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Validity of classical scaling laws in laminar channel flow with periodic spacer-like obstacles[1] WILKO ROHLFS, RWTH - Aachen, JOHN H. LIENHARD, MIT - Massachusetts Institute of Technology — Laminar channel flows with periodic obstacles occur in different technical applications involving heat and mass transfer. They are present in membrane technologies such as electro-dialysis or spirally wound membrane modules. For process design, classical scaling laws of heat and mass transfer are typically used. The laws scale the transfer (Sherwood) number, Sh, to the hydrodynamic Reynolds, Re, the fluid specific Schmidt number, Sc, and to some dimensionless geometric parameters, G, in a classical form like $Sh = CRe^{\alpha}Sc^{\beta}G^{\gamma}$. However, the validity of those classical scaling laws is limited to the region where the concentration boundary layer develops as it is well known that the transfer numbers approach a constant (Reynolds and Schmidt independent) value in the developed region of a laminar channel flow. This study examines numerically the validity of the scaling laws if the channel flow is interrupted periodically by cylindrical obstacles of different size and separation distance. In the developed region, a Schmidt and Reynolds number dependency is found and associated to wall-normal flow induced by the obstacles, for which this dependency varies with obstacle size and separation distance.

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Wilko Rohlfs
RWTH - Aachen

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