

Simulation of Exhaust Gas Heat Recovery System for an Automobile

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Introduction: An innovative method of heat recovery system using exhaust gas through concentric tube heat exchanger where the shell side consists of water and the tube side consists of exhaust gas. COMSOL Multiphysics is used to model this system.

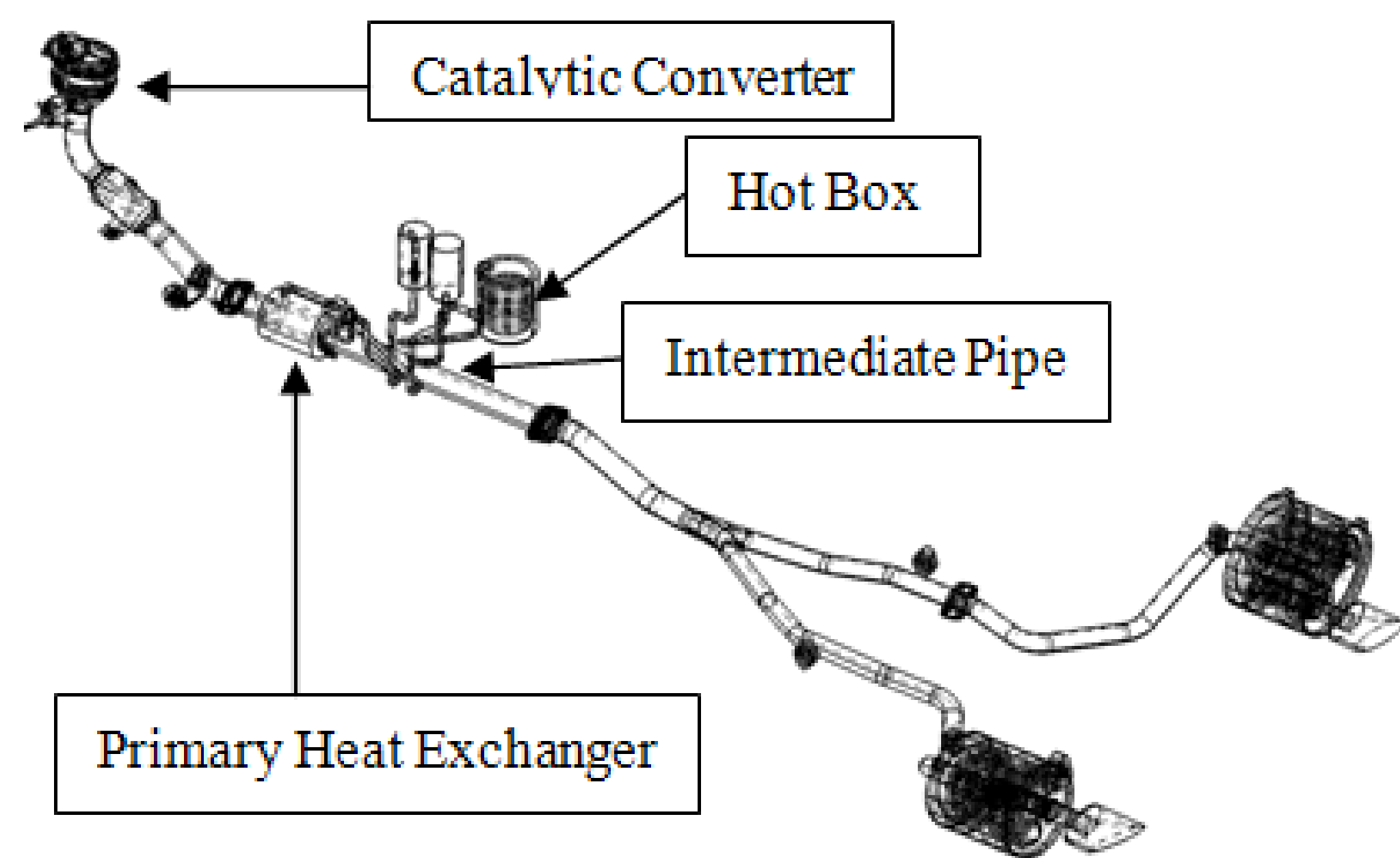


Figure 1. Exhaust gas heat recovery system

Computational Methods: The equations of continuity, momentum and heat transfer which governs the flow in the fluid domain is coupled with the heat transfer equations in the solid domain, that is through the exhaust pipe

