Sound Emission from Laminar Diffusion Flame with Controlled Oscillatory Fuel Flow

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1. Introduction

In this study, the performance of an actuator for the active control systems to attenuate the combustion oscillation is experimentally investigated. This actuator is a valve using a piezo ceramics device (called a piezo-valve). Using this valve, a small laminar diffusion flame with varying heat-release is generated. The flame can emit sound with controlled amplitude and frequencies. This property will allow us to use the flame as the second sound source of which interaction with the pressure oscillation in the combustor is expected to attenuate the acoustic modes.

2. Experimental Results

In the experiments, the sound emission from the oscillatory diffusion flame is measured. Fig.1 shows the schematic diagram of experimental apparatus. The piezo valve supplies the oscillatory fuel flow with both controlled amplitudes and frequencies. The oscillatory fuel flow is injected into the open air, and an oscillatory diffusion flame is kept. As a fuel, hydrogen and methane are used. Reynolds number based on the diameter of the fuel injection hole and mean injection velocity of the fuel is between 100 and 1000. The sound emission from the oscillatory diffusion flame is measured with a microphone.

The contribution of combustion to the rise of sound pressure level, influence of fuel on increase of sound emission by combustion, phase shift of sound emission, etc. are investigated. Fig.2 shows the sound level increase by combustion. In comparison with hydrogen combustion, sound increase effect by methane combustion diminishes at lower frequency. This is likely caused by slower combustion process of methane.

3. Conclusions

1)The valve can vary the flow rate in quasi-proportion to the input voltage.

2)Both the oscillatory fuel jet and the flame can be regarded as a monopole sound source.

3)The combustion amplifies the sound emission. But this effect disappears above a certain frequency.

4)The increase in the sound pressure level by the combustion and the frequency at which the amplification effect is lost depend on the fuel.

References

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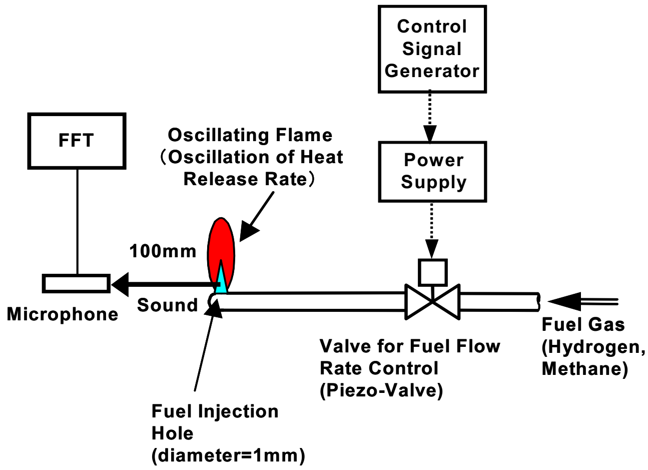

Fig. 1 Experimental Scheme of Sound Measurement

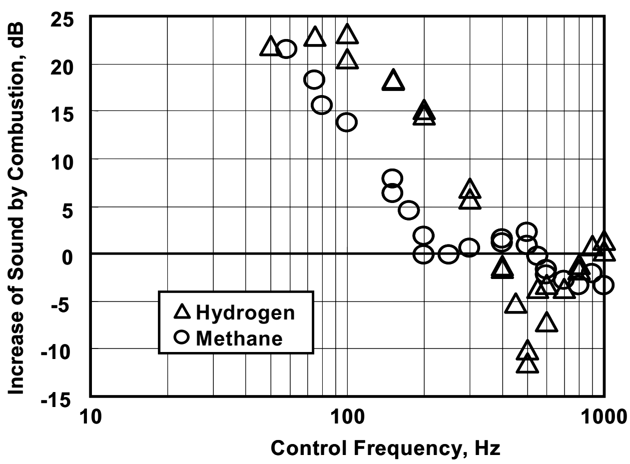

Fig. 2 Sound Increase by Combustion

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