Efficiency of Electropumping Nano-Confined Water

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Electropumping is the process by which an electric field is used to transport fluids, particularly in the context of nanofluidics. In the case of water confined to planar nanochannels and carbon nanotubes, the application of a rotating electric field that couples to the permanent dipole moment of water has been shown to be an effective means of inducing a net positive flow in fluids [1-4]. In this talk, we investigate the efficiency of electropumping relative to Couette and Poiseuille flows. We apply a spatially uniform rotating electric field to a fluid confined in a functionalized nanochannel that couples the water's permanent dipole moment resulting in a net positive flow. We then induce a net positive flow in nanochannels for traditional Couette and Poiseuille flows, matching volume flow rates to allow a direct comparison of average power dissipation per unit volume between all flow types. We show that while electropumping is less efficient than Couette flow, it is 4 orders of magnitude more efficient than Poiseuille flow [5]. This suggests that, rather than being a mere novelty, electropumping is a far more energetically efficient means of transporting water compared to conventional pressure driven pumping.

References

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