FILM COOLING MODELING FOR FAST AND ACCURATE CFD PREDICTION

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To produce more [power] per [gas turbine engine unit mass], we need to enhance turbine thermal performance. Nowadays, it can be mainly done by increasing [turbine inlet gas temperature].

Hot gases leads to thermal protection problem. Nowadays, to reach the desired turbine thermal performance, the gas temperature (up to 2000 °K) entering the high pressure turbine is far beyond the allowable metal temperature of section parts (blades, casing,...). Even most recent advances in high temperature materials cannot sustain these temperatures. Therefore, to achieve life and safety standards, materials needs to be protected against severe thermal environment by other means.

Film Cooling as a solution. Drill small holes within the blades surface to inject air, (withdrawn from the compressor) within the freestream boundary layer. This creates a thin layer of cold air insulating the blades from the hot gas stream.

Needs for efficient and fast design tools. Costs for designing a new film cooling scheme are high. Indeed, the designer needs to maintain both high level of turbine performance and low level of cooling flow (loss penalties). CFD can help to shrink the design process time and costs.

Facing the multiscale problem. The major drawback to use CFD is the inherent multiscale nature of the problem. We need both to capture flow features at the scale of the blade chord and also of the hole diameter. This leads to have much too high RAM/CPU consumption for one computation.

<u>Our solution</u>: Feature-based Film Cooling Model, tuned on experimental data, usable on a standard blade passage mesh.

To avoid the obligation of directly solving the entire film cooling physics, it is proposed to elaborate a film cooling model which can be embedded in a CFD code. The aims is to be able to simulate the film-cooled turbine blade without having to explicitly mesh the internal coolant passage, in order to give the possibility to perform a parameter study for design purposes in a reasonable time. Knowing that an under prediction of only 15K in the blade-surface temperature may result in a lifetime-reduction of about 50%, it is believe that the model has to reproduce accurately the jet-primary flow interaction. Therefore a deep understanding of this flow phenomenon is needed in order to calibrate accurately the model.