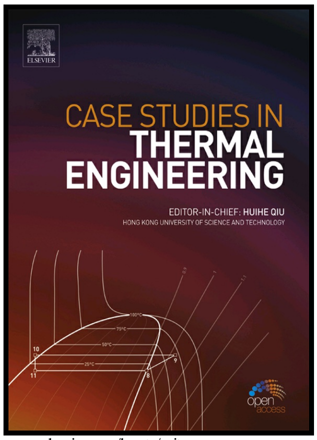


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# Case Study of Laser Hardening Process Applied to 4340 Steel Cylindrical Specimens Using Simulation and Experimental Validation

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**Abstract:**
This paper presents a numerical approach that can predict the temperature profile of cylindrical specimens made with AISI 4340 steel according to laser hardening process parameters. The developed model was built using the finite difference method (FDM) and validated using commercial finite element tools and experimental data. The proposed approach was constructed progressively by (i) examination of the temperature distribution using heat diffusion equations, boundary conditions and material properties (ii), discretization of the mathematical model using the finite difference method, (iii) validation of the proposed approach using experimental tests and simulation with COMSOL Multiphysics software and (iv) analysis and discussion of the results. The feasibility and effectiveness of the proposed approach led to an accurate, reliable model capable of predicting the temperature profile inside the heated component.

**Keywords:** AISI 4340 steel, finite difference method, finite element method, numerical simulation, laser hardening



## Nomenclature:

| | |
|---|---|
| $\tilde{a}$ | Absorption coefficient of the material |
| $C_p$ | Specific heat, $J.kg^{-1}.K^{-1}$ |
| $h$ | Thermal transfer coefficient, $W.m^{-2}.K^{-1}$ |
| $k$ | Thermal conductivity, $W.m^{-1}.K^{-1}$ |
| $\sigma$ | Stefan-Boltzmann constant, $W.m^{-2}.K^{-4}$ |
| $\emptyset_{T_{laser}}$ | Diameter of the laser spot, $m$ |
| $D$ | Diameter of the cylinder, $m$ |
| $\alpha$ | Thermal diffusivity, $m^2.s^{-1}$ |
| $\varepsilon$ | Emissivity of material surface |
| $L$ | Cylinder length, $m$ |
| n$t$ | Number of temporal mesh nodes |
| $\rho$ | Density, $kg.m^{-3}$ |
| n$r$ | Number of mesh nodes following R |
| n$z$ | Number of mesh nodes following Z |
| $Nu$ | Nusselt number |