Modeling and control of purge system

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Introduction

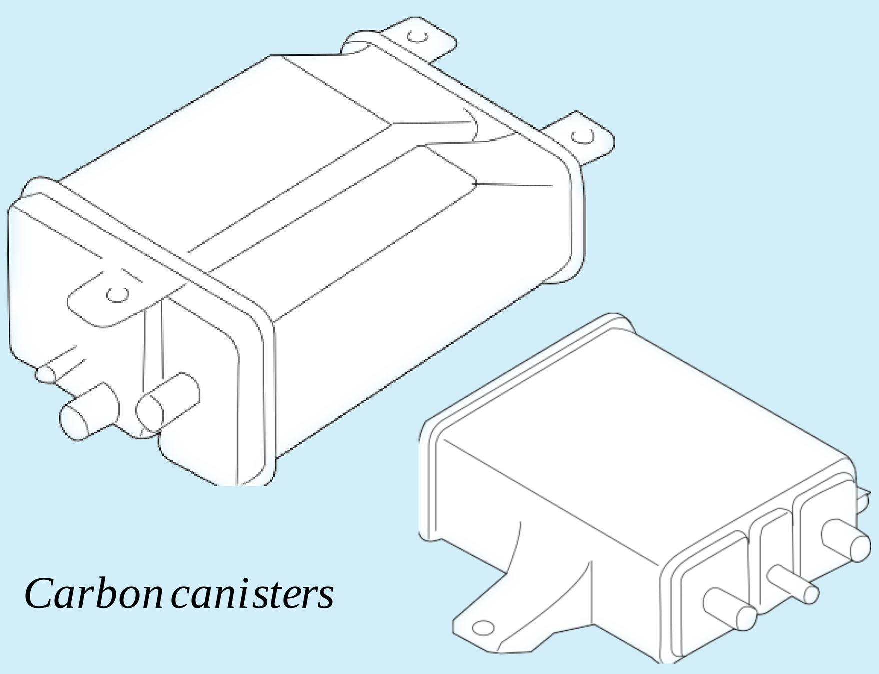
This project is in collaboration between Linköpings University and Aurobay. The project addresses the growing concerns about climate change by focusing on the EVAP system, crucial for controlling vehicle emissions. The initiative aims to improve the purging process in the carbon canister, utilizing a measuring system to gather data for modeling the canister's dynamic behavior.

Project Goals

- Commission laboratory equipment.
- Model the hydrocarbon flow from the carbon canister to the intake manifold.
- Regulate the EVAP flow for an arbitrary purging cycle.

EVAP System

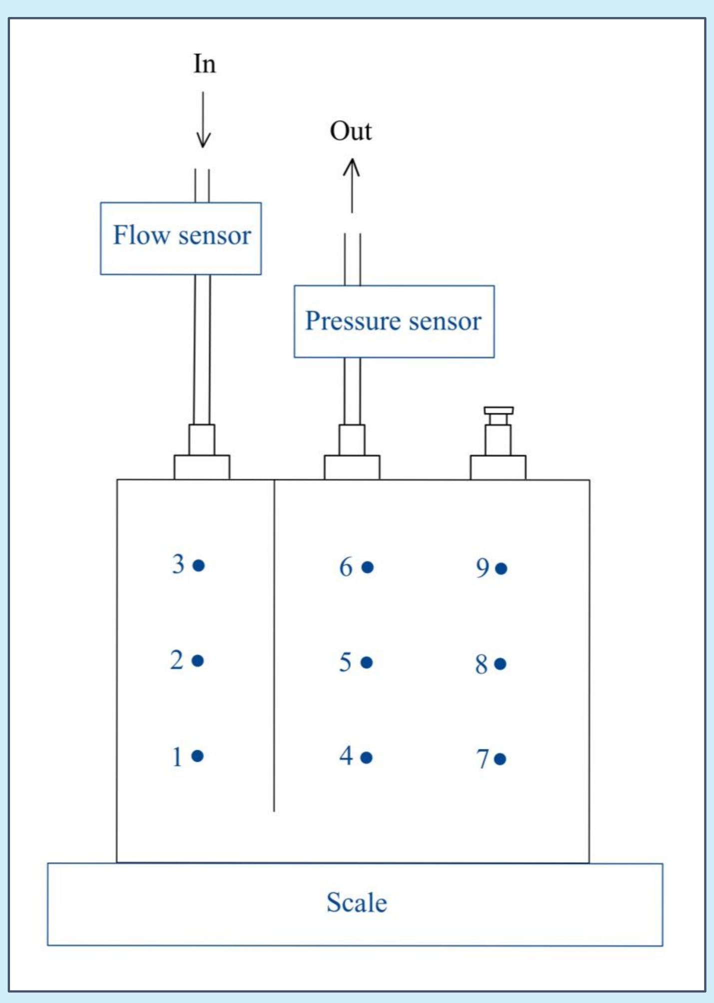
The EVAP system plays a pivotal role in capturing and controlling evaporative emissions, with the carbon canister preventing the release of harmful hydrocarbons into the atmosphere. During engine operation, stored vapors are purged from the canister, directed into the engine intake manifold, and combusted to reduce emissions and enhance fuel efficiency.



