Theoretical Comparison of Pillar Shape Influence and Ordering on Band Broadening in Electrically and Pressure Driven Flows through 2-D Porous Chromatographic Media

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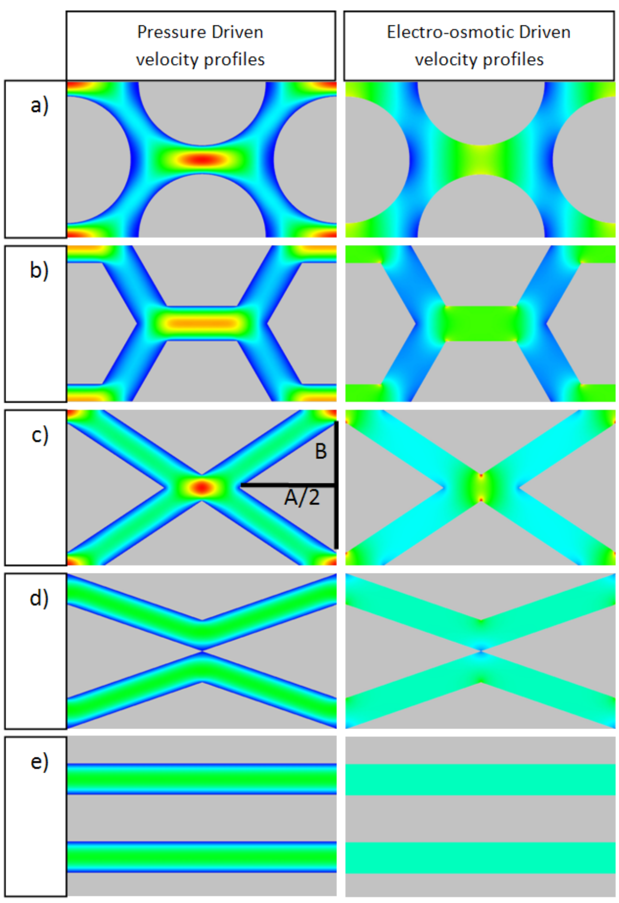
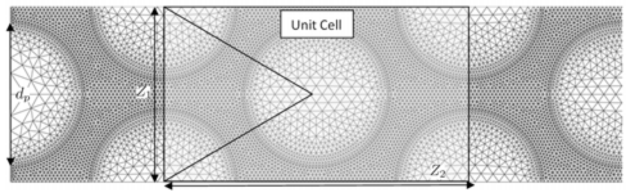
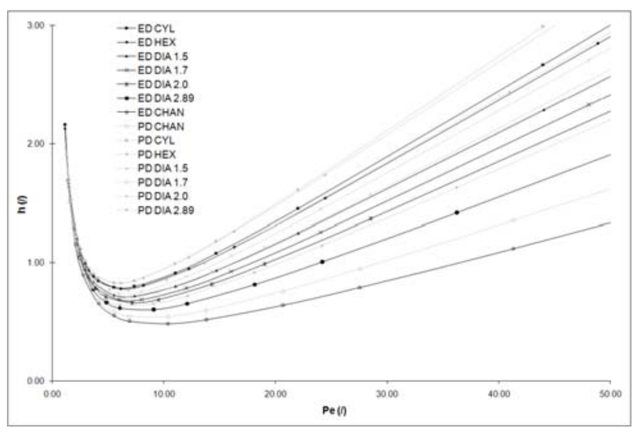
Despite great advantages in chromatography have been achieved, the search for better separation media and methods resulting in lower theoretical plates in less time never stopped. Since the introduction of capillary electro-chromatography (CEC) it is well established that electrically driven (ED) flows produce much smaller theoretical plate heights than pressure driven (PD) flows, yielding better separation efficiency over high-performance liquid chromatography (HPLC) [1]. This is mainly due to the characteristic plug-flow profile of the electro-osmotic flow (EOF), which results in an alternative way the ED velocity profile reshapes when passing through a tortuous pore structure with undulating cross section [2].



Furthermore, the impact of packing structure imperfections plays such a great role that it is considered the most important contribution to the total band broadening in modern separation devices [3]. As it's not possible to fix the particles of packed bed columns on well defined positions, alternative systems based on micro machining structural arrays of pillars in a solid substrate were developed [4].



We investigated the role of the pillar shape as well as the ordering of the pillar arrays together with etching imperfections and wall effects. The impact of these geometrical parameters on the band broadening for ED and PD flows was simulated by using our 'in-house' build CFD package. The plateheight values were fitted to the well known Knox equation ($h = A\nu^{1/3} + B/\nu + C\nu$) to provide a comparison method for the band broadening results. We conclude that for perfectly ordered arrays more elongated shapes are to be preferred if they maintain a more uniform pore space. These data perfectly agreed with findings for PD flows in similar media [5]. For ED flows we found similar results for the B-term while for the A-term in the Knox equation - an indication for the degree of uniformity - the value was smaller regardless of the used geometry. This is due to a more uniform flow in the pores caused by the plug-flow profile of EOF. As could be expected proved the C-term value lower for all the ED cases but with no significant preference for the pillar shape.



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