Active flow control insight gained from a modified integral boundary layer equation

AVRAHAM SEIFERT, Tel Aviv Univ — Active Flow Control (AFC) can alter the development of boundary layers with applications (e.g., reducing drag by separation delay or separating the boundary layers and enhancing vortex shedding to increase drag). Historically, significant effects of steady AFC methods were observed. Unsteady actuation is significantly more efficient than steady. Full-scale AFC tests were conducted with varying levels of success. While clearly relevant to industry, AFC implementation relies on expert knowledge with proven intuition and or costly and lengthy computational efforts. This situation hinders the use of AFC while simple, quick and reliable design method is absent. An updated form of the unsteady integral boundary layer (UIBL) equations, that include AFC terms (unsteady wall transpiration and body forces) can be used to assist in AFC analysis and design. With these equations and given a family of suitable velocity profiles, the momentum thickness can be calculated and matched with an outer, potential flow solution in 2D and 3D manner to create an AFC design tool, parallel to proven tools for airfoil design. Limiting cases of the UIBL equation can be used to analyze candidate AFC concepts in terms of their capability to modify the boundary layers development and system performance.

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