Effect of Combustion Air Temperature on Combustion Characteristics of New Type Combustor with Upward Swirl

T. Furuhata*, T. Sasaki and S. M. Arai
Department of Mechanical System Engineering
Gunma University
Tenjin-cho 1-5-1, Kiryu, Gunma 376-8515 JAPAN

Abstract

Our research group has proposed a low-NOx spray combustor for kerosene-fueled micro gas turbine based on an upward swirl concept. This combustor consists of primary and secondary combustion zones, and they are connected by a throat. A swirler is set between the primary and secondary combustion zones. In order to enhance the recirculation of burned gas in the primary combustion zone, the combustion air is introduced through the swirler and forced to flow upward to the combustor bottom, from which fuel is injected through a nozzle. In this study, effect of combustion air temperature on combustion characteristics of an experimental combustor with the upward swirl concept was investigated experimentally. The experimental combustor was installed in a casing. The combustion air introduced into the casing flows between the secondary combustion tube and the casing (heat exchange zone), and the air is ejected into the primary combustion zone through the swirler. Since the heat of combustion gas in the secondary combustion zone is transferred to the combustion air in the heat exchange zone, the preheated temperature of combustion air can be raised by increasing lengths of the secondary combustion tube and the casing simultaneously. Kerosene was used as a liquid fuel. Characteristics of exhaust gas and distributions of combustion gas velocity, temperature and species concentrations (CO and NOx) in the primary combustion zone were measured in order to discuss combustion characteristics of the combustor.
Preheated temperatures of combustion air were measured at the inlet of swirler in the casing. It was clear that the preheated temperatures increased with increasing the lengths of the secondary combustion tube and the casing. Relations between excess air ratio in the primary combustion zone λ_p and characteristics of exhaust gas were investigated. It was clear that emission index of NOx in the case of higher preheated temperature greatly increased in λ_p = 1.05 and 1.26. The increases of NOx were mainly caused by the rise of combustion air temperature.

Key words: Spray Combustion, Low NOx Combustion, Gas Turbine Combustor, Swirl

*Corresponding author, furuhata@me.gunma-u.ac.jp