

Transient Spray Cooling

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Spray cooling is a very efficient technology, surpassing all other conventional cooling methods, especially those not involving phase change and not exploiting the latent heat of vaporization. However, the effectiveness of spray cooling is dependent on a large number of parameters, including spray characteristics like drop size, velocity and number density, the surface morphology, but also on the temperature range and thermal properties of the materials involved. Indeed, the temperature of the substrate can have significant influence on the hydrodynamics of drop and spray impact, an aspect which is seldom considered in model formulation. This process is extremely complex, thus most design rules to date are highly empirical in nature. Transient spray cooling adds complexity by the fact that the substrate temperature is continually cooling, thus the hydrodynamics occur in different thermodynamic regimes: film boiling, transitional boiling and nucleate boiling. On the other hand, significant theoretical progress has been made in recent years about the interaction of single drops with heated walls and improvements to the fundamentals of spray cooling can now be anticipated. The present contribution has the objective of summarizing some of these recent experimental and theoretical advances and to establish a framework for future development of more reliable and universal physics-based correlations to quantitatively describe and predict quantities involved in spray cooling.