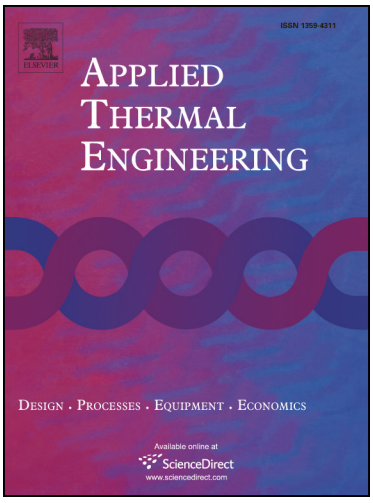

Research Paper

On the evaporative spray cooling with a self-rewetting fluid: chasing the heat

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On the evaporative spray cooling with a self-rewetting fluid: chasing the heat

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Abstract

In the study, we successfully utilize the self-rewetting fluid to enhance the evaporative cooling of a pulsed spray system by inducing the inverse Marangoni convection. We find that the superhydrophilicity of the surface is essential to promote a continuous surface-tension-driven fluid flow, which helps to replenish the hot region with the working fluid, and prevent dryout from happening. As a result, cooling lasts much longer beyond the discharge and a significant amount of heat can be removed by a single shot of spray. We coin a term 'heat chasing' effect to describe the excellent cooling caused by the inverse Marangoni convection. Besides the surface superhydrophilicity, the spray height should be confined to a certain range so that a liquid film is formed. Once the inverse Marangoni convection commences, the total heat transfer can be augmented three to seven times for a given spray amount. Although long spray always results in better heat transfer, enhancement with the inverse Marangoni convection is still present under the condition of the short spray for a surface temperature as high as 255°C.

Keywords: Inverse Marangoni effect; Heat chasing; Evaporative cooling; Self-rewetting fluid

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