PN1-3: Influence of Anisotropy and Permeability on Turbulent Pumping by Highly Space and Time-resolved Measurements

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For a wide range of engineering applications such as transpiration cooling, filtration processes, heat exchangers and geothermal engineering, understanding how porous media with different topologies interact with turbulent free flows is crucial. For this purpose, the focus is on the efficient design, operation and optimisation of such engineering applications and relies on comprehensive understanding of the exchange of mass, momentum and energy across the interface between the porous medium and the free flow.

A controversial point of discussion is whether the transport at the interface is mainly diffusion or advection controlled. It is demonstrated that a viscous sublayer exists close to the permeable wall only when the intrinsic permeability of the porous medium is small compared to the viscous length scale of the fluid [1]. If this requirement is fullfilled, a direct proportionality between the strain rate at the interface and the velocity difference between the interfacial velocity and the Darcy velocity inside the porous domain can be derived as an empirical boundary condition for coupling the porous media region and the free flow at the interface [2]. With the increase of the permeability Reynolds number [3] turbulent fluctuations start to penetrate into the porous media region, which is known as turbulent pumping, while simultaneously the porous media topology also affects the turbulent flow in the free flow region [4]. A triply periodic minimal surface (TPMS) topology is used as porous medium providing visual accessibility inside of the porous model and the possibility of achieving a high porosity of $\phi = 0.92$. Further, the TPMS is characterised by a small filament thickness as well as the definition of two different surface topologies, which are defined by the anisotropy of the porous media model.

Thus, results of highly resolved PIV measurements will be presented for such a porous periodic topology adjacent to a turbulent fluid flow considering both the penetration of turbulent fluctuations and the influence of the TPMS on the interfacial layer, specifically in terms of emerging vortices. Furthermore the impact of the TPMS models periodicity on the interfacial boundary layer will be targeted.

References

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