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Direct numerical simulation of low Reynolds number turbulent air-water transport in fuel cell flow channel

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Abstract

With performance improvement of low-temperature fuel cell (FC), high reactant supply and water generation rates may induce air-water turbulence in the FC flow channel. In this research, an air-water turbulent direct numerical simulation (DNS) model is developed to simulate different droplet sizes, locations and interactions in the air-water transport processes comprehensively. It is found that a larger droplet breaks up more easily in turbulence, and a smaller droplet tends to keep lumped. The droplet at corner does not break up because it is away from channel center. The droplet interaction simulations show that the small droplets merge to form slugs, but still keep lumped in turbulence. It is suggested that two conditions need to be satisfied for droplet break up in FC flow channel, one is turbulent flow, and another is that the droplet needs to be large enough and occupy the center region of flow channel to suffer sufficient turbulence fluctuation. The DNS results illustrate some unique phenomena in turbulent flow, and show that the turbulence has significant effect on the air-water flow behavior in FC flow channel.

Keywords: DNS; fuel cell; turbulence; air-water flow.