助成対象研究の紹介文

Turbulent burning and extinction behaviors and mechanism of ammonia/air flame under high-temperature and high-pressure environments

東北大学流体科学研究所　特任助教　XIA YU

Reducing carbon dioxide (CO_2) emissions is a critical challenge for humanity to mitigate the effects and consequences of climate change. The adoption of alternative, carbon-free fuels in combustion systems is imperative for the realization of a carbon-neutral society. Ammonia (NH_3) is a promising hydrogen energy carrier and carbon-free fuel [1]. Furthermore, NH_3 combustion does not emit CO_2, SO_x, or soot. NH_3 has a hydrogen weight of 17.7%, can be synthesized from renewable energy sources, and is easier to store and transport than hydrogen. Therefore, various applications of ammonia as a fuel are currently under consideration. Applying ammonia in combustors for producing electrical energy is regarded as a pragmatic and near-term solution to mitigate CO_2 emissions. In practical combustors, achieving high combustion efficiency and minimizing NOx emissions typically involves operating under conditions of high pressure, elevated temperatures, and a turbulent environment. Nevertheless, the utilization of NH_3/air flames poses a considerable challenge due to their weak combustion intensity and susceptibility to extinction in turbulent conditions. Therefore, this research intends to clarify the turbulent flame propagation and extinction phenomena of ammonia combustion under homogeneous turbulence environments. Moreover, the turbulent flame propagation and extinction phenomena will be further clarified under a high temperature and pressure environment. Figure 1 shows the turbulent flame extinction phenomena of ammonia combustion under moderate turbulence intensity.

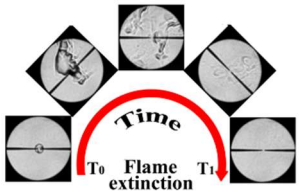

Fig. 1 Turbulent flame extinction phenomena of ammonia combustion

[1] Y. Xia, G. Hashimoto, K. Hadi, N. Hashimoto, A. Hayakawa, H. Kobayashi, O. Fujita, Turbulent burning velocity of ammonia/oxygen/nitrogen premixed flame in O_2-enriched air condition, Fuel 268 (2020) 117383.

【実用化が期待される分野】

This research helps for the application of ammonia in various energy generation and industrial processing facilities, including gas turbines and industrial boilers.