Basic co-firing characteristics of ammonia with pulverized coal in a single burner test furnace

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Objective of this study

Direct and blended combustion of ammonia in pulverized-coal-fired power plant is expected one of the promising technology regarding CO_2 reduction.

<u>What is the significant challenge of ammonia as a fuel?</u>

Ammonia (NH_3) contains N atom.

⇨ It can be main source of fuel-NOx.

⇩ If NOx emissions from combustion furnace increase;

- More quantity of NH_3 for flue-gas denitration (de-NOx)
- Improvement or addition of denitration equipment

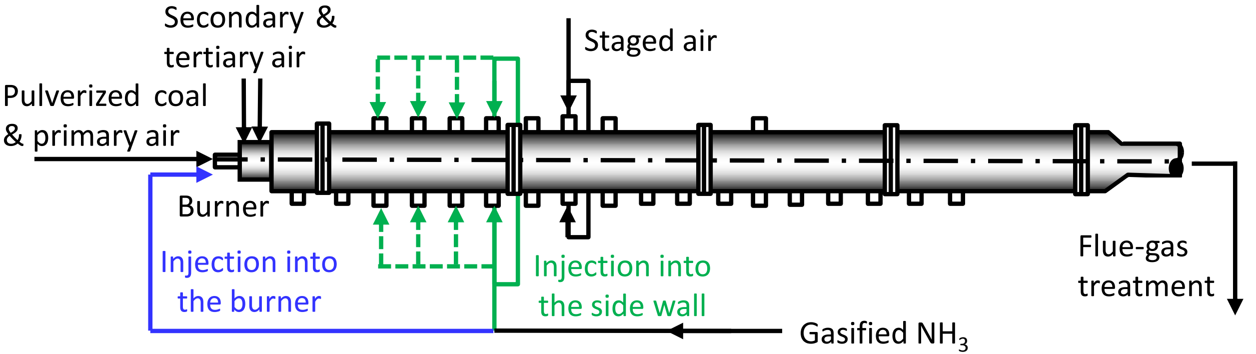
In this study, we examined the basic blended-combustion characteristics of pulverized coal and ammonia using a single-burner combustion test furnace.

Outline of the test furnace

View of the single burner

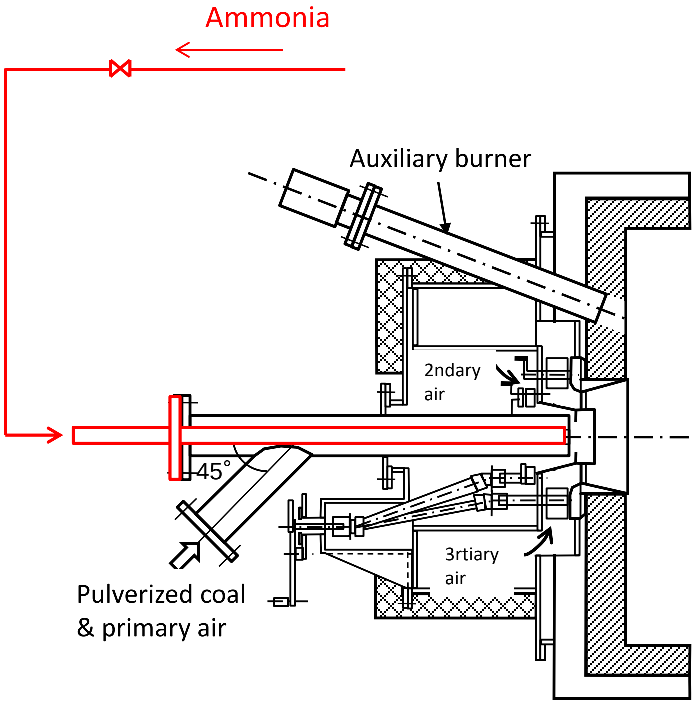
Typical conditions of the experiment

Item	Value
Combustion load (Coal consumption)	760 kW (≒100 kg/h)
Furnace size	Φ0.85m × 8m
Set exhaust O_2	4.0 %
Staged air / Total air	30 %



