Gas turbines have become an intricate part of today’s society. Besides powering practically all 200,000+ passenger aircraft in use today, they are also a predominate form of power generation when coupled with a generator. The fact that they are highly efficient, and capable of large power to weight ratios, makes gas turbines an ideal solution for many power requirement issues faced today. Part of the turbine’s success is the fact that their efficiency levels have continuously risen since their introduction in the early 1800’s. Along with improvements in our understanding and designs of the aerodynamic components of the turbine, as well as improvements in the areas of material design and combustion control, advances in component cooling techniques have predominately contributed to this success. This is the result of a simple thermodynamic concept; as the turbine inlet temperature is increased, the overall efficiency of the machine increases as well.

Designers have exploited this fact to the extent that modern gas turbines produce rotor inlet temperatures beyond the melting point of the sophisticated materials used within them. This has only been possible through the use of sophisticated cooling techniques, particularly in the 1st stage vanes and blades. Some of the cooling techniques employed today have been internal cooling channels enhanced with various features, film and showerhead cooling, as well as internal impingement cooling scenarios. Impingement cooling has proven to be one of the most capable heat removal processes, and the combination of this cooling feature with that of channel flow, as is done in impingement channel cooling, creates a scenario that has understandably received a great deal of attention in recent years.

This study has investigated several of the unpublished characteristics of these impingement channels, including the channel height effects on the performance of the channel side walls, effects of bulk temperature increase on heat transfer coefficients, circumferential heating variation effects, effects on the uniformity of the heat transfer distribution, and the thermal performance of various channel configurations.

Through these investigations, it has been shown that the channel side walls provide heat transfer coefficients comparable to those found on the target surface, especially at small impingement heights. Increases in channel height result in increased non-uniformity in the streamwise direction and decreased heat transfer levels. Bulk temperature increases have also been shown to be an important consideration when investigating surfaces dominated by crossflow heat transfer effects. Considerations of these bulk temperature changes also allow the determination of the point at which the flow transitions from an impingement dominated regime to one that is dominated by crossflow effects. Finally, circumferential heat variations have proven to have negligible effects on the calculated heat transfer coefficient, with the observed differences in HTC being contributed to the unaccounted variations in channel bulk temperature.