論文 / 著書情報
Article / Book Information

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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

As a high-aspect-ratio rectangular jet is essential for various engineering applications, controlling this jet using an active flow control technique using plasma actuators opens new possibilities. The combination of modular frequency, duty, and phase difference determines the working condition of the plasma actuators and has different effects on the flow features. The PA can affect the initial vortex and overdrive the natural vortex generation frequency and size.
The plasma Actuator can perform active flow control with high-aspect-ratio (width-to-height ratio 20) rectangular jets to enhance the centerline velocity and temperature performance. The velocity increased to 15% higher, and the temperature is 14% higher measured at the driver' s location where x/h = 70 on the centerline as the initial target is a 20% improvement. With 362 tested cases and results of full fractional designs, the phase difference is the most important parameter to the velocity; it is also known that the timing of the induced wind as a modular frequency has a substantial effect on the velocity of the rectangular jet compared with duty. It can increase or decrease the velocity at a certain point and change the profile of the centerline velocity. Additionally, duty is the most important parameter to the temperature as changing the duty cycle influences the temperature better than the modular frequency. It can also affect the temperature at a particular point, centerline temperature profile, and temperature distribution across cut sections. It was also found that under specific conditions, the plasma actuator can cause the axis-switching phenomenon to occur at a location closer to the rectangular nozzle outlet (Case E), where x/h = 20-30. It results in a "thick" distribution of the high normalized temperature in this identical area. The PA can introduce coherent structures to HAR rectangular jet flows. The combination of the periodic excitation and vectoring effects stemmed from the modular frequency and phase difference, respectively, which transfers the mean energy of the flow to complex organized structures called spanwise vortexes. Simultaneously, during the formation of the coherent structures, the energy cascading process gradually decreases the vortical structures owing to the interaction between multi-scale turbulence structures. These spanwise vortexes

create low-pressure zones when they travel streamwise that create suction, drawing low-energy air into the core of the vortexes. The concept of PV was used to explain the mechanism. When the rectangular jet flow is released into the still air, the flow enters a highly dissipative environment. This environment dilutes the vorticity of the coherent structures, making it decrease rapidly after fully forming spanwise vortexes. The compression of the coherent structures then occurs since the absolute vorticity must be proportional to the length of the coherent structure. As a result, the length of the spanwise vortex shortens when it travels streamwise resulting in a convergence effect from the X-Y Top View and a divergence effect from the X-Z Side View. Energy spectra analysis showed that PAs can overdrive the dominant frequency by doubling the modular frequency for cases where coherent structures are created. The flow features and quantitative characteristics of the rectangular jet flow controlled by PAs can be predicted by calculating the Strouhal number using the modular frequency applied to PA to control the flow. By understanding the mechanism, the spanwise vortex created by PA can be utilized to introduce coherent structure into the flow to control the jet width; depending on the orientation of the PA versus the rectangular jets (e.g., on the long edge or the short edge) converging or diverging effects can be archived. By utilizing this know-how, velocity and temperature of the rectangular jet can be controlled.

In summary, the velocity and temperature performance are improved by using Plasma Actuator to actively control the high-aspect-ratio rectangular jet without increasing the air-conditional total energy budget. Just by changing the PA operating parameters, various flow effects will be created to fit various thermal conditions of an automobile. For the novelty and academic contributions of this research, there are three points:

- Applying a small amount of control comparing the main jet energy at the beginning shear layer can affect the velocity and temperature performance further in the flow field. This can be done by manipulating (enhancing or suppressing) the integral length scale introduced into the flow.
- Mechanisms of PAs to control sub-sonic high-aspect-ratio rectangular jet width are multi-scale turbulence structures, energy cascade, and potential vorticity.
- Among the operating parameters of Plasma Actuators, the most important parameter to control velocity and temperature is identified.