Review comments for JoVE57630R2

We sincerely appreciated for the kind efforts and time for providing the following editorial comments aimed at improving the quality of the manuscript. We have fully responded all the Editorial comments. In the revised manuscript, the modifications and corrections for English usages are indicated as the red bars at the No. of sentences. The modifications and corrections made to respond the rest of comments are indicated as the pink prints in the revised manuscript. In what follows, the itemized responses are summarized.

Editorial comments:

1. **There are still numerous grammar and usage errors; please proofread, ideally by a fluent English speaker.**

I have ask the helps from my friend Andrew Neeson, Austrian native English speaker, to improve the English. All the modifications and corrections in the respect are indicated as the red prints in the revised manuscript.

2. **There are still a few inline variables made in an equation editor (e.g., in the paragraph after equation 1); please try to make these into Calibri text (note that this is not necessary, though, and may be impossible for some).**

To make this request possible, we have changed the vector symbols in the flow equations. Then all these inline variables are changed into Calibri texts.

3. Results: Ref. 32 is cited twice in one citation (Line 428).

The repeated citations for Ref. 32 is corrected. Thank you.

Protocol:

1. **Some of the protocol still seems to be lacking in detail (see below); detailed descriptions of how exactly the protocol is done (that is, what exactly someone who is carrying out the protocol should be doing) are necessary for planning of filming. Previous JoVE videos and their accompanying protocol text may help you get a better idea, in particular in the engineering section: https://www.jove.com/journal/engineering. Note that it is not necessarily a problem that construction of the module is not detailed, but operation of it should be explained more.**

The lacking details itemized in the following comments 2-7 are modified to enhance the descriptions of how exactly these protocols are done. Thank you for the helps.

2. 1.1: This is unclear, do you mean to simply choose a range of Re, Ro, and Bu?

The ranges of Re, Ro and Bu are determined in accordance with the operating conditions of a gas turbine rotor blade. Thus, protocol 1.1 is revised as:

1.1. Formulate the experimental conditions in terms of Re, Ro and Bu from the targeted operation conditions of a gas turbine rotor blade.

3. 1.4: Please include a citation here for design and construction.

Reference 2 is cited for protocol 1.4. Thank you.

4. **2.4: How are temperatures read out? A display on the instrument? Computer display?**

The temperatures are read out on the computer screen. Protocol 2.4 is revised as below:

2.4. Feed electrical heating power through the heating foil and measure temperatures simultaneously by thermocouple and infrared thermography system from the computer display at the steady state.

5. **3.2: What is the vibrational limitation? How are conditions checked?**

The vibrational limitation is checked by viewing the instant temperature images displayed on the computer screen. The stable image allowing for data acquisition and transmission is needed. Protocol 3.2 is modified as below:

3.2. Adjust the counterbalancing weight gradually until the running condition of the rotating rig satisfies the vibrational limitation for the infrared thermographic measurements to exhibit the stable thermal image on the computer display.

6. **4.2: How is the module installed?**

Protocol 4.2 is revised into:

4.2. Install the filled test module on the rotating test rig by fitting the test module on the rotating platform and connecting the heater power supply and all the instrumental cables.

7. 5.1: How are heat transfer tests performed? It is unclear if this has been described in the previous steps.

The heat transfer tests are performed by feeding coolant flows and heater powers to the test module with all the relevant data monitored by the on-line data acquisition program. Protocol 5.1 is revised as below:

5.1 Perform heat transfer tests at the targeting Reynolds numbers at zero rotating speed (Ro=N=0) by feeding coolant flows and heater powers to the test module. Ensure the supplied coolant mass flow rate is constantly adjusted in order to control Reynolds number at the flow entry plane at the targeting value.

Figures:

1. **Please include more relevant details (e.g., what the error bars are and in general everything discussed below) in the Figure legends, instead of in the Results or Introduction, so that they can be more readily interpreted just from the legends.**

FIGURE LEGENDS:

Figure 1. Realistic operating Re, Ro and Bu ranges and the emulated laboratory conditions for a rotating coolant channel in a gas turbine rotor blade. The test conditions performed by NASA HOST program[3-6] are indicated as the bar symbol. The open and solid symbols respectively signify the Bu, Bo and Re test ranges for the pointed and full-field heat transfer measurements.

Figure 2. Typical heat loss coefficients (h_{loss}) at various rotating speeds[30] using the trapezoidal twin-pass rib-roughened rotating channel as an illustrative example. The

top portion depicts the constructional details of the rotating test module. The slope of each data trend constituting by the heat loss flux against wall-to-ambient temperature difference shown in the left lower portion reveals the heat loss coefficient at the specific rotating speed. By correlating the heat loss coefficients detected at all the rotating speed tested, the generated heat loss correlation typified by the right lower plot is incorporated into the data processing program for Nu accountancy.

