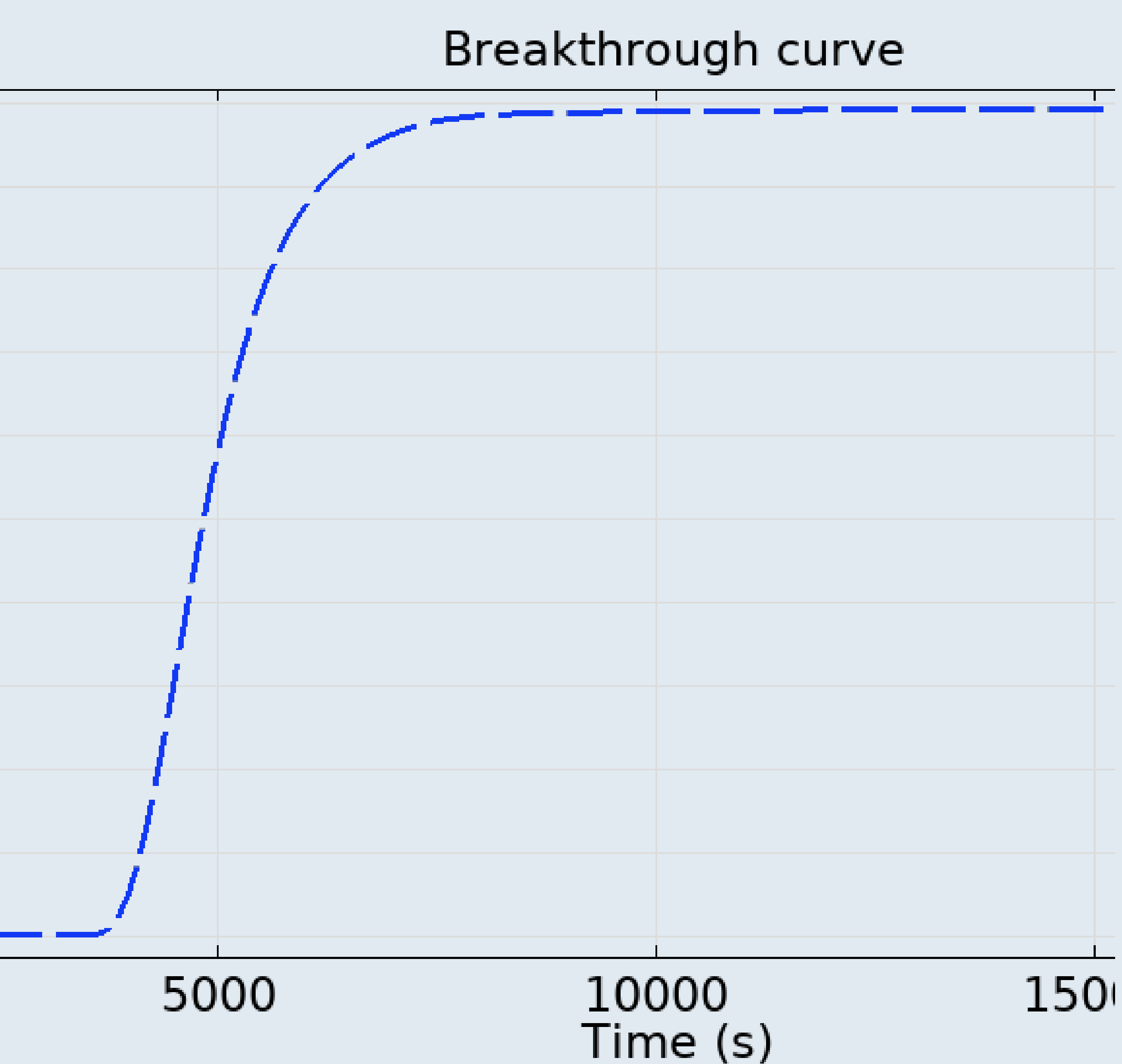




Modelling the H₂S adsorption from biogas with COMSOL Multiphysics®

A 2D time-dependent COMSOL model simulates hydrogen sulphide adsorption from biogas using activated carbon in a porous fixed-bed column, computing adsorption and breakthrough curves.

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Abstract

Biogas is a promising renewable energy source, but hydrogen sulphide removal is essential to prevent corrosion. This study develops a two-dimensional, time-dependent COMSOL model to simulate hydrogen sulphide adsorption onto activated carbon within a fixed-bed column.

