Rice husk combustion in a BFBC using alternative bed material

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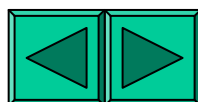
ABSTRACT

Rice husk was burned in a bench-scale fluidized bed combustor using two kind of bed materials (BM); porous alumina (alternative BM) and silica sand (conventional BM)

Suppression of both CO emission and NOx emission was achieved by the present porous alumina.

Clinker trouble occurred in case of the sand bed whereas it did not occur in case of the porous alumina bed.



Background

Rice husk:

CO_2 neutral

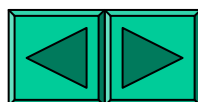
Easy to collect (less logistic problem)

Possible to use fly ash as silica source

<u>Clean and efficient use is required.</u>

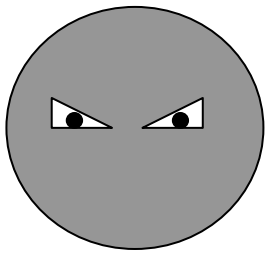
Emission of unburned fraction (source of dioxins)

NOx from fuel-N

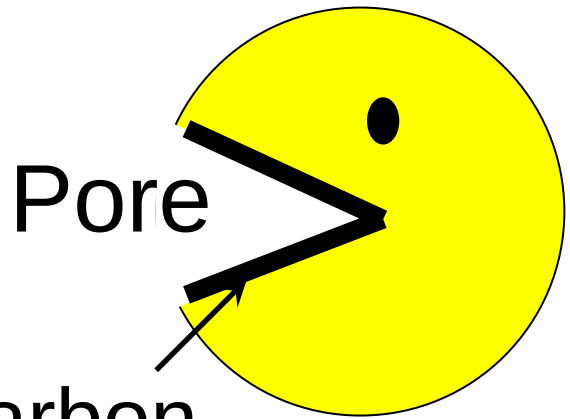


An approach to improve V.M. conversion: capacitance effect

V.M., tar



Porous solids

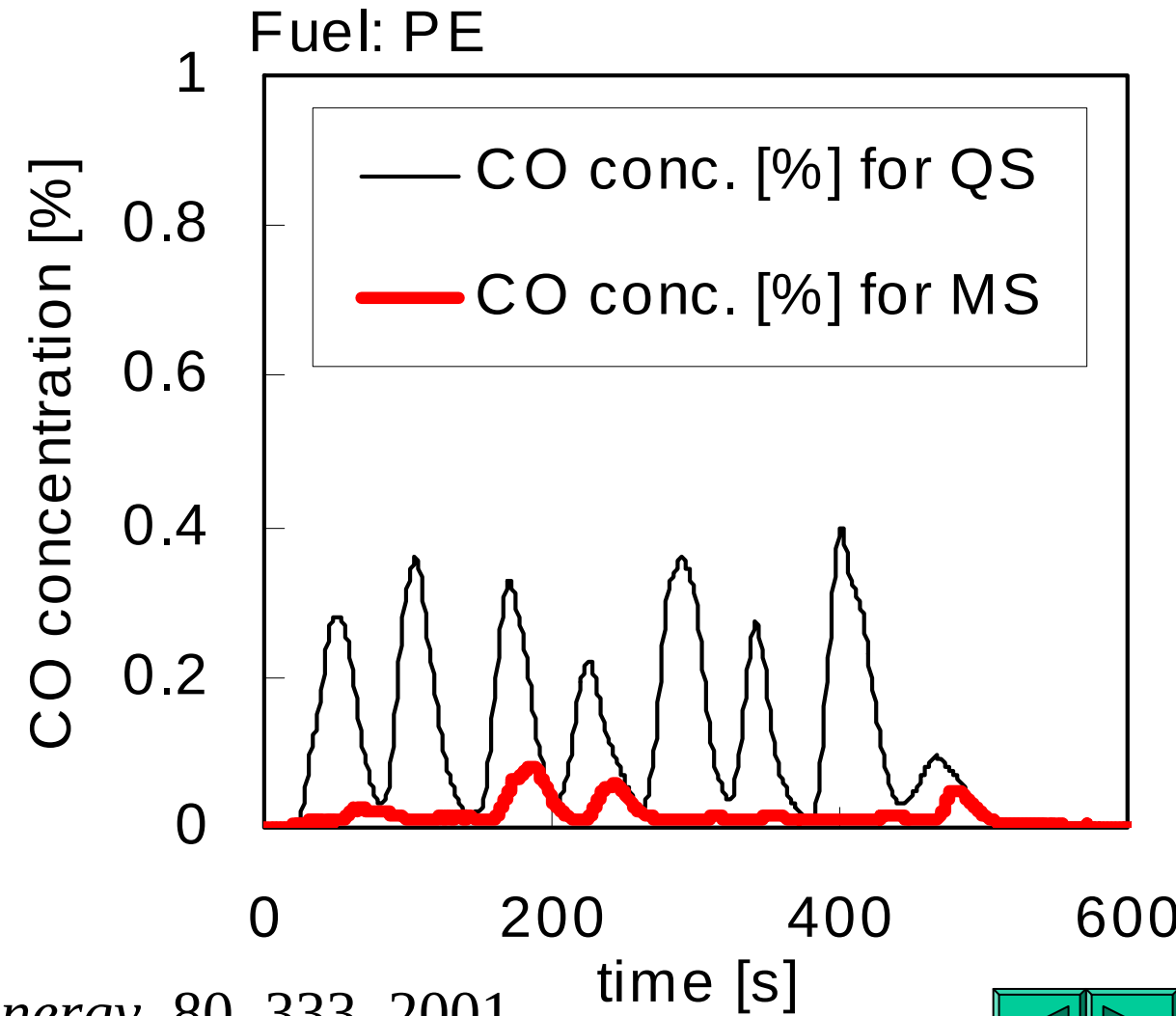


Porous particles capture V.M. at high temperatures; carbon deposit is formed within pores.

