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Deposition, Reduction and Transformations of Diesel Particulate Matter in a Novel Open Substrate

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Introduction

- Particulate Matter (PM) emission causes problem for human health as well as for the environment
- Open filters (monolithic flow-through reactors with low pressure drop) have a potential for energy-efficient reduction of PM and, for some applications, may even suffice
- Designs that enable high mass transfer rates towards the catalytically active walls and with enhanced mixing in the gas phase are of considerable interest
- Detailed understanding of capture related phenomena in such substrates is needed
- An open substrate can be used as an in-situ analyzer for the HC content of the PM [1]

Objectives

- To assess the potential benefits of using a novel open substrate
- To use an inert monolith to enable in-situ monitoring of the PM HC content
- To assess the effects of deposition, reduction and transformations of PM separately

The conceptual model

- Sigmoid functions to describe HC contents [1]
- Pure volatiles and semivolatile HC (solid core)
- Assuming heavy hydrocarbon (C<sub>20</sub>H<sub>42</sub>)
- 8 adjustable parameters, fitted to experimental data by gradient search method (Ispognolin)

Tanks-in-series model (Matlab)

Capture efficiency [%]

Investigations of the PM capture efficiency in the novel substrate

Performance of the novel substrate

- Particle size distributions measured before and after substrate (Fig. 1)
- PM reduction compared to model calculations (Fig. 2)
- Enhanced PM reduction owing to the channel design (i.e. global Sherwood number significantly higher than in a straight channel of constant cross-section)

Conclusions

- Novel open substrate exhibits enhanced PM reduction due to efficient combined PM oxidation and deposition within the specially designed channels
- PM measurements over an inert monolith together with the conceptual model offers a pathway to in-situ predictions of the PM properties in the filter

References


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