Using the Brinkman equations for the fluid flow, mass transport, and a linear driving force model coupled to Langmuir and Freundlich equilibrium isotherms, the simulation successfully characterizes mass transfer zones, operational parameters, and breakthrough curves, indicating favourable adsorption kinetics.

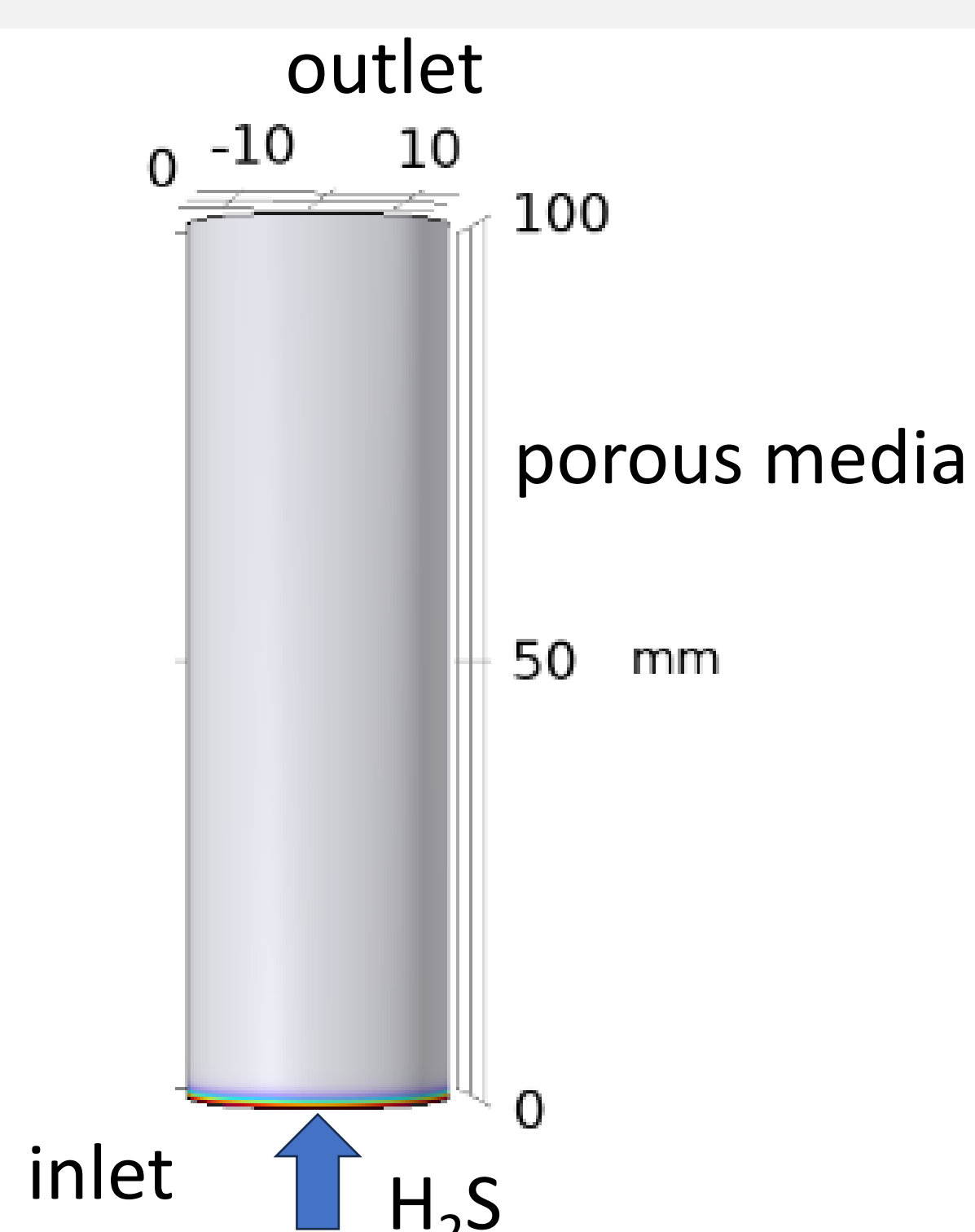


Figure 1. Schematic of the porous fixed-bed column.

Methodology

The physical model consists of a porous fixed-bed column of packed spherical particles with incoming gas (Fig.1). The computational model uses a two-step study: a stationary step to solve first the Brinkman equations and a secondary time-dependent step for the Transport of Diluted Species in Porous Catalysts interface. The model describes mass transfer by diffusion, convection and adsorption mechanisms [1], using the Linear Driving Force approximation and non-linear Langmuir and Freundlich equilibrium isotherms [2,3]. The computations conducted in steady-state and time-dependent steps use a structured quad mesh.

