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Enhancing Ammonia Adsorption Equilibrium Time on a Sensitive Surface Through Flow Field Optimization: A CFD Approach

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Extended Abstract

This work presents a computational fluid dynamics (CFD) study aimed at reducing the ammonia adsorption equilibrium time on a chemically sensitive surface embedded in a 2D channel flow, for ammonia sensors application. The initial phase of the study focused on analysing the impact of fundamental flow parameters, namely channel height and inlet velocity, on the adsorption process. Results showed that both factors significantly influence the rate at which ammonia reaches equilibrium on the surface, primarily through their effect on convective mass transport [1].

To try to further improve adsorption performance, a two-dimensional obstacle was introduced into the channel to modify the flow pattern aiming some modification of the convective mass transfer in the sensitive surface vicinity and some possible impact on adsorption process. A parametric study was conducted by varying the obstacle's height and position, as well as the location of the sensitive surface relative to the obstacle. The goal was to investigate how localized changes in flow conditions—particularly shear stress and velocity gradients—affect the transport and adsorption of ammonia.

The results demonstrated that properly placed obstacles can effectively increase shear stress near the sensitive surface, leading to enhanced mass transfer rates. This increase in convective transport reduces the time needed to reach adsorption equilibrium. The study thus highlights the importance of flow field manipulation as a passive strategy to optimize adsorption-based sensing or separation processes.

These findings are particularly relevant for the design of gas-phase chemical sensors and compact adsorption systems, where response time and sensitivity are critical. By leveraging flow-structure interaction within simple channel geometries, system performance can be significantly enhanced without requiring additional energy input or complex configurations.

References

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