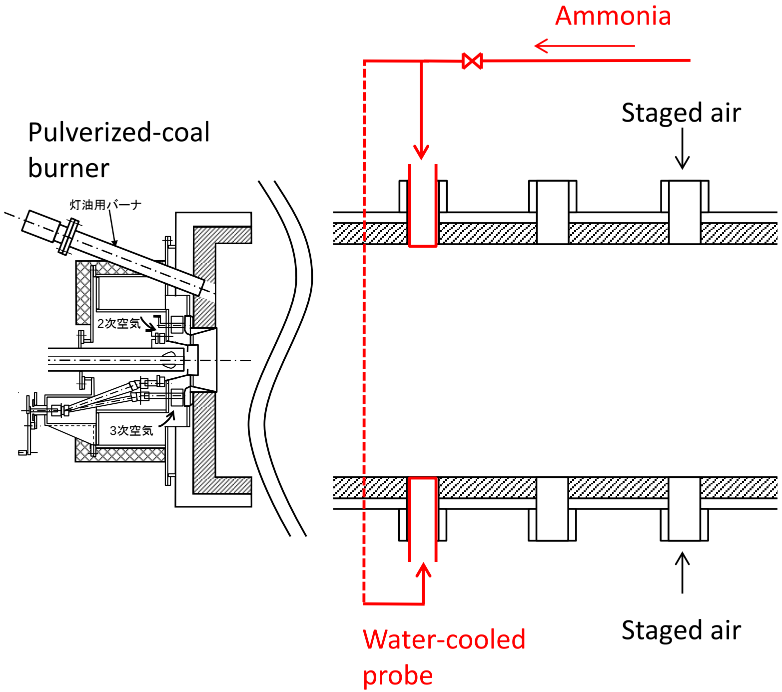
Flow rate of NH_3: Max. 30.0kg/h
→ Max. 20.3% (LHV basis) of the total load

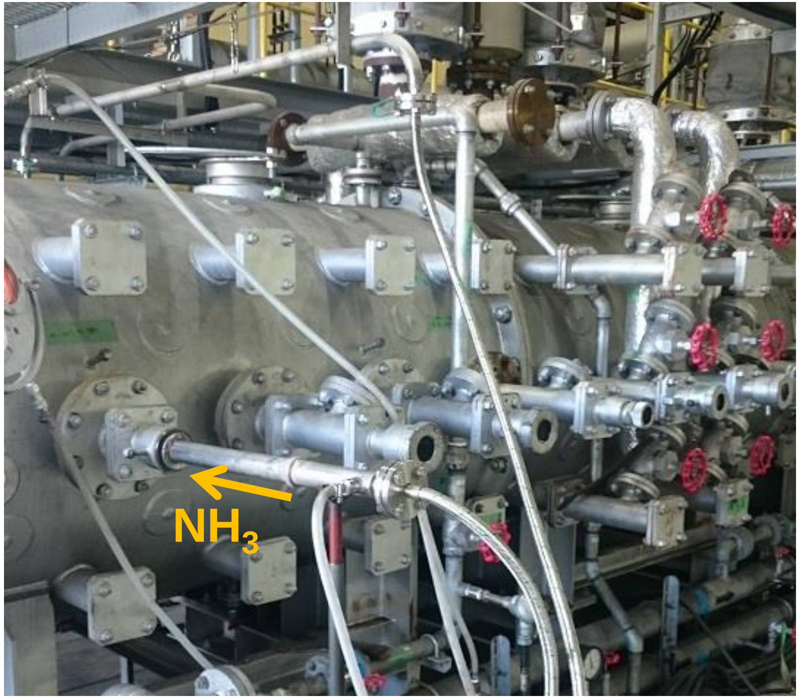
NH_3 injection into the coal burner



Ammonia injection pipe is inserted into the pulverized-coal burner.

NH_3 injection through the side port





Ammonia is injected into the pre-OFA zone through the measurement port.