→ Increased residence time of V.M.

Improvement of combustion by porous bed material during plastic combustion

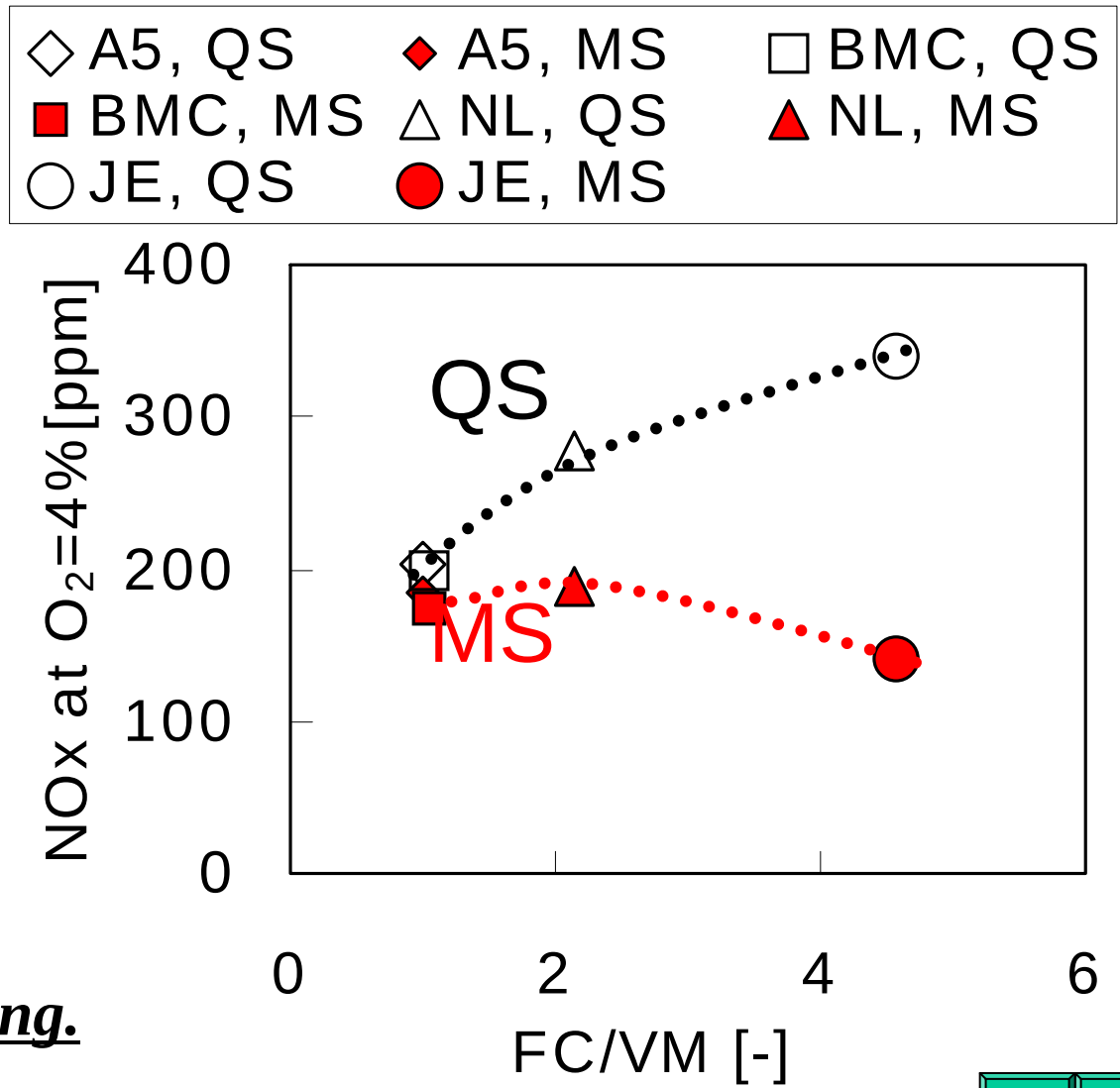
Volatile matter capture by MS (porous MB) reduced emissions of unburned gas / tar / soot in comparison to sand bed.



Shimizu, *J. Jpn. Inst. Energy*, 80, 333, 2001

Suppression of NOx emission by porous alumina bed material

A kind of porous alumina reduced NOx emission during BFBC of coal in comparison to sand bed. It was more effective for higher F.C. coal.



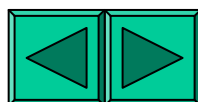
Shimizu et al., ***J. Chem. Eng. Japan***, 36, 782, 2003

This work

Can porous alumina suppress unburned gas emission during rice husk combustion?

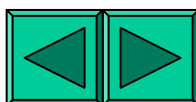
Is this bed material effective for NOx control for low fixed carbon fuel such as rice husk?

BFBC experiments were conducted.