$$\nabla \cdot \mathbf{u} = 0$$

$$\rho(\mathbf{u} \cdot \nabla) \mathbf{u} = \nabla \cdot [-\mathbf{PI} + \nu(\nabla \mathbf{u} + (\nabla \mathbf{u})^T)] + \mathbf{F}$$

$$\nabla \cdot (-k \nabla T) = Q - \rho \cdot C_p \cdot \mu \cdot \nabla T$$

$$\rho \cdot C_p \cdot \mu \cdot \nabla T = \nabla \cdot (k \cdot \nabla T) + Q$$

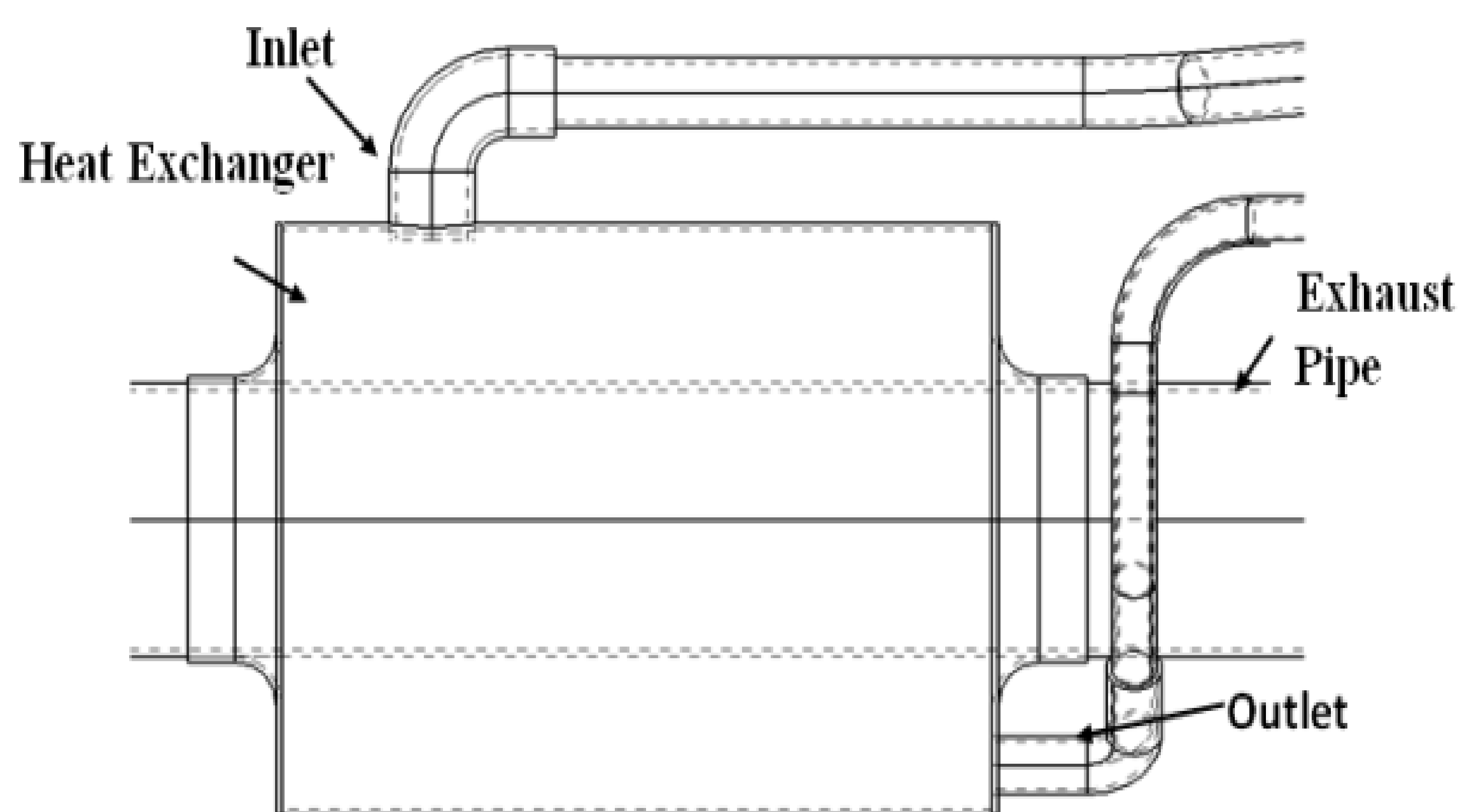


Figure 2. Primary Heat Exchanger

Results: The percentage difference between the simulated and measured maximum outlet temperature is found to be 3.2 per cent. The Log Mean Temperature Difference (LMTD) of the heat exchanger is 276.89 deg C.