Figure 3. Local Nusselt number distribution of the static twin-pass S-channel roughened by curly ribs at Re=15000 measured by present infrared thermography method. The top diagram depicts the endwall of two-pass wavy channel and the longitudinal S-ribs. As indicated by the AA' section view, the pair of longitudinal S-ribs is in-lined arranged on two opposite channel endwalls. In the detailed distribution of Nusselt number over the two-pass wavy endwall shown as the lower plot, the Nu data along the two longitudinal S-ribs are discarded due to the wall conduction effects on the distributions of heat-flux and wall-temperature.

Figure 4. Examples demonstrating the isolation of Re impact from Ro and Bu effect on local[31] and regionally-averaged heat transfer properties of rotating channel [31]. The upper portion exhibits the detailed Nusselt number distributions at fixed Ro of 0.15 with different Re of 5000, 7500 and 12500 to enlighten the impacts of Reynolds number on the heat transfer properties of the rotating endwall. The lower portion depicted the area-averaged heat transfer properties over the rotational leading and trailing endwalls. The normalized Nu/Nu_0 ratios highlight the heat transfer variations from the non-rotating scenarios by rotation.

Figure 5. Examples demonstrating the uncoupled Ro effect from Bu impact on heat transfer properties of rotating channel[32,33]. Each Bu-driven Nu/Nu_0 variation is obtained at the fixed Ro and correlated as a linear function of Bu as indicated by the straight line in each plot. The correlation coefficients of these fitted lines fall between 0.96 and 1.02. The extrapolation of the Nu/Nu_0 data trend toward $Bu \rightarrow 0$ along each fitted line reveals the Nu/Nu_0 ratio at the tested Ro. The magnitude and slope of each Bu-driven Nu/Nu_0 data trend disclose the manners of buoyancy effect on heat transfer performances. The magnitudes of the slopes represent the degrees of Bu impact on Nu/Nu_0. The positive and negative slopes respectively reflect the improving and impairing buoyancy impact on heat transfer levels.

Figure 6. Uncoupled Ro and Bu effects on regionally averaged heat transfer performances of the rotating wavy channel[32,33]. The upper portion collects the heat transfer scenarios at various Ro but with vanished buoyancy effect at Bu=0. Such Nu/Nu_0 variations are solely caused by the various Coriolis forces at different Ro. The lower portion shows the variations of Bu impact on Nu/Nu_0 at different Ro. The negative and positive ψ_2 values indicate the respective impairing and improving Bu impacts on the heat transfer performances for the furrowed[32] and pin-fin[33] channels.

2. **Figure 1: What are the labeled data points? References? Also, 'Engine worse condition' is still an odd way of putting it, as well as 'Lower limit of engine condition', how about ''Engine conditions at highest rotor speeds' and 'Engine**

conditions at lowest rotor speeds', respectively (or similar)?

In the revised caption of Figure 1, all the labeled data points are illustrated. The references corresponding to all the labeled data points are indicated in the Figure legends. The "Engine worse condition" is changed to "Engine conditions at highest rotor speeds and density ratios". The 'Lower limit of engine condition' is changed to "Engine conditions at lowest rotor speeds and density ratios".

Thank you for the suggestions.

3. **Figure 2: Please explain all parts of the Figure in the legend, including the top diagram and the graph at the left.**

Thank you for this suggestion. As we explained for comment 1, the legend of Figure 2 is revised as below to illustrate the plots at the top, the lower left and the lower right portions.

Figure 2. Typical heat loss coefficients (h_{loss}) at various rotating speeds[30] using the trapezoidal twin-pass rib-roughened rotating channel as an illustrative example. The top portion depicts the constructional details of the rotating test module. The slope of each data trend constituting by the heat loss flux against wall-to-ambient temperature difference shown in the left lower portion reveals the heat loss coefficient at the specific rotating speed. By correlating the heat loss coefficients detected at all the rotating speed tested, the generated heat loss correlation typified by the right lower plot is incorporated into the data processing program for Nu accountancy. The data range indicated in the lower right plot indicates the range of experimental uncertainties for h_{loss}[30].

4. Figure 2: What is the 'data range'? 'Range' in the statistical sense (i.e., the top and bottom of the error bars are the largest and smallest values), or something else like standard deviation?

The data range indicated in the lower right plot represents the range of experimental uncertainties for h_{loss}[30]. Thus, the explanation for such data range is added in the caption of Figure 2. Thank you.

Figure 2. Typical heat loss coefficients (h_{loss}) at various rotating speeds[30] using the trapezoidal twin-pass rib-roughened rotating channel as an illustrative example. The top portion depicts the constructional details of the rotating test module. The slope of each data trend constituting by the heat loss flux against wall-to-ambient temperature difference shown in the left lower portion reveals the heat loss coefficient at the specific rotating speed. By correlating the heat loss coefficients detected at all the rotating speed tested, the generated heat loss correlation typified by the right lower plot is incorporated into the data processing program for Nu accountancy. The data range indicated in the lower right plot indicates the range of experimental uncertainties for h_{loss}[30].