Experimental conditions

Experimental parameters

① Percentage of NH_3 blending (Max. 20%(LHV basis))

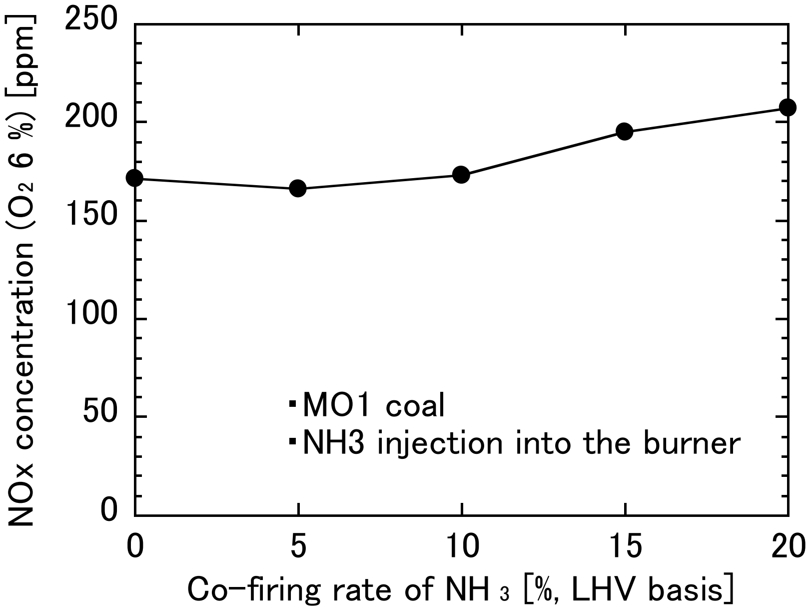
② Position of the side port where NH_3 is injected

Typical coal properties

Common bituminous coals were used for the experiment.

Item	Unit	Coal	
		MO1	MO2
Moisture (AD)	%	2.8	3.5
Ash (dry)	%	12.6	14.0
Volatile matter (dry)	%	35.4	36.0
Fixed carbon (dry)	%	52.1	50.1
Nitrogen (dry)	%	1.74	1.64
LHV (dry)	MJ/kg	29.2	28.4