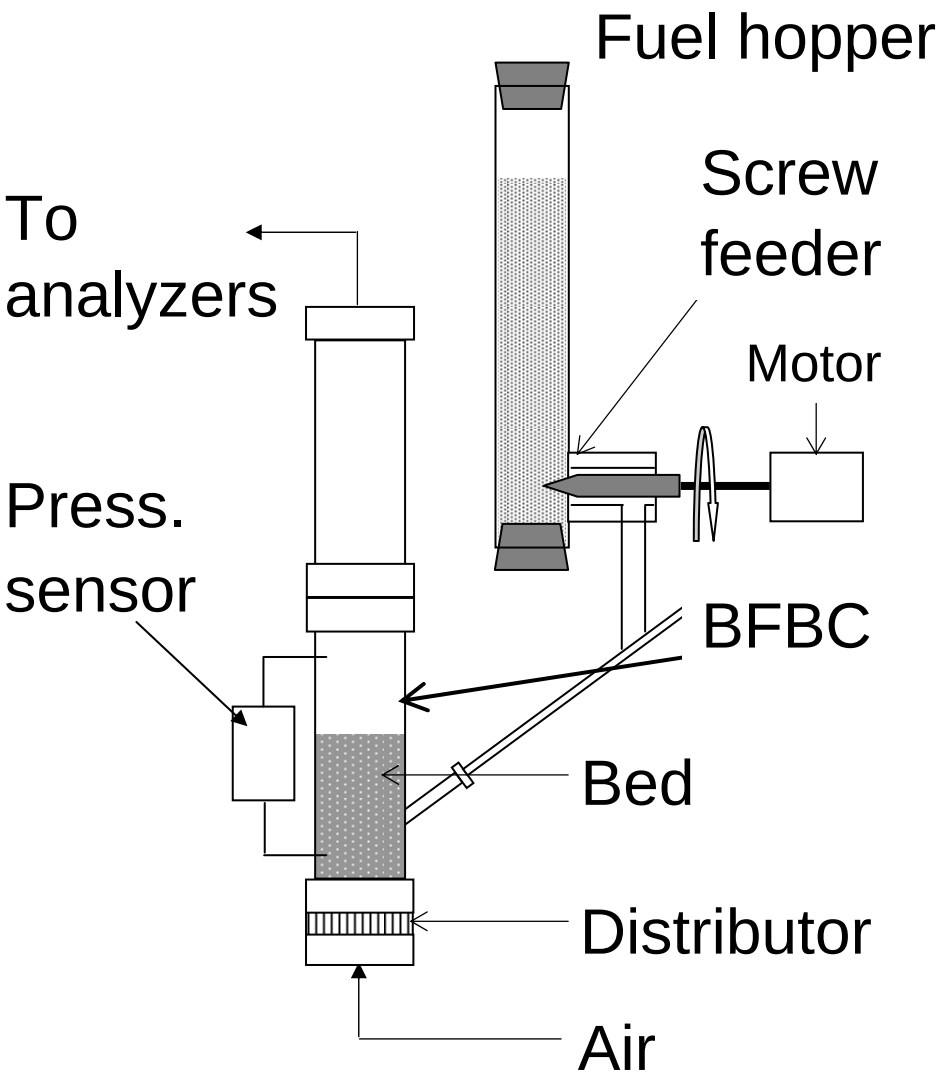


EXPERIMENTAL

Bench-scale BFBC experiments



BFBC experimental apparatus



Height 1.3m

I.D. 53mm

Fuel feed by a screw feeder and pneumatic conveying system into bottom of bed

<u>Conditions</u>

Temp. 1123±10K

Gas velocity 38.5cm/s

Single stage air feed

Composition [wt-%] of bed materials

	MS (Alumina)	Quartz sand(QS)
Size [µm]	690	273
Al_2O_3	91.32	-
SiO_2	-	100
Fe_2O_3	0.54	-
CaO	0.07	-
MgO	0.15	-
Na_2O	0.03	-
SO_3	2.10	-
Area [m^2/g]	187	Non-porous

Fuel properties

LHV [kcal/kg]		3160
Ultimate analysis [wt-%(dry)]	C	42.6
	H	5.54
	O	33.66
	N	**0.28**
	Cl	0.038
	K	0.28
	Total S	0.03
	S in ash	0.06
	SiO_2 in ash	96.82