Carbon canisters

Set-up

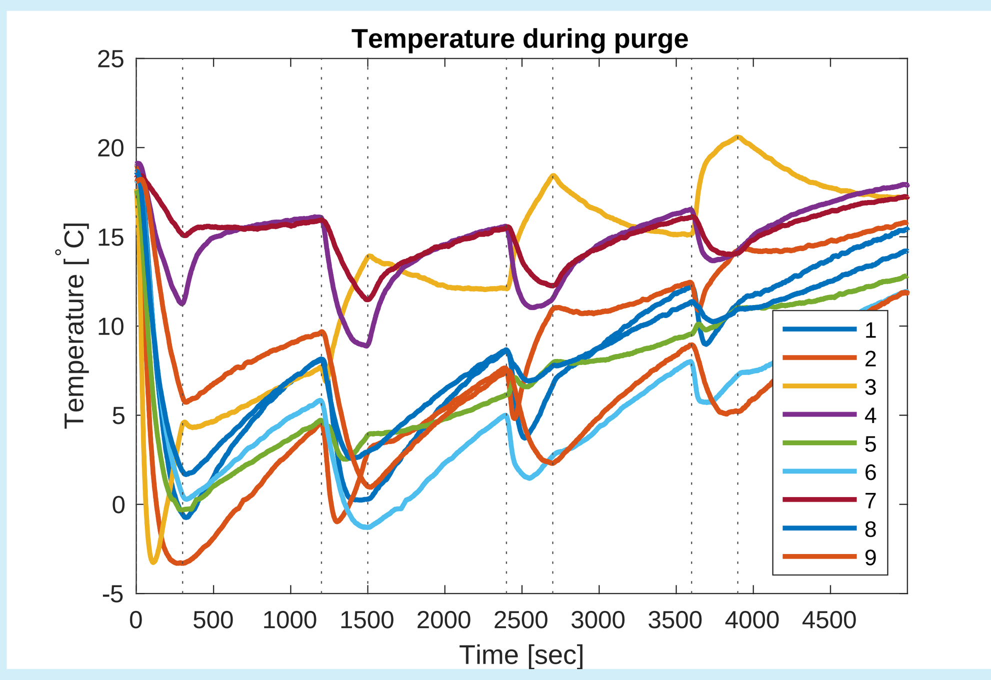
- 2 Flow sensors
- 1 Pressure sensor
- Up to 12 Temperature sensors
- Scale



Canister layout

Experiments

Experiments were conducted to evaluate the behavior and performance of the carbon canister under various conditions. Each experiment targeted specific aspects, from sensor validation to understanding the dynamic behaviors of the system. Following a systematic proceeding, thorough evaluations and discussions, to make informed decisions on the objectives of future tests. This iterative process ensured a methodical and well-informed approach for each test.