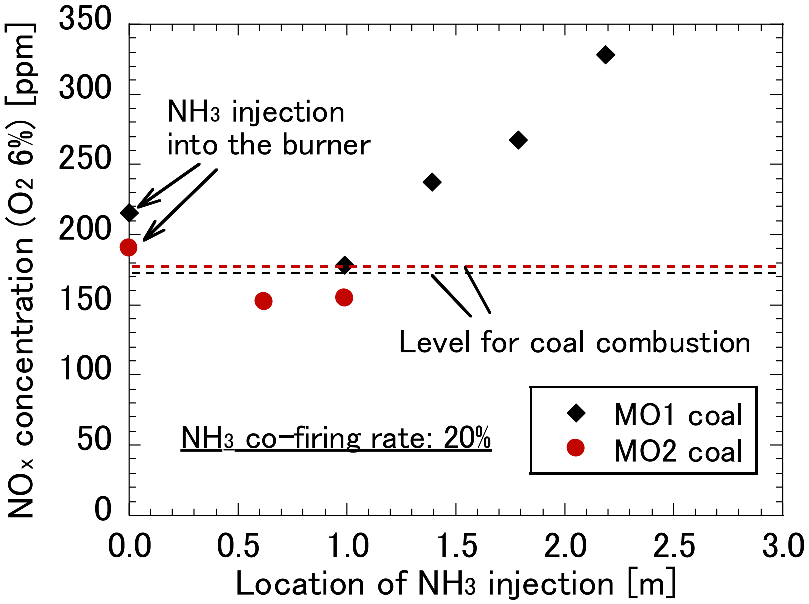
Effect of NH_3 co-firing rate to NO_x



When NH_3 was injected into the pulverized-coal burner

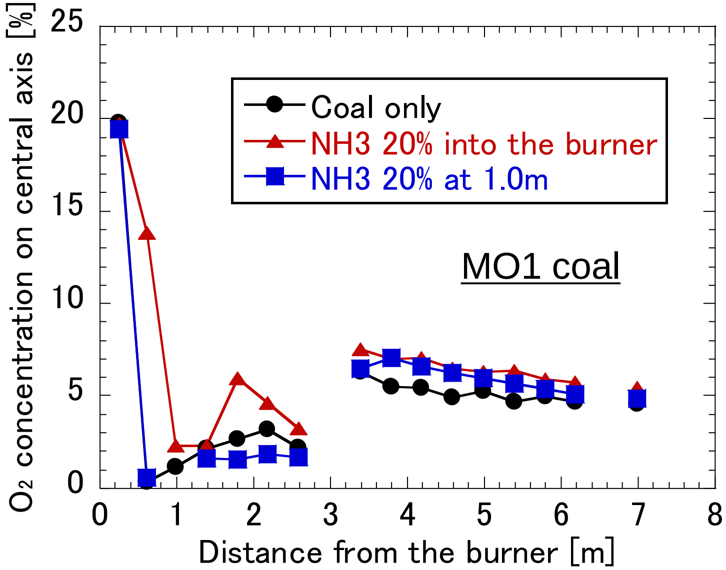
- Co-firing rate≦10% ⇨ Exhaust NOx was much the same as coal combustion.
- Co-firing rate≧10% ⇨ Exhaust NOx increased as input NH_3 increased.

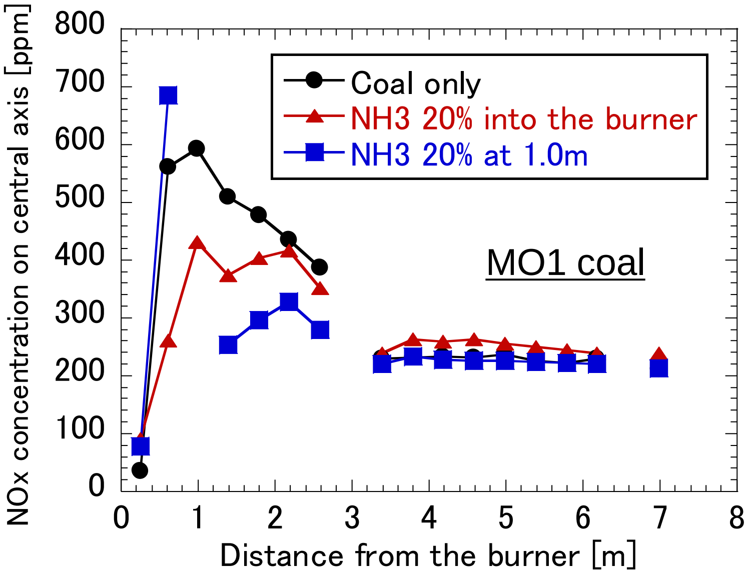
Effect of NH_3 injection position



Exhaust NO_x concentration were decreased by injecting NH_3 through the side port, compared with injecting NH_3 into the coal burner.