RESULTS AND DISCUSSION

CO emission

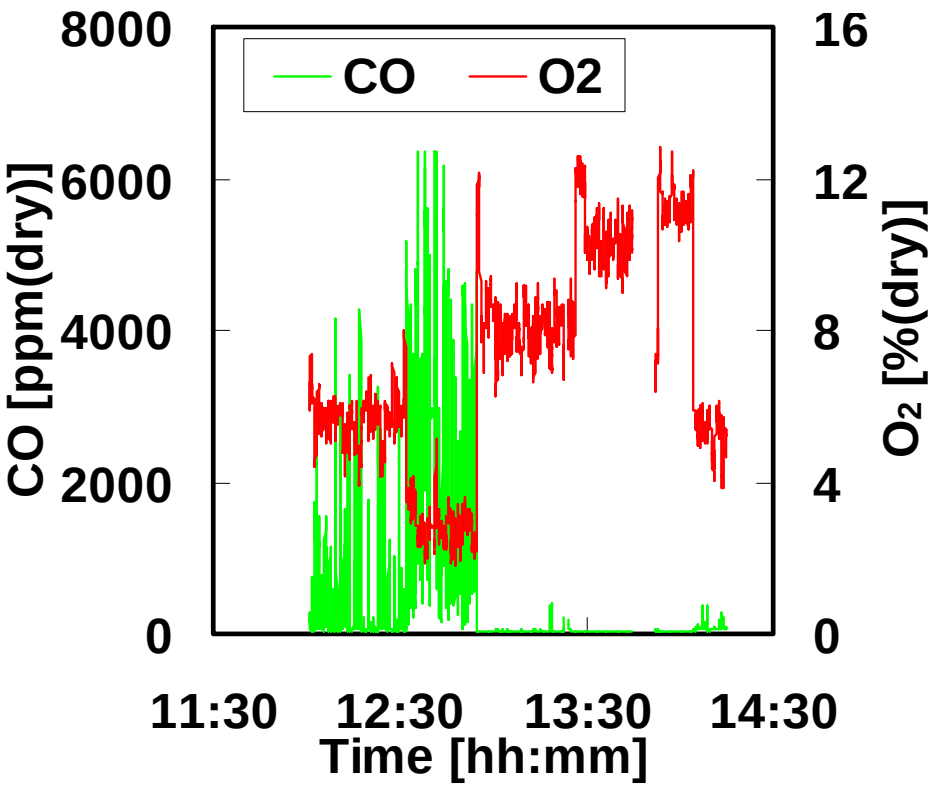
NOx emission

Clinker trouble

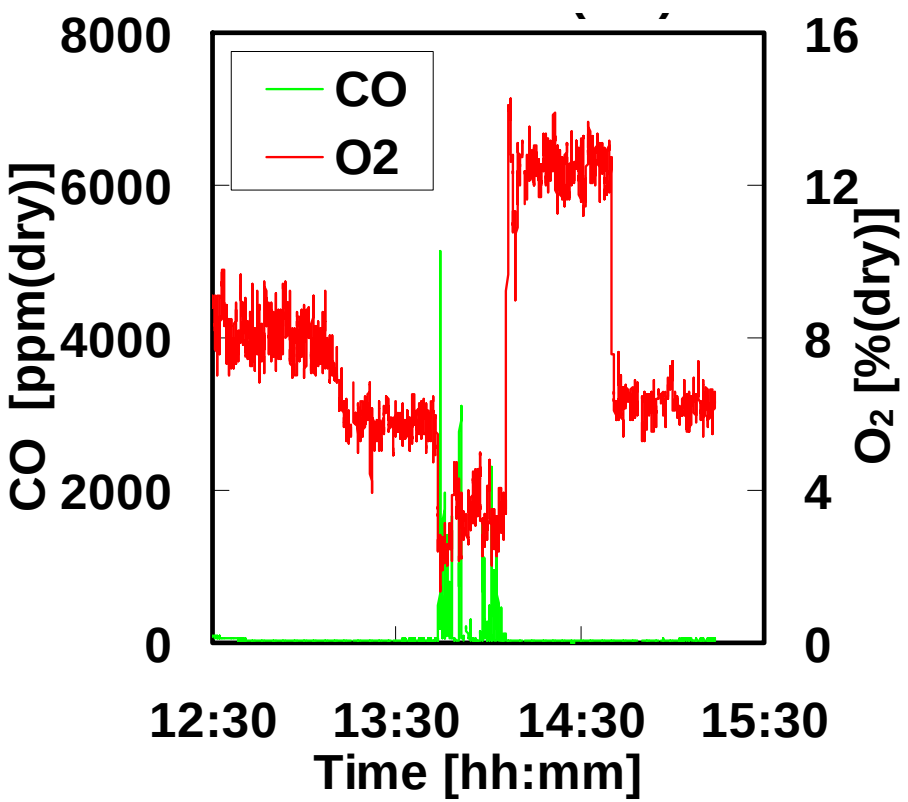
CO emission

Fuel feed rate was controlled to attain desired flue gas O_2 concentration. CO "spikes" appeared when flue gas O_2 concentration was low.