5. **Figure 3: Please explain the diagram at top more fully (in the legend as well). What are the dotted lines? What are the colored circles? What are A and A'? What does '5 mm' indicate, and what are the other dimensions? What are the wavy lines going through the module?**

Thank you for the comment. The unnecessary dotted lines are removed. The only dotted line indicates the location of AA' section. The colored circles are removed. As

indicated in the revised Fig. 3, the 5mm is the height of S-rib. The other dimensions are removed. The wavy lines going through the module are indicated as the longitudinal S-ribs in the revised Figure 3.
The revised Fig. 3 along with its modified caption are depicted as below.

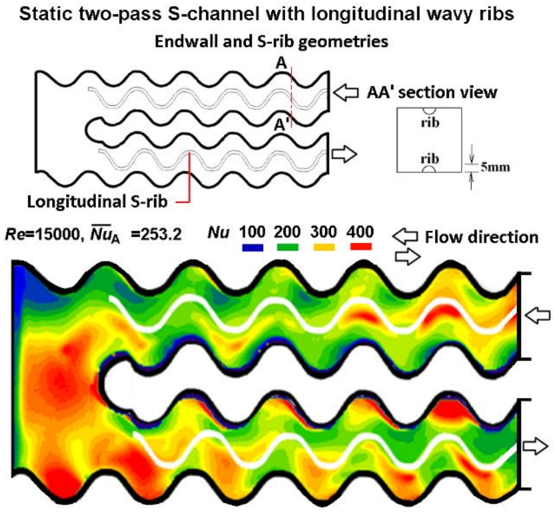


Figure 3. Local Nusselt number distribution of the static twin-pass S-channel roughened by curly ribs at Re=15000 measured by present infrared thermography method. The top diagram depicts the endwall of two-pass wavy channel and the longitudinal S-ribs. As indicated by the AA' section view, the pair of longitudinal S-ribs is in-lined arranged on two opposite channel endwalls. In the detailed distribution of Nusselt number over the two-pass wavy endwall shown as the lower plot, the Nu data along the two longitudinal S-ribs are discarded due to the wall conduction effects on the distributions of heat-flux and wall-temperature.

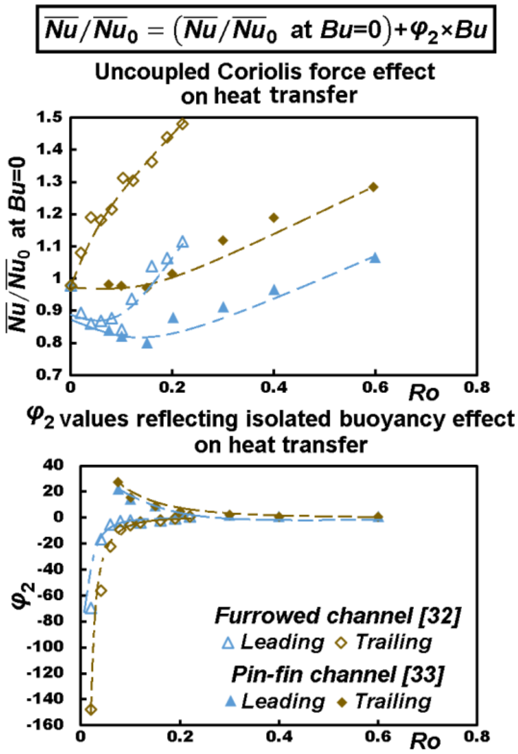
6. Figure 5: Please explain the lines and how well they fit in the Legend.

Thank you for the comment. The responses to this comment are included in the revised caption of Figure 5 as follows:

Figure 5. Examples demonstrating the uncoupled Ro effect from Bu impact on heat transfer properties of rotating channel[32,33]. Each Bu-driven Nu/Nu_0 variation is obtained at the fixed Ro and correlated as a linear function of Bu as indicated by the straight line in each plot. The correlation coefficients of these fitted lines fall between 0.96 and 1.02. The extrapolation of the Nu/Nu_0 data trend toward Bu→0 along each fitted line reveals the Nu/Nu_0 ratio at the tested Ro. The magnitude and slope of each Bu-driven Nu/Nu_0 data trend disclose the manners of buoyancy effect on heat transfer performances. The magnitudes of the slopes represent the degrees of Bu impact on Nu/Nu_0. The positive and negative slopes respectively reflect the improving and impairing buoyancy impact on heat transfer levels.

7. Figure 6: 'trasnfer' is a typo. Also, please explain the dotted lines in the legend.

Thank you. This typo is corrected in the revised Figure 6.



8. Figures 5/6: It looks like ref. 33 should also be cited in the Legends to these figures.
All the results compared in Figs. 5 and 6 are re-plotted as an attempt to demonstrate the differential Bu impacts on the heat transfer properties of the rotating channels with furrowed ednwalls[32] and pin-fins[33]. Thus, Figures 5 and 6 are the new plots. The ref. 33 are added in the Figure caption.