

Characterisation of Structure and Transport in Porous Media by Pulsed-Field-Gradient (PFG) NMR Technique.

Part I: Master Curve and Characteristic Inner Length.

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Abstract

We perform systematic experimental studies aiming at the practical application of observation time-dependent pulsed-field-gradient (PFG) NMR. Thus, we hope to provide engineering scientists a reliable experimental tool for a characterisation of structure and transport in fluid filled porous media. In the present work, we have investigated observation time-dependent self-diffusion in glass bead packs as model systems, where the diffusing species (molecules of the solvent or dissolved particles) serve as probes for the confining geometry in the porous medium. First, we experimentally checked a basic question, namely if the obtainable structure information is independent of the actual mobility of the diffusing probe particles. We could demonstrate that plotting the *normalised* time-dependent diffusion coefficient $D(t)/D_0$ versus the *actual* migration length $l_D(t)$ during a given observation time t , yields indeed a characteristic “master curve”, which is independent of the mobility of the diffusing species, thus reflecting, as desired for a reliable method, solely the effects of the confining geometry of the porous system of interest. We further show that from the master curve a new quantity, namely a “characteristic inner length” or “correlation length” x_D can be derived, which corresponds to a path length in the porous medium after which particles in the pore fluid experience an *averaged* restricting geometry and diffuse with an *effective* diffusion coefficient D_{eff} . It turned out that x_D is surprisingly small, namely in the order of the bead radius. We show further that the normalisation of this migration length with the bead radius, delivers a common master curve for all mono disperse bead packs used and thus it is obviously possible to derive and record master curves for different kinds of packs, beds or other porous media, as references, which can be used to characterise or certificate the *kind* of the porous matrix of interest.