Sand bed

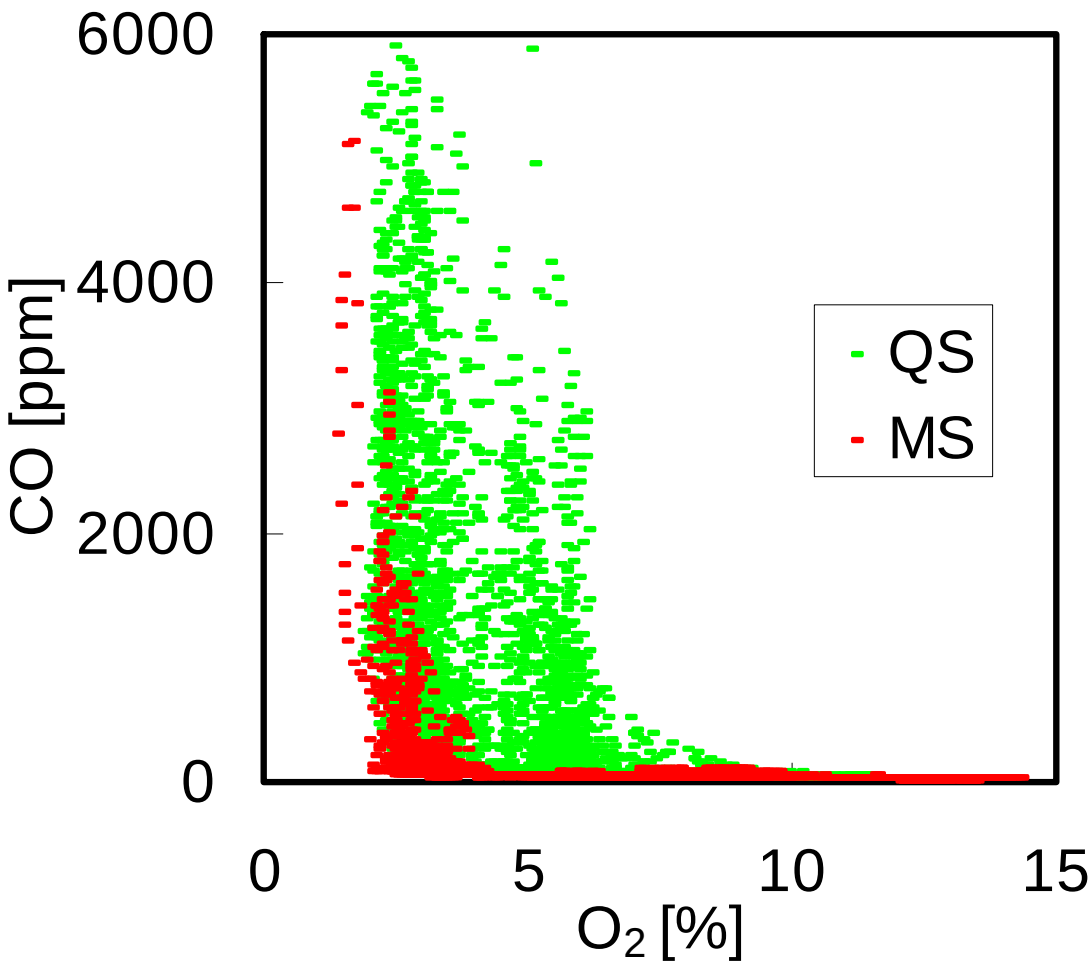


MS bed

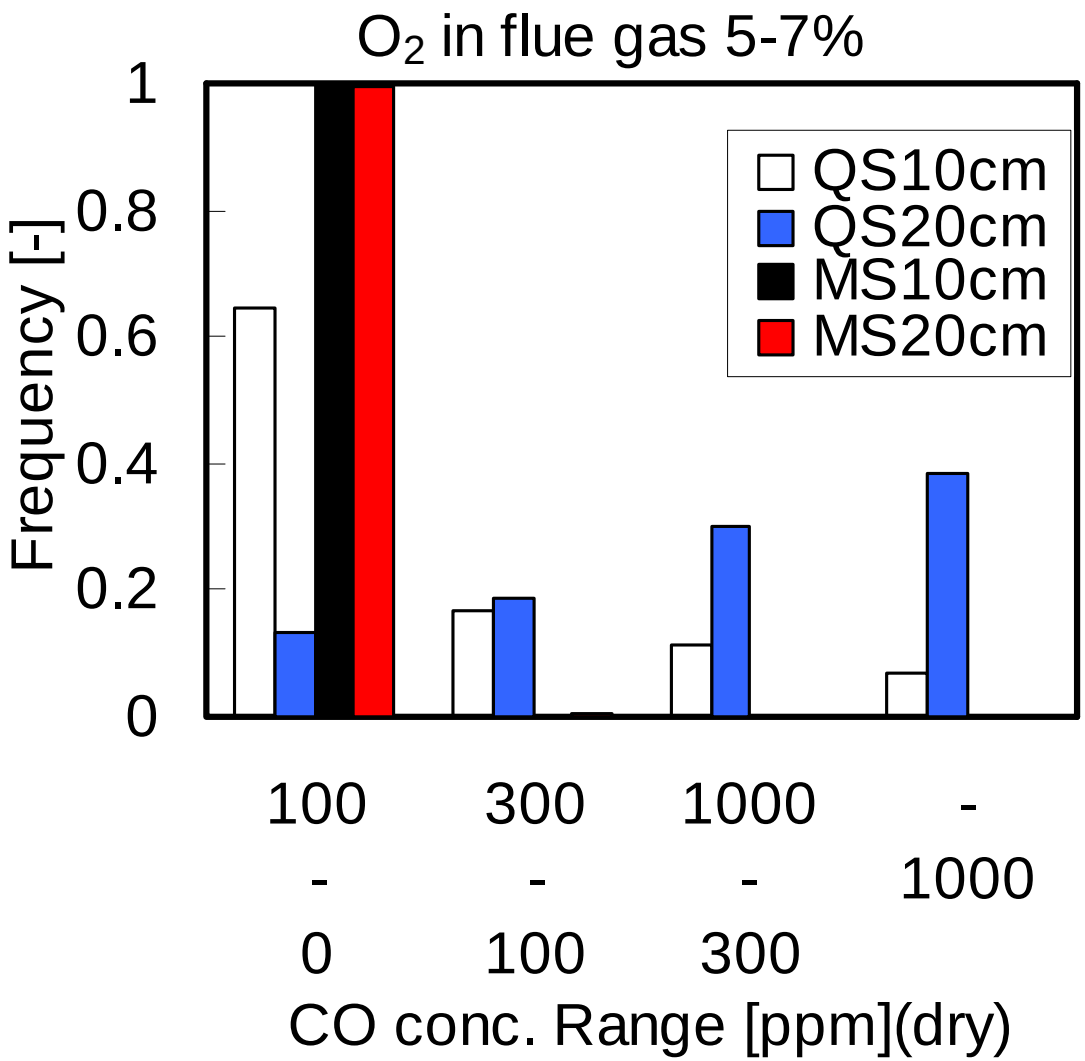


Effect of O_2 conc. on CO emission

With decreasing O_2, CO emission increased but the scattering was much.



