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Disc actuators for turbulent drag reduction DANIEL J. WISE, CLAUDIA ALVARENGA, PIERRE RICCO, The University of Sheffield, SHEFFIELD FLUID MECHANICS GROUP COLLABORATION — The response of a turbulent channel flow to flush-mounted steadily rotating discs is investigated numerically. The effect on drag reduction of the discs arrangement is studied at a Reynolds number of R_b=5600, based on the bulk velocity and channel height. The flow exhibits complex dependence on the positioning of the discs. For low disc-tip velocity the drag reduction scales linearly with the percentage actuated area, whereas for higher tip velocity the drag reduction may be higher than predicted from this coverage scaling. Therefore by halving the number of discs increased drag reduction can be found. The departure from linear scaling is found to relate to the presence of stationary-wall regions upstream of discs. This is explained by the impingement of the disc boundary layer onto the areas of unactuated wall. For some arrangements tubular, streamwise-elongated structures occur between discs. The criteria for their creation are elucidated through the employment of the Fukagata-Iwamoto-Kasagi identity and flow visualisations. Improvements in the performance of the disc actuators are found with inspiration from the laminar solution to the disc flow. Through the introduction of novel half-disc and annular configurations, a maximum drag reduction of 26% is obtained.

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