Purge during the small intervals between dotted lines

Model

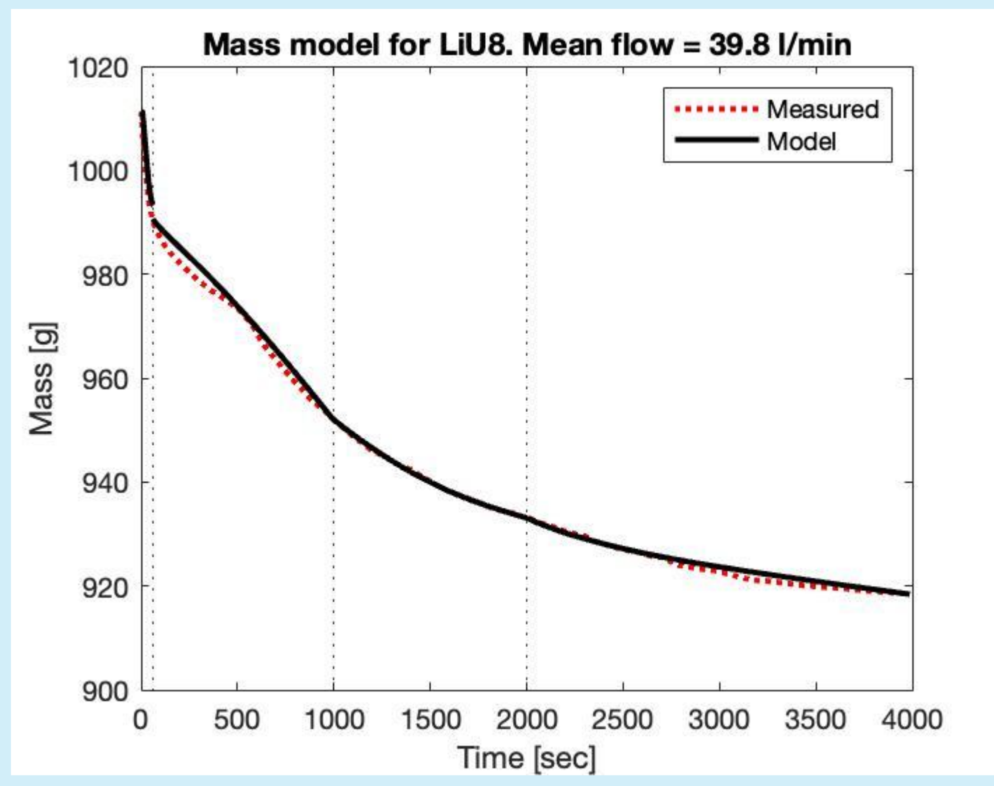
A model was developed using the experiment data to characterize the canisters behavior and calculate the mass of purged hydrocarbons. The model was tested and evaluated to make the most accurate estimates of parameters.

$$\dot{m}_{f,can} = k_1 \cdot \theta \cdot \rho_a \cdot \dot{m}_a + k_2 \cdot \Delta T^2 \cdot \dot{m}_a$$

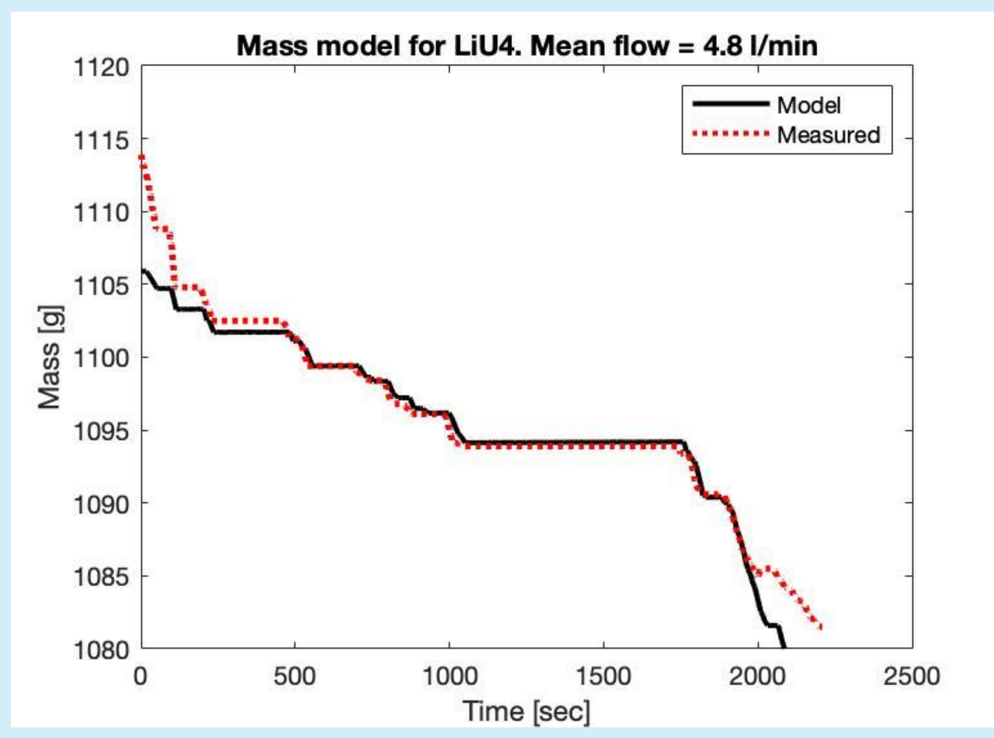
There is no "one size fits all" model, the model must be tweaked depending on size of the canister and flow.

Results

The derived model for the flow of hydrocarbons through the canister can be seen below together with measured mass from experiments.



Constant flow, 40 l/min



Variable flow (FTP-75)

Conclusions

The results shows that the model with correct parameters can handle both static and dynamic driving cycles.

The temperature is vital to obtain dynamic models, therefore a temperature sensor should be mounted to the canister. Furthermore, some sensors from the vehicle needs to be incorporated in the EVAP-system for the model to work optimally.

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