Effect of bed material and bed height on CO emission

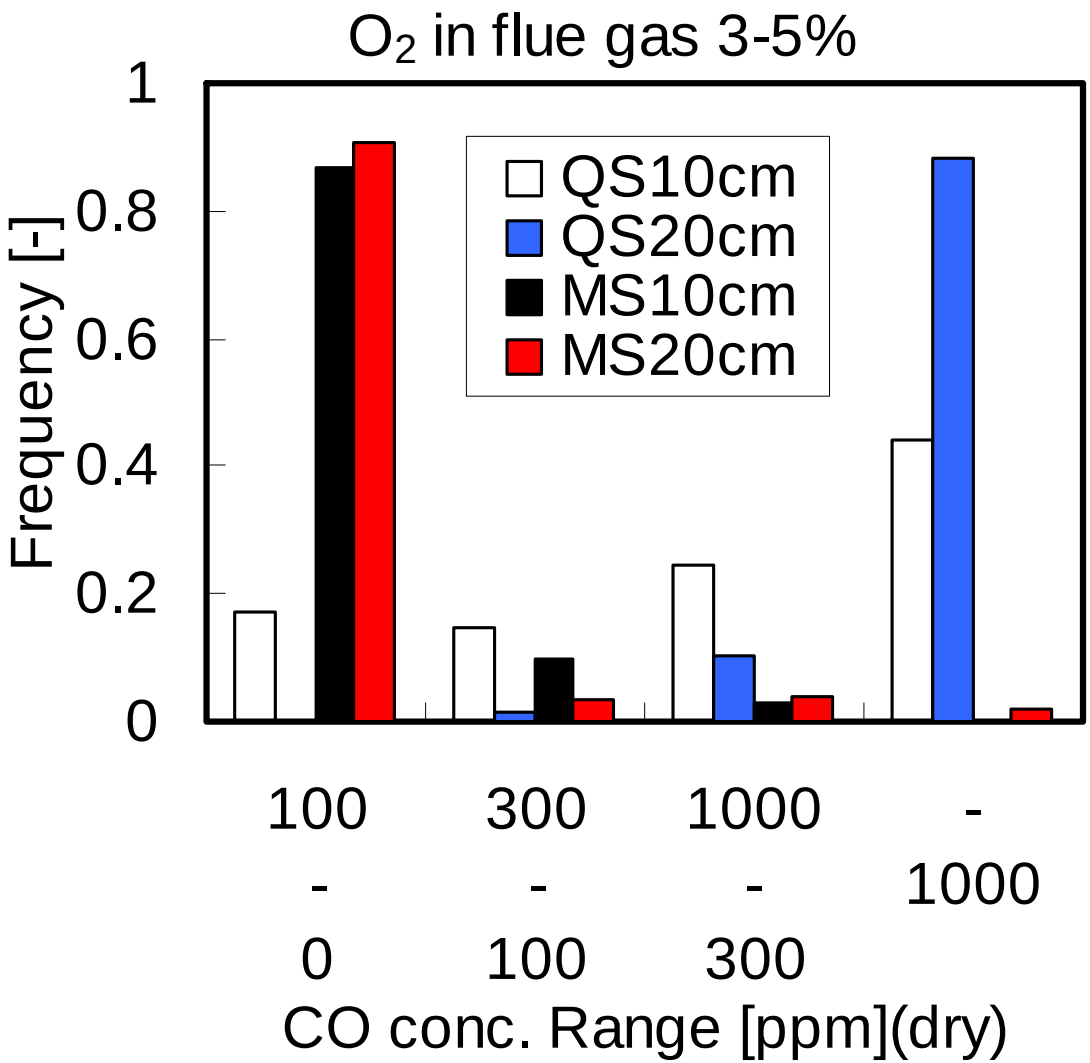


Frequency of CO spikes (>100ppm)

MS < QS

For QS, increase in bed height did not reduce CO emission.