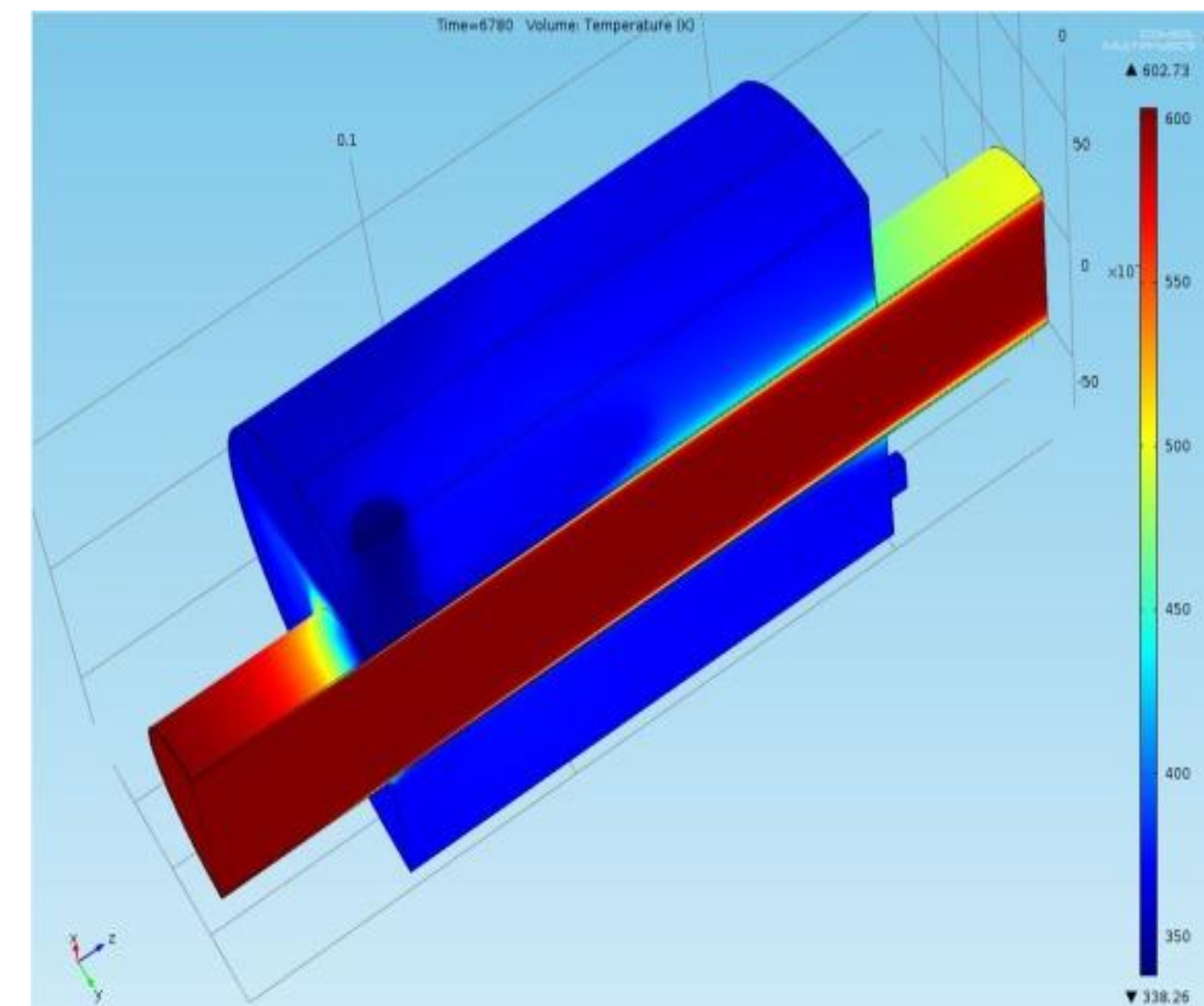


Figure 3. Temperature

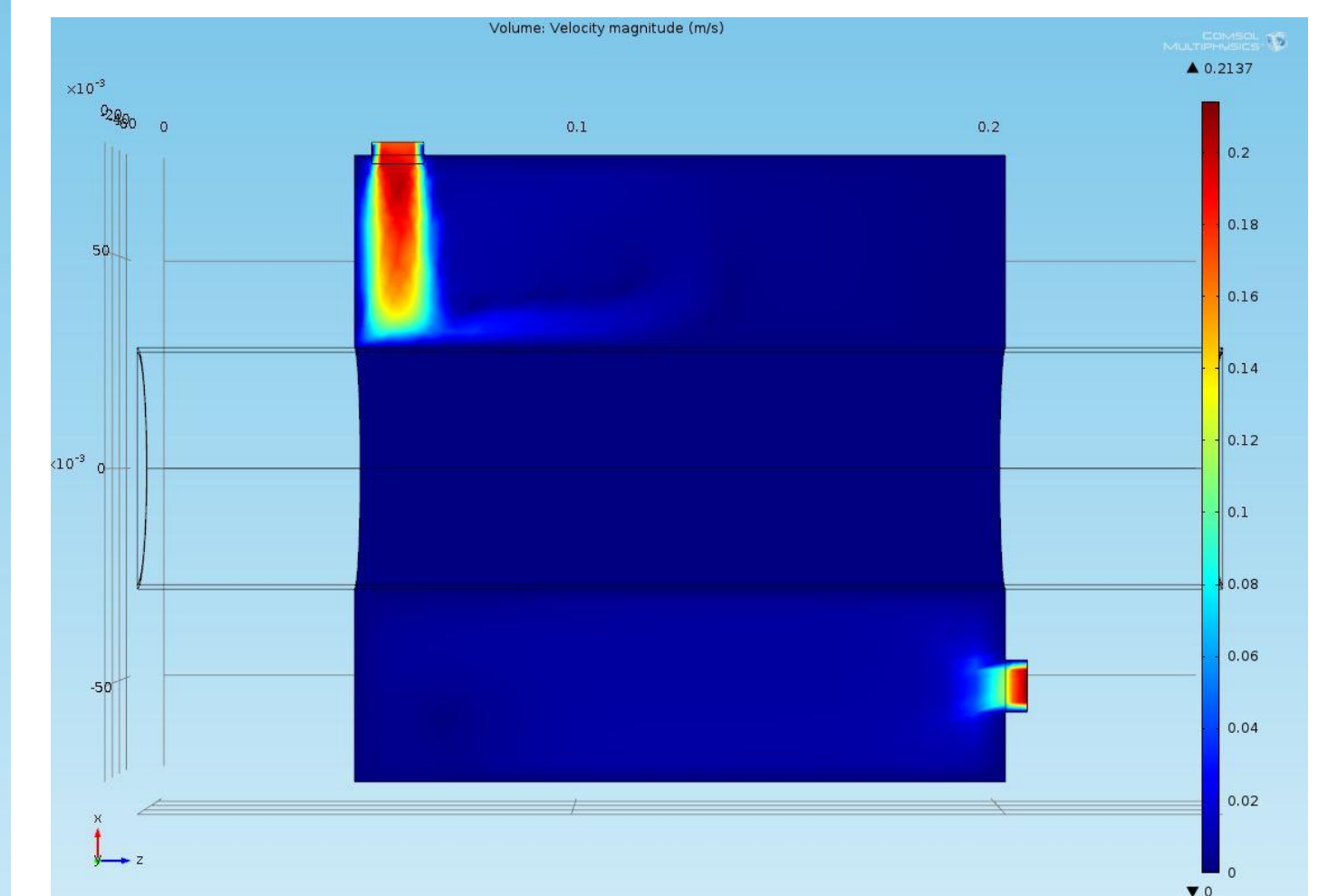


Figure 4. Velocity

Substance	Thermal conductivities (W/mK)
Stainless steel	16
Water	0.58
Exhaust gas	0.0146

