Introduction

Ion probes are used in detonation measurement and flame measurement in engines as a method of measuring the presence or absence of the arrival of a flame. The multiple-ion probes method enables temporal and spatial resolution of the flame behavior near the wall of the combustion chamber. Furthermore, a design that takes thermal and mechanical strength into consideration is possible. In this study, we used a 120-ch probes. By using the 120ch ion probes, we aimed to improve the time and space resolution within the measurement range and measure the propagation flame more precisely. The fuel used in the experiment was a stoichiometric mixture of CH₄ and O₂, and was diluted with N₂ according to the experimental conditions.

Measurement principle of ion probe

The ion probe measures the flame using the weak electrical conductivity of the flame-3V is added in advance to the tip of the ion probe, and when the flame passes, the combustion tube begins around and an output voltage is generated. Although the output voltage used is a flame detection signal, since the signal is weak as it is, the signal amplification circuit amplifies the signal.

Experimental apparatus and conditions

The propagating flame propagates from left to right in the combustion tube shown in Fig.2. Multiple-ion probes are placed at a position 1640 mm from the spark plug, and the flame transitioning to detonation is measured by a disturbing tube. In order to calculate the average propagation velocity of the flame, independent ion probes are attached at 100 mm on both ends of the multi-ion probe.

Experimental results

Fig.4 to Fig.7 visualize the results under each experimental condition. In Fig. 4, between each ion probe It can be seen that the propagation velocity repeats acceleration and deceleration. Fig.5 to Fig.7 are contours showing the flame surface shape with time. The color of the contour represents the detection time, which means that the detection time is delayed as it changes from red to blue.

Conclusions

Detailed measurement experiments of flames were conducted using multiple ion probes. Under the condition of NMF = 0, we were able to capture micro-explosions of the detonation wave front and two-dimensional flame propagation. Under the condition of NMF = 0.45, it was possible to measure the acceleration and deceleration of the propagation flame, and under the condition of NMF = 0.71, it was possible to measure the appearance of the flame propagating in the unburned region and the tube circumferential direction.

References