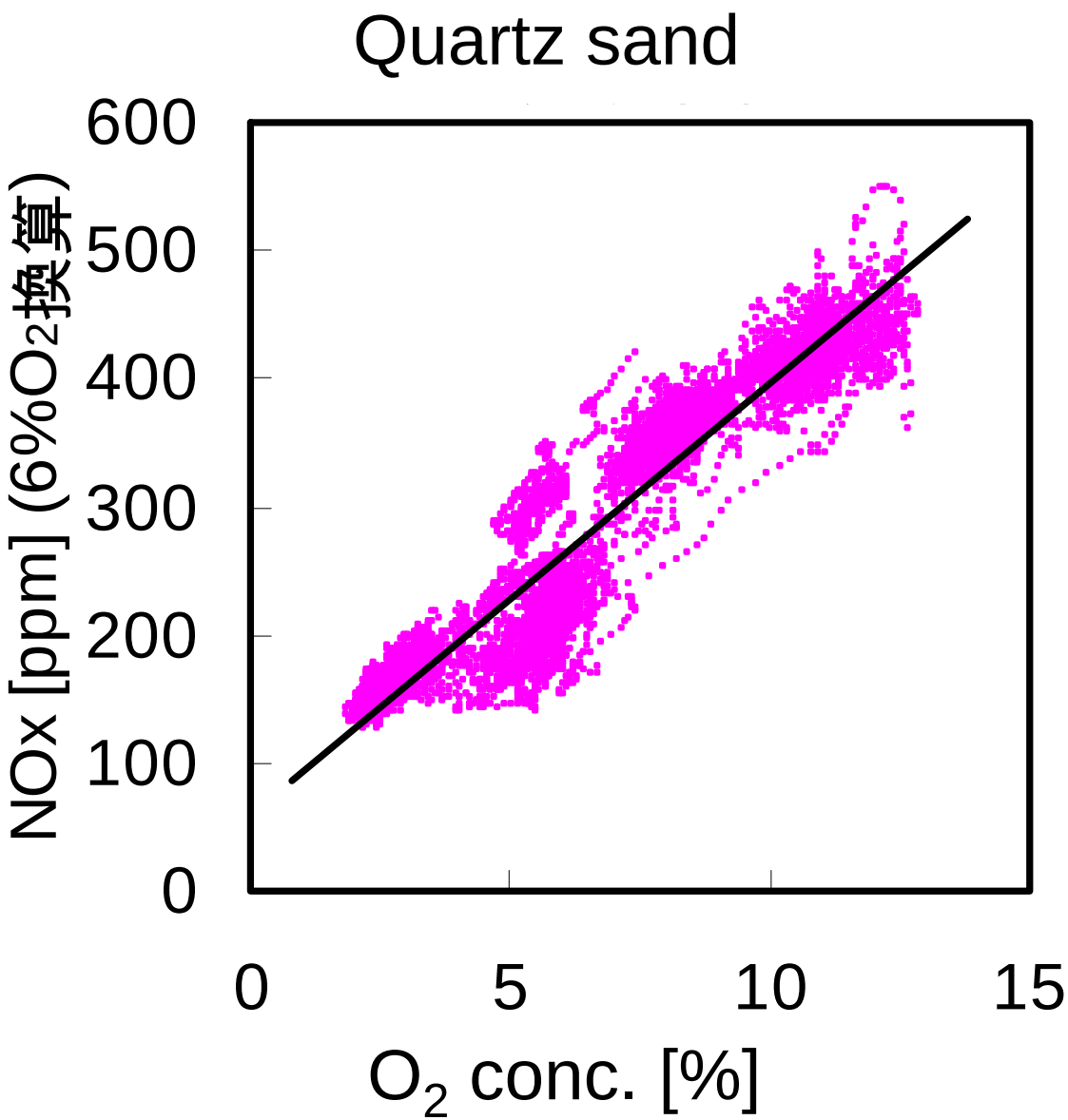
Effect of bed material and bed height on CO emission



Frequency of CO spikes (>100ppm)

