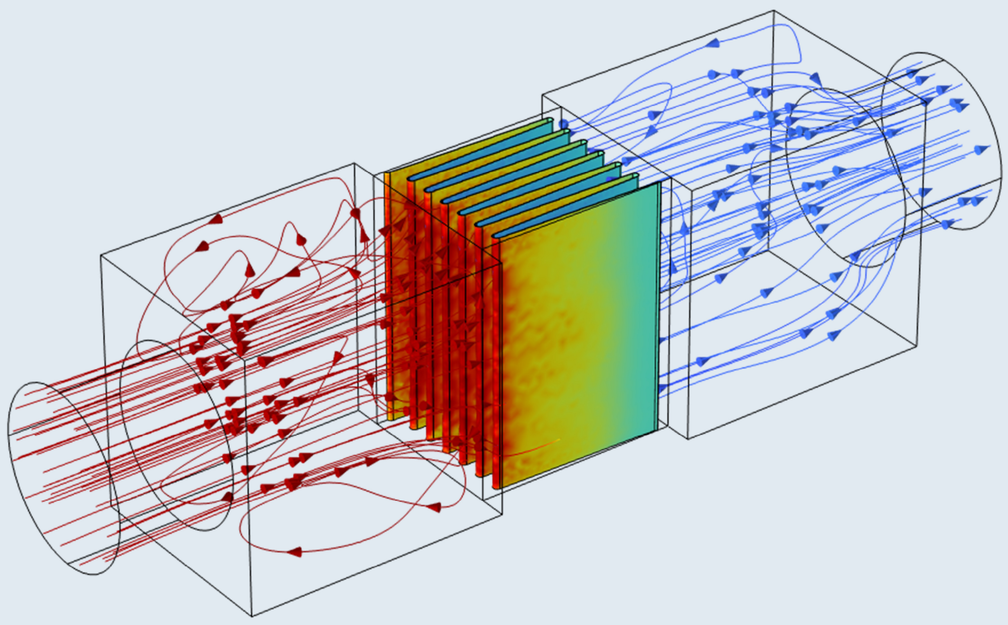

# Delayed Desorption in Activated Carbon Filters for Air Purification

Modeling desorption behavior of volatile organic compounds in activated carbon filters at high temperatures as a part of air purification reactors.

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## Abstract

Activated carbon filtration has proven to be a reliable method to clean indoor air.[1] However, these filters work by adsorbing volatile organic compounds (VOCs) onto carbon particles, instead of breaking them down. Thus, the filters need to be regenerated to keep their efficiency.

Activated carbon filters can be modeled as porous domains in which adsorption and desorption of gases is modeled with appropriate kinetic rate expressions. By utilizing varying kinetic constants, the desorption behavior of VOCs can be predicted. The model can be used to optimize adsorption/desorption of VOCs at different times.

Additionally, desorption at high temperatures can be used in conjunction with other systems to model the complete breakdown of contaminated air.

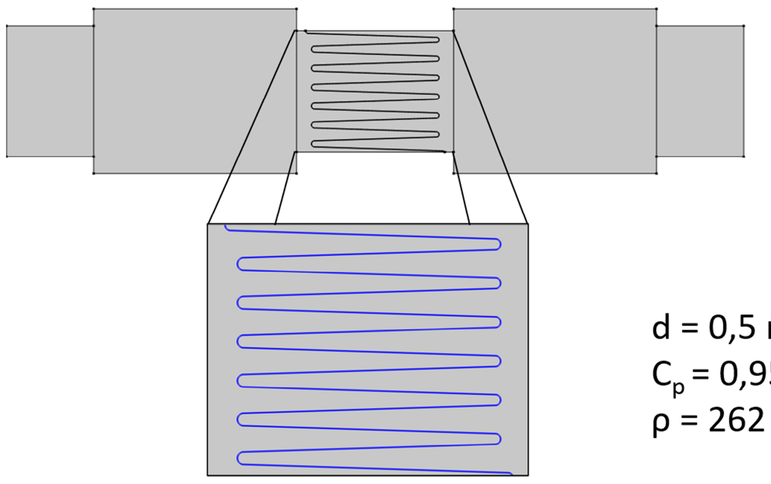


FIGURE 1. reactor geometry and activated carbon filter close-up.

## Methodology

The kinetic rate expressions for adsorption and desorption of contaminants are based on a modified version of the Langmuir-Hinshelwood mechanism for porous materials.

$$R_{ads} = k_{ads} * c_{bulk} * \left(1 - \frac{c_{ads}}{c_p * \rho}\right)$$

$$R_{des} = k_{des} * \frac{c_{ads}}{c_p * \rho}$$

To account for the increase in desorption rate, a time-dependent constant $k_{des}(t)$ is introduced. A ramp function is used in the variable to mimic the temperature increase in the overall system.

$$k_{des}(t) = k_{des} * ramp(t)$$

## Results

By varying $k_{des}$, the model was able to predict the desorption behavior of the VOC as seen at elevated temperatures. In this way, adsorption at room temperature and desorption at high temperature could be modeled in the same study.

In future work, the goal is to make use of temperature dependent rate constants instead of time dependent rate constants. More work on the adsorption and desorption behavior of VOCs at different temperatures in necessary to construct direct relationships between adsorption/desorption and temperature.

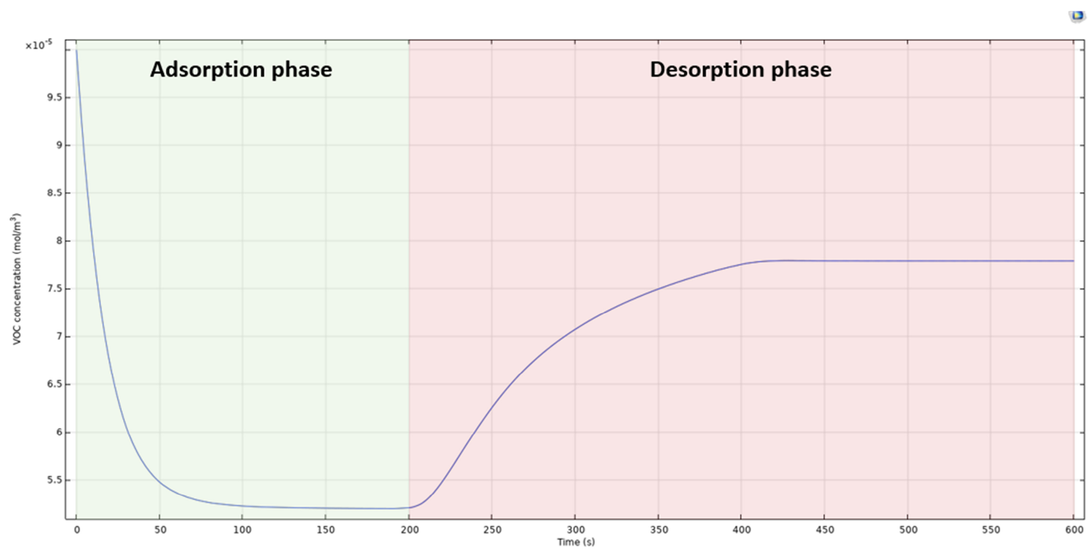


FIGURE 2. VOC concentration in reactor in adsorption and desorption phase.

## REFERENCES

1. Roegiers, J. & Denys, S. CFD-modelling of activated carbon fibers for indoor air purification. *Chem. Eng. J.* **365**, 80–87 (2019).

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