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Variation of Airfoil Pressure Profile Due to Confined Air Streams: Application in Gas-Oil Separators

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Abstract : An innovative design has been examined for a gas-oil separator based on pressure reduction over an airfoil surface. The primary motivations are to shorten the release trajectory of the bubbles by minimizing the thickness of the oil layer as well as improving uniform pressure reduction zones. Restricted airflow over an airfoil is investigated for its effect on the pressure drop enhancement and the maximum attainable attack angle prior to the stall condition. Aerodynamic separation is delayed based on numerical simulation of Wortmann FX 63137 Airfoil in a confined domain using FLUENT 6.3.26. The proposed set up results in higher pressure drop compared with the free stream case. With the aim of optimum power consumption we have pursued further restriction to an air jet case over the airfoil. Then, a curved strip model is suggested for the air jet which can be applied as an analysis/design tool for the best performance conditions. Pressure reduction is shown to be inversely proportional to the curvature of the upper airfoil profile. This reduction occurs within the tracking zones where the air jet is effectively attached to the airfoil surface. The zero slope condition is suggested to estimate the onset of these zones after which the minimum curvature should be searched. The corresponding zero slope curvature is applied for estimation of the maximum pressure drop which shows satisfactory agreement with the simulation results.

Keywords : airfoil, air jet, curved fluid flow, gas-oil separator
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