IMPINGEMENT HEAT TRANSFER IN GAS TURBINE SYSTEMS

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ABSTRACT

Impingement heat transfer is one of the most effective techniques for heating, cooling, or drying of a surface. Applications of impingement jets include electronic chip cooling, material processing such as cooling of hot metal sheets, paper or textile drying, cryogenic tissue freezing, and cooling of gas turbine components. Due to the high performance and wide range of applications, flow and heat transfer characteristics of impinging jets have been of great interest.[1,2]

High inlet temperature, beyond the failure limit of component materials, is employed in the first turbine stage of modern gas turbine systems. Proper cooling techniques for components are essential to prevent the failure and improve the durability of the system. Impingement heat transfer is used in many component due to its high cooling capacity including internal cooling of turbine vanes and blades, combustor outer wall cooling,and turbine rotor disk cooling. As the inlet temperature of turbines is increased to improve the performance of turbine systems, the demand for higher performance of impingement cooling continues to grow.

A review of impinging jet flow and heat transfer can provide a summary of current understanding on the technique and the directions for future research. This review focuses on impingement heat transfer in gas turbine systems. Single-phase circular or slot jet impingement and impingement of an array are discussed.

The flow fields of impinging jet consists of a free jet region, a stagnation flow region, and a wall jet region. Flow characteristics of each regions are reviewed. The coherent structure of ring vortices and its role in turbulence and heat transfer is discussed. Local and averaged heat transfer characteristics for both a single jet and an array of jets are reviewed. Flow condition in real gas turbine systems are complicate due to high temperature, turbulence, combustion, rotation and interaction of coolant with hot combustion gas. The effect of crossflow, rotation, impinging on a curved surface and angle of impact are reviewed.

REFERENCE

[1] H. Martin, "Heat and Mass Transfer between Impinging Gas Jets and Solid Surfaces," *Adv. in Heat Transfer* **13**, 1 (1977).

[2] R. Viskanta, "Heat Transfer to Impinging Isothermal Gas and Flame Jets," *Experimental Thermail and Fluid Science* **6**, 111 (1993).