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Activities of the Core

Nov. 6, 2021	The research content of Professor Matsumura's comprehensive promotion of environmental research was introduced in the weekly post.
Nov. 11, 2021	Mechanical Systems Seminar (co-organized)
Nov. 18, 2021	The 97th Hiroshima University Biomass Evening Seminar (co-organized)
Nov. 18, 2021	The 65th HU-ACE Steering Committee Meeting.
Nov. 27, 2021	The 10th joint Conference in Renewable Energy and Nanotechnology 2020（JCREN2021）(online) (co-organized)

We co-organized the International Conference JCREN2021.

On Nov. 27, 2021 we co-organized the international conference of Joint Conference on Renewable Energy and Nanotechnology (JCREN2021). This conference is held every year and though this time was 10th anniversary, unfortunately the conference was held online as well as in the last year owing to COVID19 situation. Thanks to Prof. Dowaki (Tokyo Univ. of Science, chairperson) and the executive committee, we had fruitful discussion. Because the conference was online, we could have many participants from all over the world. JCREN2022 is scheduled to be held by the executive committee in Vietnam. We wish that it can be held face-to-face.

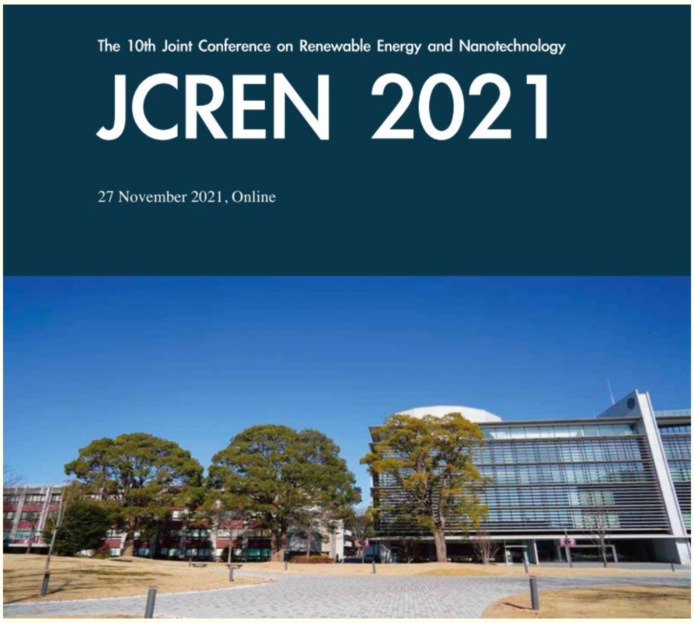

Fig. Cover picture of the conference program

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Research Topics

Wall heat transfer of pulsating flow toward exhaust system design in automotive engines

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Research fields: Fluid Engineering, Mechanical engineering
Keywords: CFD, Turbulent flow, Internal Combustion System

Abstract

Background

CAE (Computer Aided Engineering) has become mainstream for Research and development (R&D) of industrial products owing to improvement of computer, parallel computing and numerical scheme accuracy. The flow in the intake and exhaust manifolds of an automotive intake and exhaust system is a typical pulsating flow. The flow and heat transfer characteristics of the intake and exhaust manifolds directly affect the efficiency of the catalyst installed downstream of the exhaust manifold. Correlation between wall heat transfer and pulsating flow with high frequency is significant to reduce heat loss and realize higher efficiency of exhaust catalysts to meet stringent and worldwide emission standards.

Methods

Both experimental and numerical studies have been performed to investigate the turbulent pulsating flow and heat transfer in a straight pipe and a 90 ° curved pipe, which are often used in engine manifolds. The aim of this study is to clarify the heat transfer performance of pulsating flow in straight and curved pipes and analyze the heat transfer mechanism in combination with numerical simulation. The steady turbulent flow was used as a comparison to confirm whether the pulsating flow enhances or suppresses heat transfer.

Results

Wall heat flux is significant to evaluate heat transfer performance in an automotive exhaust system. Figure shows the local heat flux at different positions along the streamwise direction (left), and comparison of the temperature and velocity contours of the 90 degree curved pipe (right), respectively. In the “SC” and “PC,” owing to the impact of the secondary flow and the high-temperature core on the outer wall of the bend, the heat flux was maintained at a high level near the outlet of the curved part (X/D=6 to 10 in left figure). For a steady flow in a curved pipe, the impingement of the high-temperature core can enhance the heat transfer in Figs. (a) and (b). On the other hand, while high temperature core impingement and thin boundary layer also take place at maximum flow speed in Figs. (c) and (d) to enhance heat transfer, the flow impingement of the low-temperature core reduced the outer wall temperature around the bend in Figs. (e) and (f) in decelerating phase for pulsating flow. It is found that the temperature difference between the outer wall and ambient temperatures was reduced, and the heat transfer was suppressed in the phase.

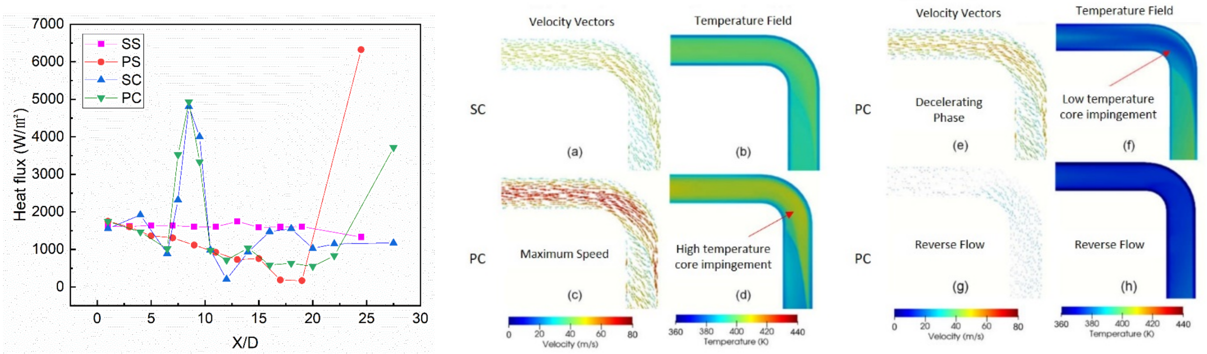

Figure Left : Comparison (straight and curved pipes) of heat flux on the wall. SS : Steady Flow-Straight pipe, PS : Pulsating Flow-Straight Pipe, SC : Steady Flow-Curved Pipe, PC : Pulsating Flow-Curved Pipe. Figure Right : Instantaneous velocity vectors and temperature fields of the horizontal section along the center axis of the curved pipe in the simulation.[1]

References

[1] Guo, G., Kamigaki, M., Inoue, Y., Nishida, K., Hongou, H., Koutoku, M., Yamamoto, R., Yokohata, H., Sumi, S., and Ogata, Y. : Experimental study and conjugate heat transfer simulation of pulsating flow in straight and 90° curved square pipe. Energies, 14(13), No.3953, 2021