Experimental investigation of lab-scaled flameless combustion system with thermal recuperation

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1. Introduction

Mech Aero-2018 Conference was an international podium for presenting research about mechanical and aerospace engineering and exchanging thoughts about it and thus, contributes to the propagation of information. Mechanical Conference represents the huge area where the focus lies on developing product-related technologies with rapid advancement in research in recent years. Since Flameless combustion is one of the main researches in Combustion and Sustainable Energy Laboratory (ComSEL) at Arkansas Tech University (ATU), the results of this investigation were presented in this conference.

2. Summary of the project

Depletion of fossil fuel resources and increasing rates of pollutant formation have motivated the combustion community to work on combustion efficiency improvement. Recently, flameless combustion systems have been widely developed due to extremely low pollutant formation and fuel consumption reduction in flameless mode. In the flameless regime, the combustion air is highly preheated without increasing the rate of pollutant formation, in particular NOx emissions. The non-premixed air/fuel are injected into the combustor at high velocities; hence, the availability of oxygen in the reaction zone reduces. In fact, the reaction zone is dispersed throughout the furnace, the hot spots are eliminated, and uniform temperature is observed in the chamber. Investigation about combustion stability is still the most important issue in flameless combustion systems. In this regard, the objective of this study is to experimentally investigate the effects of recuperation system on the stability of a lab-scaled flameless combustion system and the rates of pollutant formation. In this design, fuel is injected axially from one end of the cylindrical-shaped combustion chamber and air is introduced coaxially from the same side while the flue gases are exhausted from the other end of the chamber. To maintain inside temperature of the chamber over auto-ignition temperature of the fuel, a helical pipe is installed inside the chamber to transfer the

fresh air from exhaust zone to burner zone and preheat the combustion air (recuperator). Temperature distribution inside the chamber, wall temperature, and the temperature uniformity (considered as one of the most important parameters in flameless mode) are measured. Various radicals inside the chamber are measured to analyze pollutant formation and stability of flameless combustion.

3. Conclusion

The effects of burner configuration on the characteristics of flameless combustion were performed experimentally. The experimental implementations were explained in the conference. In all of the studied cases, the inlet jet of the fuel was located at the center of the burner, surrounded by four oxidizer parallel jets in coaxial burners and perpendicular jets in tangential configuration. The reducing of the axial distance from the fuel injection to obtain a uniform temperature within the combustion chamber when using the tangential configuration is an important result of this article. Although heat loss from the combustor walls is higher in the tangential burner, the efficiency of tangential flameless combustion mode is 2% higher than the coaxial burner.

The conference was held on November 08-09, 2018 in Atlanta, GA and the PI successfully presented the results of this project in the conference.