Table 1. Material properties

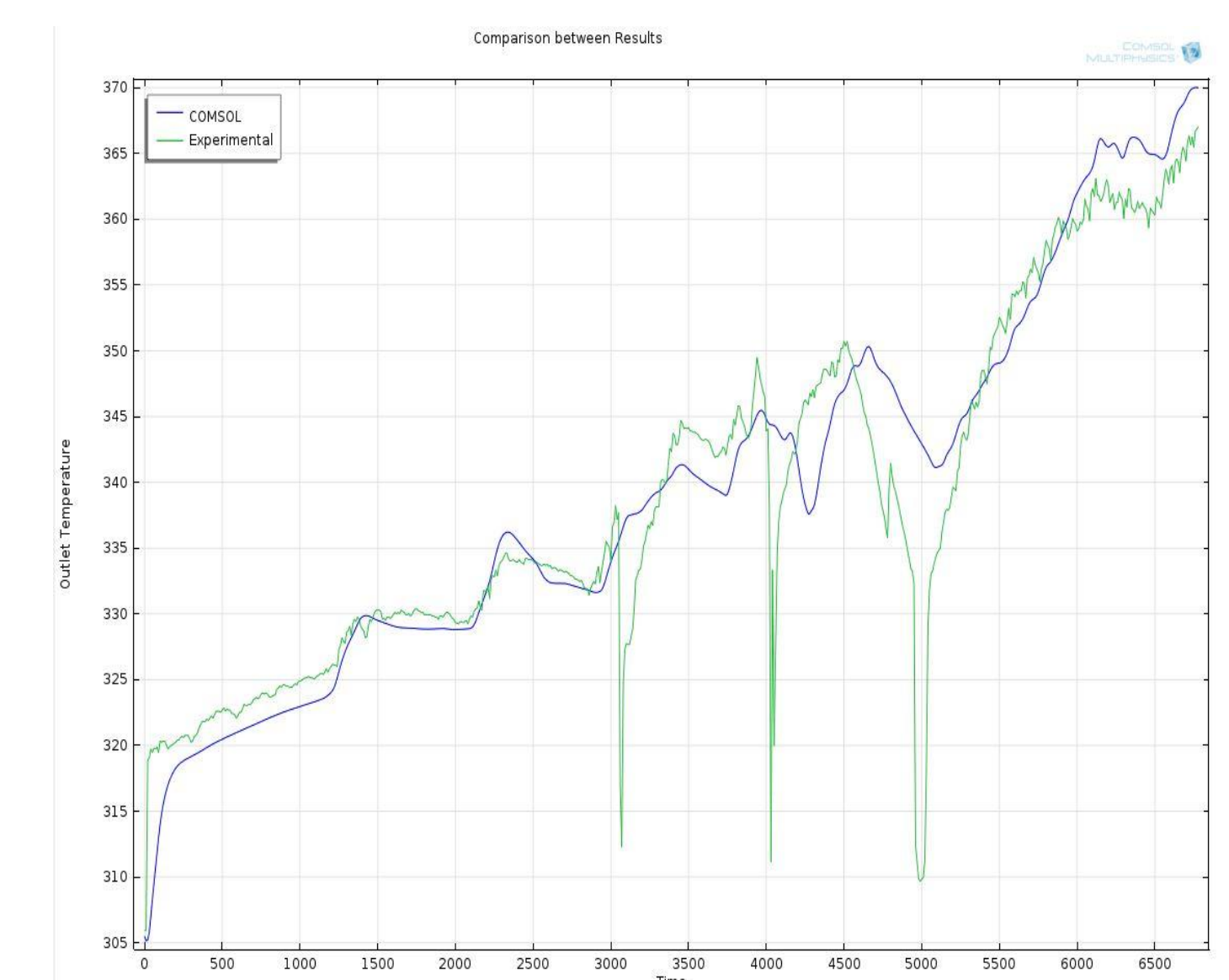


Figure 5. Validation

Conclusions: The results obtained by COMSOL Multiphysics is found to be in good in good agreement with the measured data. The model presented here can be further extended to include the heat transfer in the Hot Box.

References:

1. David Pumthianlal Neihguk; Aravindh Rajaram; Samir Rawte, Non Intrusive Exhaust Gas Heat Recovery System for an Automobile: An Experimental Investigation, *SAE 13CVI-0097* (Manuscript under review)
2. Kakaç, Sadık, Anchasa Pramuanjaroenkij, and Hongtan Liu. Heat exchangers: selection, rating, and thermal design. CRC press, 2012