Preheating of an automotive catalytic converter

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Motivation
• The TWC (Three Way Catalytic converter) is the most common type of catalytic converter it is mandatory for petrol cars in most countries for private automobiles
• It is essential for converting harmful gases like CO or NOx contained in exhaust fumes and prevent their released into the atmosphere

Issue
• The TWC is only fully functional when above light-off temperature (300°C to 400°C) so when you start your car and the TWC is cold it is not effective for the first few minutes
• Facts: this warm-up time accounts for 70% to 80% of all CO emissions from cars
• Consequences: include smog, acid rain and health issues and death
• Goal: to keep the TWC hot for as long as possible after stopping the engine
• Proposed solution: store heat in a Phase Change Material (PCM) enclosed around the catalytic converter and wrapped in insulation

Methodology
• Simulate the temperature over time to see how long it takes to cool down
• Simulate the classic TWC without PCM or insulation to compare it with our model
• Validate the classic model with experimental data from EMPA
• Only gas to solid convection and conduction between the layers are considered
• Comparing models reduce inaccuracies, our results are relative not absolute
• Weight and size are limiting actors, it must fit under the car

Simulating different PCMs

Cooldown time vs thickness

Pizza-delivering cycle

Shopping cycle

Conclusions
• We are able to extend the cooling time by over an hour, with reasonable PCM and insulation
• Our solution is especially useful for drivers that make short stops such as pizza delivery drivers and people going shopping
• The model gives a good insight into the potential of the concept
• PCM as heat storage is polyvalent and can be used for many other applications, such as concentrated solar power

References

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