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Activities of the Core

Dec. 22, 2022 The 77th HU-ACE Steering Committee Meeting.
The 104th Hiroshima University Biomass Evening Seminar (co-organized).

Energy Letter

HU-ACE publishes a monthly Energy Letter. The Letter consists of two sections: "Energy Topics," which introduces energy-related topics, and "Energy Fundamentals," which explains basic technologies/terms. Recent articles are listed in the table below. In addition to the purpose of sharing information among HU-ACE members and advisors, the Energy Letter is distributed to members of the Highly-Advanced Energy Utilization Research Subcommittee of the Institute of Advanced Energy Utilization. The subcommittee provides members with information on seminars and exchange programs, as well as information distribution through the Energy Letter. The subcommittee is always looking for new members. Please contact us at the address below for more information.

Table: Recent Energy Letter Articles

	Energy Topics	Energy Fundamentals
Vol. 12 (Jul. 2022)	EV strategy	Price of solar photovoltaics
Vol. 13 (Aug. 2022)	Small modular reactor	Geothermal power
Vol. 14 (Sep. 2022)	Sakhalin 2	Carbon dioxide capture and storage
Vol. 15 (Oct. 2022)	Decarbonization leading area	Gas engine
Vol. 16 (Nov. 2022)	Integrated coal gasification combined cycle	Octane number
Vol. 17 (Dec. 2022)	Carbon dioxide emissions	Sustainable aviation fuel

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Research Topics

No. 38

Low NOx high temperature air combustion fueled NH_3

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Research fields: Combustion Engineering

Keywords: High temperature air combustion, Ammonia

Abstract

Background

An urgent issue in the combustion field is the application of alternative fuels to realize non-carbon society. The application of “ammonium” is strongly promoted in the field of industrial heating. The problem concerning combustion of ammonium is the emission of nitric oxides (NOx). Because of the NOx problem, th use of ammonium as fuel is not considered in the combustion field, however, the low-NOx ammonium combustion has recently been achieved in gas-turbine combustors [1,2]. Research and development of low-NOx ammonium combustion in the industrial heating field is also in progress in many universities and companies.

Methods

In the industrial heating field, metal heating furnaces, for example, generally utilize the combustion technique of “high temperature air combustion”, in which the air is preheated to 1000°C while fuel is separately injected from the air with high velocity. This technique realizes a so-called “flameless” combustion regime in which a uniform temperature profile (around 1200°C) can be obtained without the formation of high temperature “flame front” in the furnace, then the thermal Nox, which needs a temperature of 1800°C, is inhibited. Its high air preheating temperature (>1000°C) differs from the technique of other combustors, for example, the air preheating temperature in gas-turbine combustors are 500°C at most. The target of our research is to apply the high temperature combustion in the case of ammonium.

Results

We have examined 40kW thermal input combustion in a bench-scale furnace developed with Sanken Sangyo. For the first step, fuel of 30% ammonium and 70% natural gas based on LHV is used. With a conventional combustion technique, 1500ppm NOx, which is almost 10 times of natural gas combustion, is emitted even when mixing 30% ammonium[3]. Recently, we successfully suppressed NOx concentration to less than half of that by using unique combustion technique. In the next step, we will examine the effects of ammonium on the metals through metal heating experiments.

References

(1) Okafor, C. E. et al., Proc. Combust. Inst. 37 (2019), 4597.
(2) Ito, S. et al., J. Combust. Soc. JPN, Vol61, 289-292 (2019)
(3) Qiao, Y, Shimokuri, D et. al., Presented in Thermodynamic conference 2022