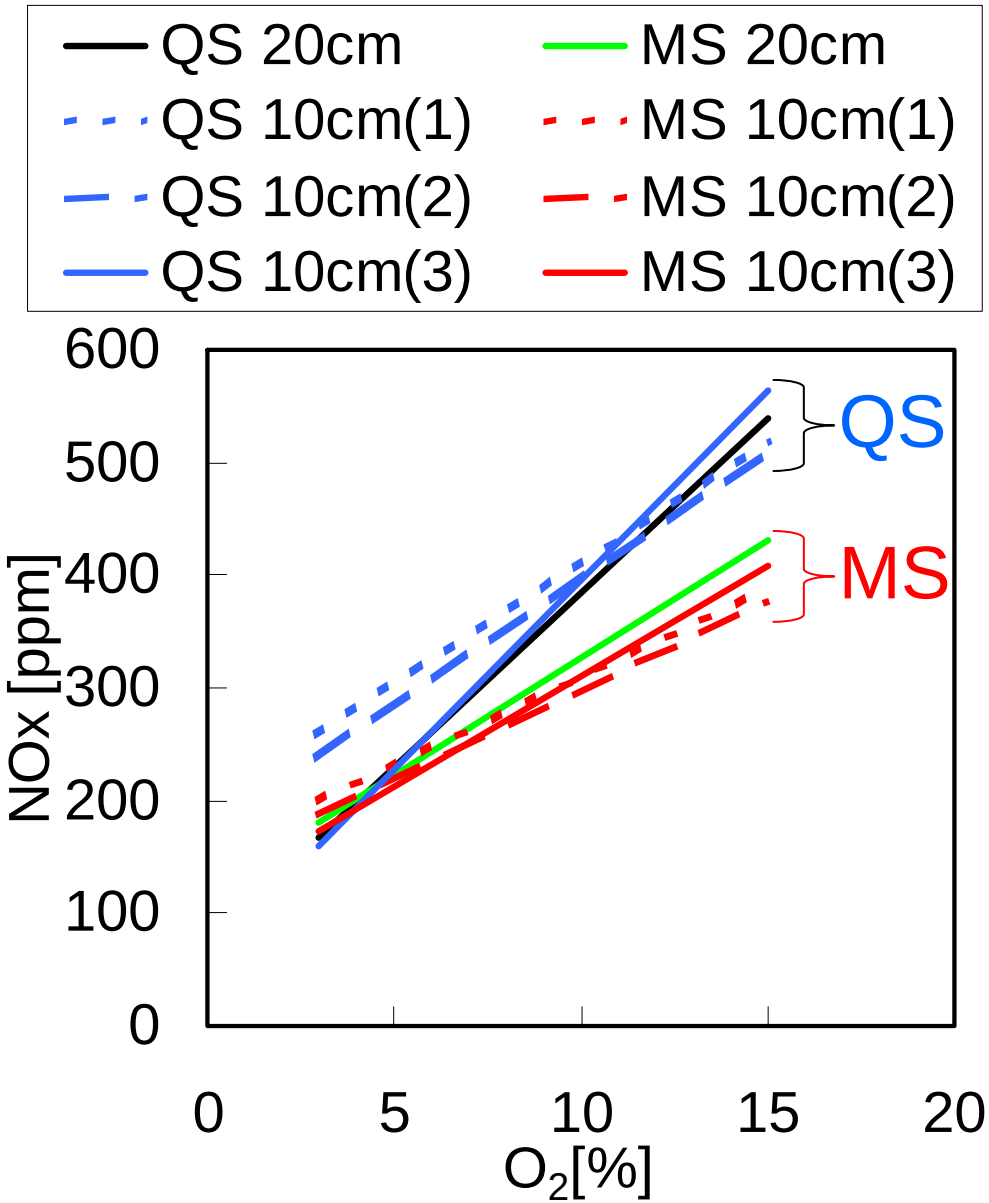
MS < QS

Effect of O_2 conc. in flue gas on NOx



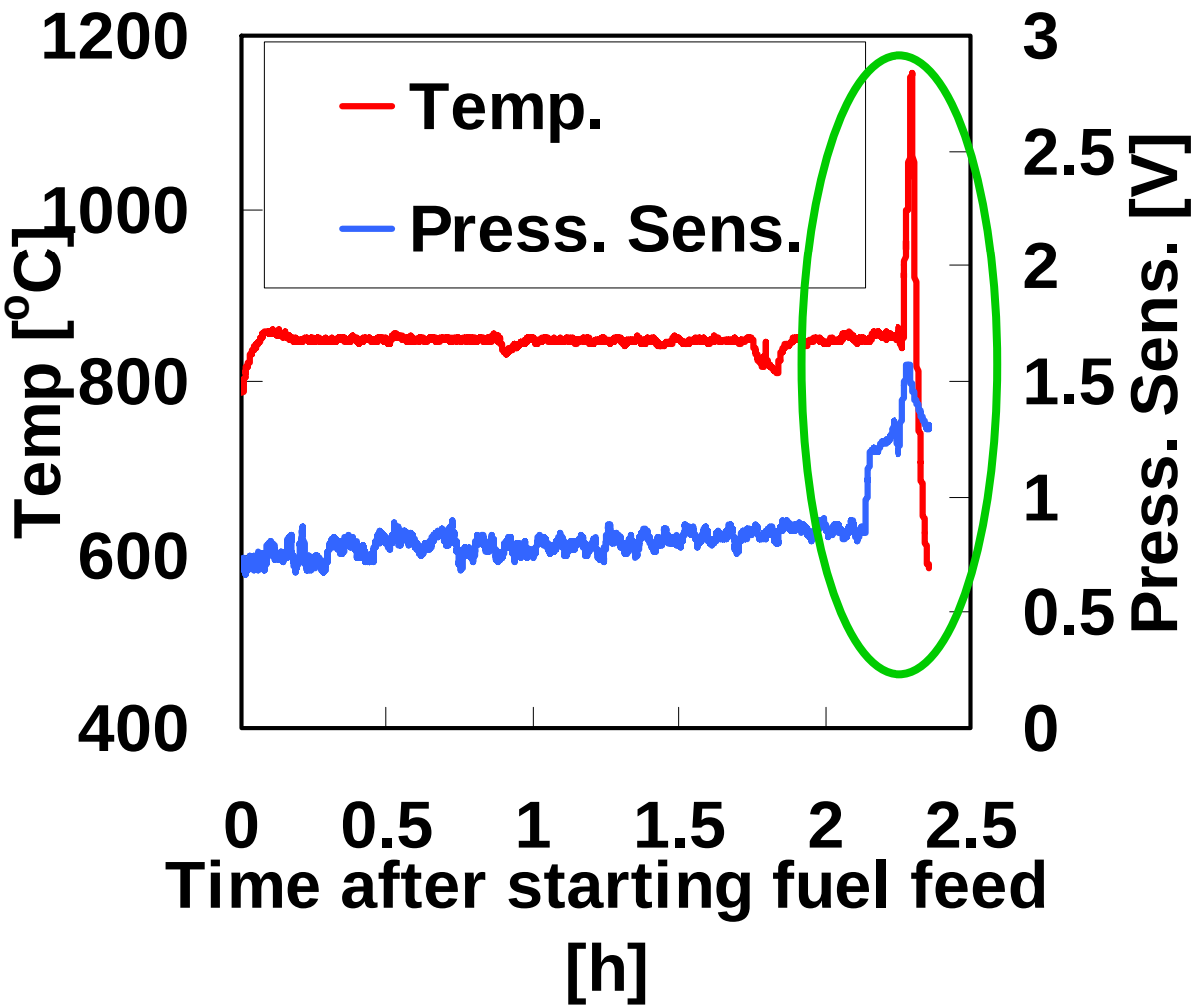
NOx emission (corrected to 6% O_2) increased with increasing air ratio (O_2 in flue gas). Straight line relationship was obtained between NOx and O_2.

Effect of bed material on NOx emission



The present porous alumina could reduce NOx emission a little.

Clinker trouble and temperature rise for QS bed material



BM height 10cm

Temperature rise to 1200°C was observed after increase in pressure drop.

Condition of temperature rise

BM	Bed h.	Fuel amount [g]	
QS	10cm	337	Temp rise
		317	
		318	
	20cm	321	
MS	10cm	388	No temp rise
		398	
		392	
	20cm	374	

For QS at bed height of 10cm, temperature rise occurred when total amount of fed rice husk reached 320g.

Reproducibility of trouble was good.

Conclusion

By employing porous alumina as bed material, stable combustion with less emissions of NOx and CO was achieved in comparison to conventional sand bed.