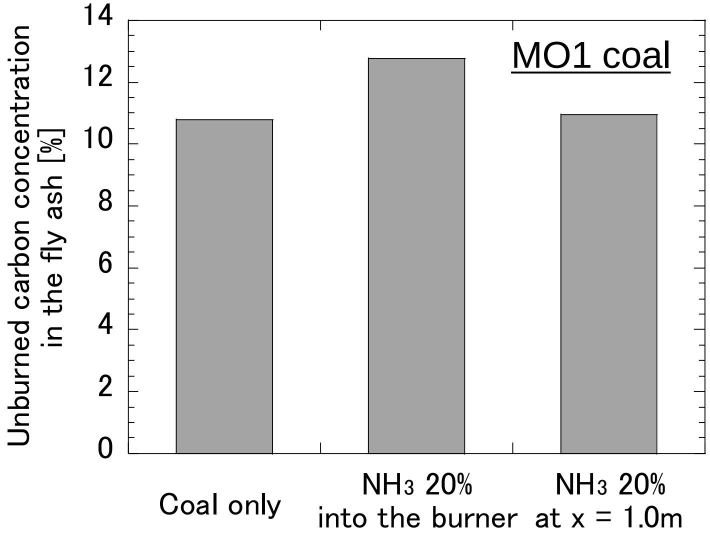
Streamwise distributions of O_2 & NO_x

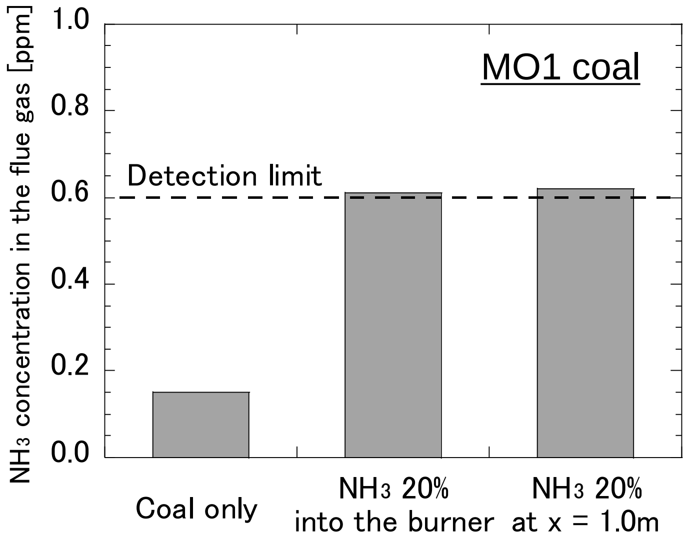




- In the case of NH_3 injection into the burner, NOx generation in the flame is low but it increases after the staged-air injection.
- In the case of NH_3 injection at 1.0 m from the burner, NOx is decreased after NH_3 injection and is not much regenerated after the staged-air injection.

Unburned contents



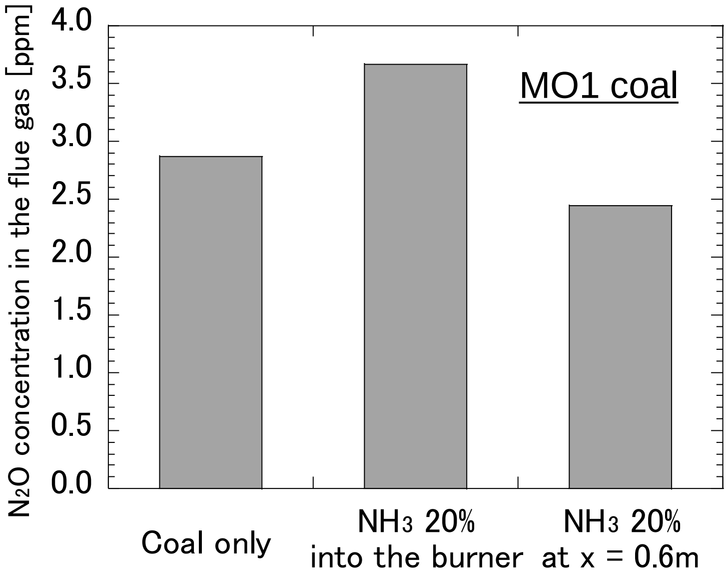


Unburned carbon concentration in the fly ash is slightly high in the case of NH_3 injection into the burner.

Unburned NH_3 concentration is increased by injecting NH_3, but is enough low considering the detection limit.

NH_3 injection through the side port has an advantage regarding the unburned carbon in the fly ash as well as NOx.

Exhaust N_2O concentration



N_2O concentration was increased when NH_3 was injected into the burner, but is negligibly low to work as global warming gas.

Conclusions

Basic co-firing characteristics of pulverized coal and ammonia was investigated using single-burner test furnace. Main conclusions are below.

(1) Effect of NH_3 co-firing rate to NOx generation in case of injecting NH_3 into the coal burner

- Co-firing rate ≦ 10% ⇨ Exhaust NOx was much the same as coal combustion.
- Co-firing rate ≧ 10% ⇨ Exhaust NOx increased as input NH_3 increased.

(2) Effect of position of the side NH_3 port

- When NH_3 was injected at 0.6 m or 1.0 m from the pulverized-coal burner, NOx in the flue gas was decreased compared with the case injecting NH_3 into the coal burner.
- By injecting NH_3 into low O_2, high NOx region, fuel-NOx generation is suppressed and NH_3 possibly works also as reductant for existing NOx.

(3) Effect of NH_3 injection to unburned content

- When NH_3 was injected into the burner, unburned carbon in the fly ash slightly increased probably due to the lower flame temperature.
- Unburned NH_3 concentration was enough low even in the cases of NH_3 co-firing.

Acknowledgement

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Thank you for your attention!