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Flow Control Using Interference of Two Pulsating Jets with Phase Difference

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Extended Abstract

Jet technology is used in many fields such as air conditioning, cooling, flue gas treatment, cutting, cleaning, printers, combustion acceleration, aircraft thrust generation, attitude control, and so on. Research on the jet control has been conducted for many years from various viewpoints. Conventional jet flow control has been mainly based on geometrical methods such as louver angles and variable nozzles. Recently, non-mechanical control methods using unsteady jets such as synthetic jets have been proposed [1]-[3]. However, it is difficult to generate synthetic jets with large momentum, and it is currently impossible to apply them to fluid machinery that requires large momentum. Therefore, a pulsating jet that combines the characteristics of both a continuous jet and a synthetic jet have been considered promising for high momentum flow control. Previous studies have already clarified the fluid behavior and mixing characteristics by interfering continuous and pulsating jets [4], and some insight has been gained into the behavior of impinging pulsating jets [5]. It has also been reported that the direction and width of the jet can be controlled by applying phase differences between pulsating jets [6], [7]. Recently, it has been shown that for two pulsating jets with the phase difference π in the exit velocity, the formation of the substantial jet is determined by the non-dimensional amplitude of the jet, and the structure of the jet can be controlled by time variation of the velocity [8]. However, parametric reports examining how frequency affects the flow field when two pulsating jets interfere with the phase difference π is still insufficient.

In this study, the influence of non-dimensional frequency with the phase difference π on the jet structure and fundamental flow characteristics of interference between two pulsating jets is investigated mainly by numerical calculations. Numerical simulations were performed using the scFlow solver, an unstructured grid-based thermal-fluid analysis system. The velocity amplitude $U_{sa} = 1$ m / s and the time-averaged velocity $U_{sc} = 3$ m / s were used for the flow velocity. The non-dimensional $f^* = 1.83 \times 10^{-3}, 3.67 \times 10^{-2}, 7.33 \times 10^{-2}, 1.47 \times 10^{-1}, 2.93 \times 10^{-1}$ is used as a parameter, The non-dimensional number $\frac{c}{b_0} = 9.09 \times 10^{-2}$ where c and b_0 are the slot pitch and slot width, respectively. The standard k-ε model is used for the turbulence model, and the number of meshes is about 200,000. The main results show that the jet width can be increased by decreasing the non-dimensional frequency of the two pulsating jets with the phase difference π, and that the decay process of the jet center velocity depends on the non-dimensional frequency. In addition, the interference with the solid wall was discussed for several frequencies of the pulsating jets.

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