Results

The computational results describe satisfactorily the adsorption process of H₂S from biogas, showing the influence of the main operational parameters. The evolution of the mass transfer zone in the porous bed fixed-column is also well characterized, showing its progression (Fig.2) along the reactor. The breakthrough curves simulated by the model indicate favorable kinetics and bed efficiencies. The Freundlich model exhibits a more realistic, rounded shape in its final section and matches better some experimental measurements of literature [3].

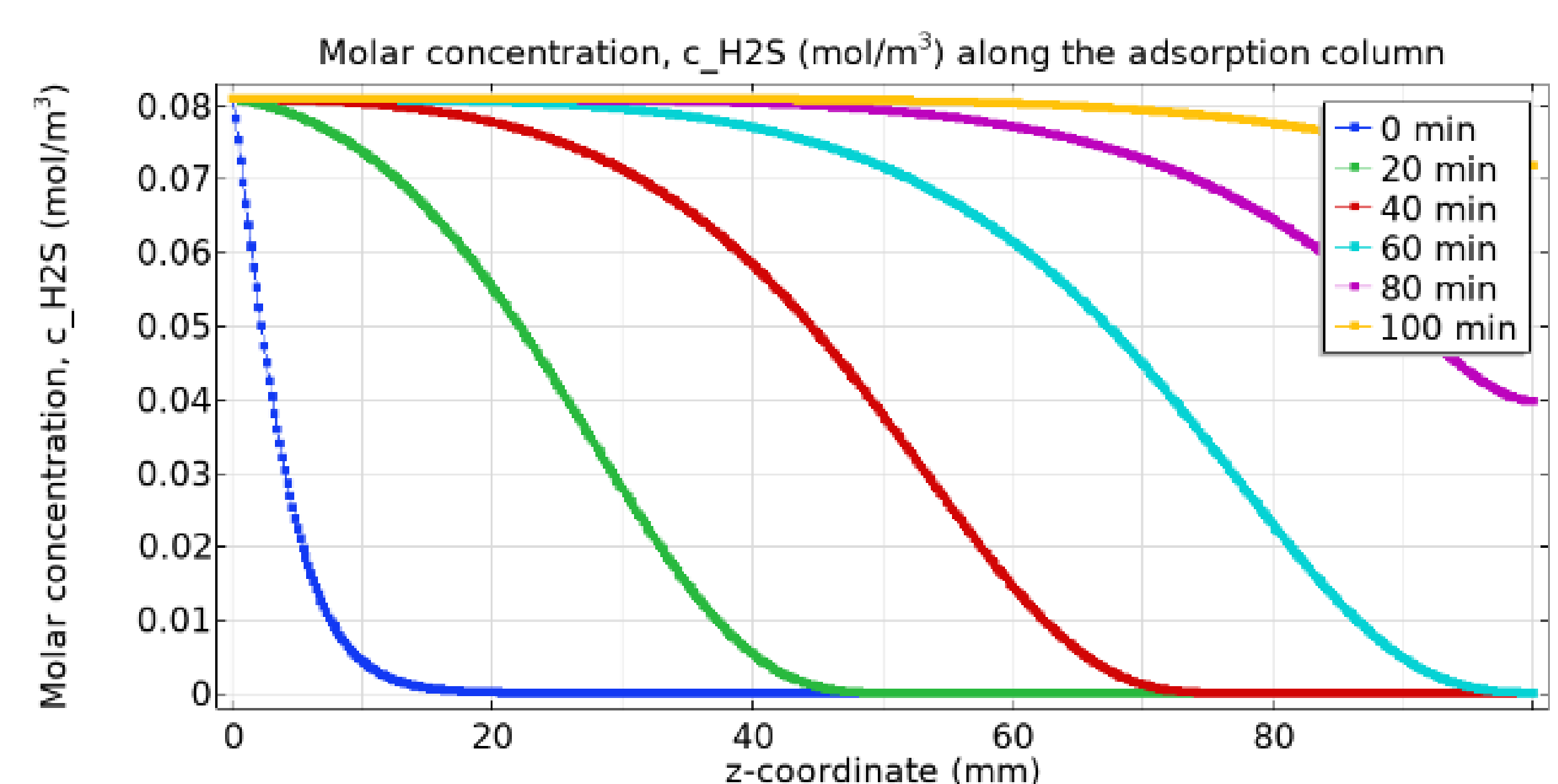


Figure 2. Molar concentration profile of H₂S along the adsorption column, using the Freundlich isotherm.

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