

On the removal of large quantities of contaminant via column sorption**Authors:**

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Abstract:

Column sorption is a practical method for removing a contaminant from a fluid. It has uses in environmental applications such as greenhouse gas capture, groundwater remediation and biogas cleansing as well as industrial uses such as the purification of biopharmaceutical products, the cleansing of flue gases, biofuel purification and many more. It is one of the most widely used methods for the removal of environmental contaminants and is regarded as an essential component in achieving the UN Sustainable Goals and EU Green Deal. Mathematical models for sorption are equivalent to those describing the storage of hydrogen in a metal hydride matrix, so providing further motivation for its study.

Standard mathematical models of the process describe the capture of trace amounts of contaminant, however these are not appropriate for the cleansing of flue gases where the contaminants may be the main component (up to around 70% of the fluid) or hydrogen storage (100% of the fluid). In this talk we describe a new mathematical model for the adsorption of an arbitrary amount of contaminant. The model consists of a coupled PDE/ODE system describing the evolution of the contaminant concentration, the fluid velocity and pressure and the rate of contaminant adsorption. An approximate travelling wave solution is developed and shown to reduce to previous results in the limit of small amounts of contaminant. Both numerical and analytical solutions are shown to compare well against experimental data for the capture of CO₂.

References:

- [1] Modelling large mass removal in adsorption columns TG Myers, M Calvo-Schwarzwalder, F Font, A Valverde. Submitted to Int. Comm. Heat and Mass Transfer, Apr. 2024. ArXiv preprint:2404.02939