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Contribution ID: **250**   Type: **Oral Presentation**

Fluid flow control devices with 3D-graded permeability

Wednesday, 2 June 2021 16:00 (15 minutes)

Chemical engineering systems often rely on components that involve intimate contact between a fluid and a solid, such as in catalyzed reactive flows, fluid purifiers, and chromatographic separations. To accomplish this, it is often necessary to distribute the fluid from a relatively narrow tube to a broader cross section, to an array of tubes, or into a porous medium that can be modeled by Darcy's Law or similar flow model. Ideally, the flow rates in the tube array or throughout the porous medium are uniform, and the size, weight, and cost of this portion of the system are a small fraction of those of the chemically reactive portion.

Additive manufacturing techniques raise the possibilities that porous media can be fabricated in which the permeability can be arbitrarily specified in three dimensions, and that a broader range of permeabilities can be achieved than by traditional methods used to manufacture porous media.[1] We are using optimization algorithms [2] to design devices that distribute a fluid from a narrow inlet to a broad outlet, where the outlet flow rate is spatially uniform, and device geometry and/or pressure drop are constrained, by spatially varying the permeability in the device. We have considered a Darcy's law model, as well as a modification of the Navier-Stokes equations with a term representing permeability.[3] Numerical models show that designs varying permeability in three or two dimensions can achieve greater uniformity than designs that vary permeability in only one dimension (such as with stacked flow elements).

Meanwhile, we are evaluating methods to fabricate structures with spatially varying porosity on conventional additive manufacturing tools, as a path to build the designed devices for future experimental testing.

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Time Block Preference

Time Block C (18:00-21:00 CET)

References

[1] V. P. Palumbo et al. "Porous Devices Made by Laser Additive Manufacturing."US Patent Application 2017/0239726 A1, Mott Corporation, 2017.
[2] M. A. Heroux, R. A. Bartlett et al. "An overview of the Trilinos project"ACM Trans. Math. Softw. 31(3), 397-423, 2005.
[3] T. Borrvall, J. Petersson. "Topology Optimization of Fluids in Stokes Flow."Int. J. Numer. Meth. Fluids 41, 77–107, 2003.

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