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REVIEWER'S REPORT

Manuscript No.: IJAR-58961

Title: EFFECT OF BLADE-ALIGNED CASING TREATMENT SLOTS ON PERFORMANCE OF A TRANSONIC COMPRESSOR ROTOR.

Recommendation:
Accept as it is ………………………………
Accept after minor revision……………..
Accept after major revision ……………..
Do not accept (*Reasons below*) ………

Rating	Excel.	Good	Fair	Poor
Originality		✓		
Techn. Quality		✓		
Clarity		✓		
Significance		✓		

Reviewer Id: JPR-395

Reviewer's Comment for Publication.

The manuscript investigates the aerodynamic effects of blade-aligned over-tip casing treatment slots on the performance and stall margin of NASA Rotor 37. The topic is relevant to the design of high-speed transonic axial compressors, where tip leakage vortex behavior, shock–vortex interaction, and stall-margin extension are important engineering concerns. The study compares a baseline smooth casing with three casing-treatment configurations having different slot depths and presents CFD-based performance, Mach-number, and entropy-flow-field analyses.

The manuscript has several positive aspects. The use of the well-known NASA Rotor 37 benchmark provides a suitable basis for CFD validation and comparison. The authors have also attempted a grid-independence study and comparison with published experimental performance data. The investigation of different slot depths is practically relevant, and the reported improvement in stall margin for CT-1 provides an interesting result. The discussion of the trade-off between stall-margin improvement and efficiency loss is also useful.

However, the following issues should be addressed before publication:

1. **Clarification of slot geometry is essential.** The manuscript alternately refers to slot "depth," "height," and "width." For example, CT-1 is described as a 3 mm depth and 3 mm width, while Table 1 lists height and width separately. The terminology and dimensions of CT-1, CT-2, and CT-3 should be defined consistently, preferably with a clear schematic showing slot width, depth/height, length, circumferential extent, and orientation relative to the blade.
2. **The description of the number of configurations is inconsistent.** The manuscript states that "two distinct casing treatment configurations" were modeled, but CT-1, CT-2, and CT-3 are subsequently presented. This should be corrected.
3. **The CFD validation needs to be strengthened.** Although the baseline CFD prediction is compared with experimental data, the validation should include quantitative error values for mass

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flow, pressure ratio, efficiency, choke point, and stall point. A table comparing CFD and experimental values would make the validation much more convincing.

4. **The definition and calculation of stall margin should be explicitly provided.** The reported 2.3% improvement should be accompanied by the exact equation used to calculate stall margin and the baseline and treated operating-point values used in the calculation. This is particularly important because stall prediction using steady RANS requires careful interpretation.
5. **Steady RANS limitations should be discussed more carefully.** Stall inception and tip-leakage-vortex breakdown are inherently unsteady phenomena. The use of steady RANS can provide useful engineering trends but may not accurately predict the actual onset of rotating stall. The authors should clearly distinguish between the computed near-stall operating point and experimentally observed stall inception.
6. **The turbulence-model description contains an inconsistency.** The abstract/keywords mention a "k-ε turbulence model," whereas the methodology states that the SST k-ω model was used. This must be corrected throughout the manuscript. The exact SST formulation and relevant solver settings should also be reported.
7. **Boundary conditions require more detail.** The inlet total pressure, inlet total temperature, exit pressure range, turbulence intensity, turbulence length scale, and treatment of the casing/rotor interface should be clearly stated. This information is necessary for reproducibility.
8. **The treatment of the stationary casing in the rotating reference frame should be clarified.** The statement that the stationary casing was assigned "counter-rotating relative motion" could be confusing. The authors should explain the reference-frame/interface treatment used in ANSYS CFX and ensure that it represents the physical stationary casing correctly.
9. **Mesh-independence analysis should include quantitative uncertainty.** The comparison of 0.6, 1.2, and 2.4 million-cell grids is useful, but the authors should provide numerical differences between G2 and G3 for pressure ratio, efficiency, and stall mass flow. If possible, a formal grid-convergence indicator should also be provided.
10. **The physical explanation of slot flow requires additional evidence.** The manuscript states that high-pressure fluid is bled near the trailing edge and reinjected upstream of the shock. This is central to the proposed mechanism. Streamlines, velocity vectors, pressure distributions, or mass-flow-rate information through the slot would provide much stronger evidence for this explanation.
11. **The entropy analysis should be quantified.** The manuscript provides qualitative descriptions of high-entropy regions, but it would be valuable to report integrated entropy-generation or total-pressure-loss quantities for the baseline and three treated cases. This would substantiate the claim that larger cavities increase mixing and viscous losses.
12. **The conclusion that CT-1 is optimal should be supported by a more systematic comparison.** A summary table containing stall mass flow, stall-margin improvement, peak pressure ratio, peak efficiency, and efficiency penalty for all four cases would clearly demonstrate why CT-1 is preferred.
13. **Some interpretations appear stronger than the CFD evidence supports.** Statements such as "This proves that the slot reinjection jet successfully energizes the primary passage flow" should be softened unless supported by quantitative flow-field evidence. A CFD visualization demonstrates an association/mechanism, but "proves" is too strong for the presented analysis.
14. **The statement regarding "massive bright red high-momentum cores" should be revised.** Mach-number contours alone do not necessarily demonstrate improved energy transfer or reduced loss. The interpretation should be based on appropriate velocity, total-pressure, entropy, and/or blockage metrics.
15. **The literature review should be better connected to the specific research gap.** The manuscript cites several studies on casing treatments, but the novelty of blade-aligned slot geometry should be stated more explicitly. The authors should explain precisely how the present configuration

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differs from conventional axial slots, circumferential grooves, skewed slots, or self-recirculating casing treatments.

16. **Reference quality and relevance should be checked carefully.** Several references appear only indirectly related to transonic compressor casing treatment. The authors should ensure that the literature review primarily relies on directly relevant compressor, tip-leakage, casing-treatment, and NASA Rotor 37 studies.
17. **Figures require improved labeling and readability.** Several figure captions are incomplete or inconsistent, and the manuscript contains expressions such as "Figure .2," "Figure.6," and "Figure 14Variation." Figures should be renumbered, captions standardized, and axes, units, legends, and operating points clearly identified.
18. **There are numerous grammatical and formatting errors.** Examples include missing spaces, inconsistent use of quotation marks, inconsistent units ("3mm," "3 mm"), "shroudyet," "stall marginimproving," and several incomplete sentences. The manuscript should undergo thorough language and technical proofreading.
19. **The terminology should be standardized.** Terms such as "adiabatic efficiency," "isentropic efficiency," "stable mass-flow boundary," "stall mass flow," "stall margin," "slot depth," and "slot width" should be defined and used consistently.
20. **The conclusions should avoid overgeneralization.** The reported 2.3% stall-margin improvement applies to the specific NASA Rotor 37 geometry, operating conditions, slot configuration, clearance, and numerical methodology. It should not be presented as universally applicable to transonic compressors without further experimental validation.

Overall Assessment

The manuscript presents a technically relevant CFD investigation and has potential value for researchers working on transonic compressor stability enhancement and passive casing treatment. The comparison between different slot depths and the identification of a trade-off between stall-margin improvement and efficiency degradation are useful contributions.

Nevertheless, clarification of the slot geometry, correction of the turbulence-model inconsistency, stronger CFD validation, explicit definition of stall margin, improved evidence for the proposed slot-flow mechanism, and substantial language/formatting corrections are required.

Recommendation: Accept after minor revision.