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# Filtration in Porous Media: Influential Parameters and Comparison with Experiments

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## Introduction

There is a considerable and ongoing effort aimed at understanding the transport and the deposition of suspended particles in porous media, especially **non-Fickian transport** and **non-exponential deposition** of particles [1-6]. In this work, the influential parameters in filtration models are studied to understand their effects on the non-Fickian transport and the non-exponential deposition. The filtration models are validated by the comparisons between the modelling results and the experimental data.

## Moldeling non-Fickian transport

$$\frac{\partial c_i}{\partial t} + v_i \frac{\partial c_i}{\partial x} = D_x \frac{\partial^2 c_i}{\partial x^2} + D_t \frac{\partial^2 c_i}{\partial t^2} - \lambda_i c_i;$$

$$\frac{\partial s_i}{\partial t} = \lambda_i c_i;$$

**Temporal dispersion term for non-Fickian transport**

The elliptic equation stems from the microsopic description of particles in pores in the framework of continuous time random walk theory[1-3]. It is applied to to model non-Fickian transport in heterogeneous porous media. The additional term compared to the classical advection dispersion equation (the temporal dispersion term) describes the non-Fickian behaviors of particles. The temporal dispersion coefficient, by its definition, is the variance divided by the mean value of the particle residence time .

## Heterogeneous particle-grain interactions

$$p(\lambda_i) = \frac{1}{\lambda_i \sigma \sqrt{2\pi}} \exp\left[\frac{(\ln \lambda_i - \mu)^2}{2\sigma^2}\right]$$

$$p(\lambda_i) = a(\Lambda_i)^{-b}$$

Log-normal, power-law and other distribution types are applied to describe heterogenous particle-medium interactions, such as heterogeneous surface charges, energy minima, distributed particle sizes via size exclusion[3,6].

## Released and migratory deposition

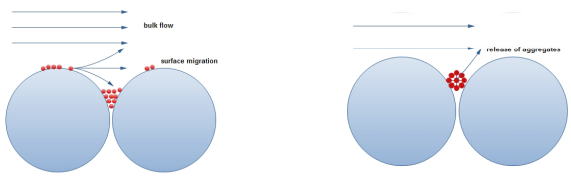
$$\frac{\partial c}{\partial t} + v \frac{\partial c}{\partial x} = -(\lambda_s + \lambda_d)c + \lambda_r s + \lambda_{mr} s_m;$$

$$\frac{\partial s_m}{\partial t} + v_m \frac{\partial s_m}{\partial x} = \lambda_s c - \lambda_m s_m - \lambda_{mr} s_m;$$

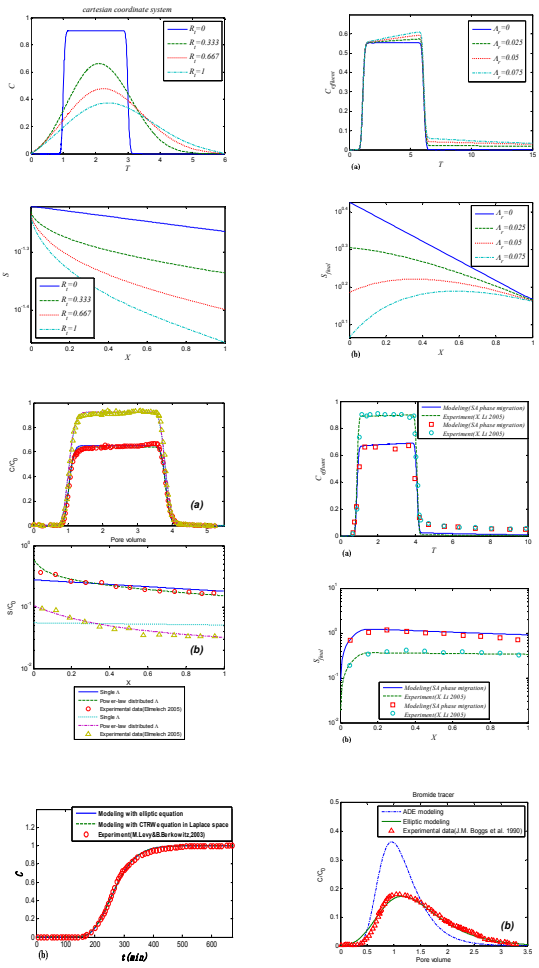
$$\frac{\partial s}{\partial t} = \lambda_m s_m + \lambda_d c - \lambda_r s;$$

**Migratory particle population: surface-associated particles or released aggregatés**

A third equation is applied to describe the released and migratory particles. The third particle population may be the surface-associated particles or the released large aggregates. The boundary condition for the third population is zero at the injection side [5].




## Results




## Conclusions

1. The elliptic equation can be applied to model the non-Fickian transport. It results more dispersed breakthrough curves and hyperexponential deposition.
2. The consideration of a third migratory particle population may result in non-monotonic deposition and long tails after the end of injection in the breakthrough curves.
3. Distributed filtration coefficients can be applied to model heterogeneous particle-medium interactions. The modelling results can match the hyperexponential deposition in experiments.
4. The elliptic equation and the CTRW equation expressed in Laplace space can both catch the non-Fickian transport of tracers in heterogeneous porous media, while the advection dispersion equation cannot.

## References

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