The Emission characteristics of PFBC with Flue Gas Recirculation System

42nd IEA-FBC Meeting

May 10-11, Sydney, 2001

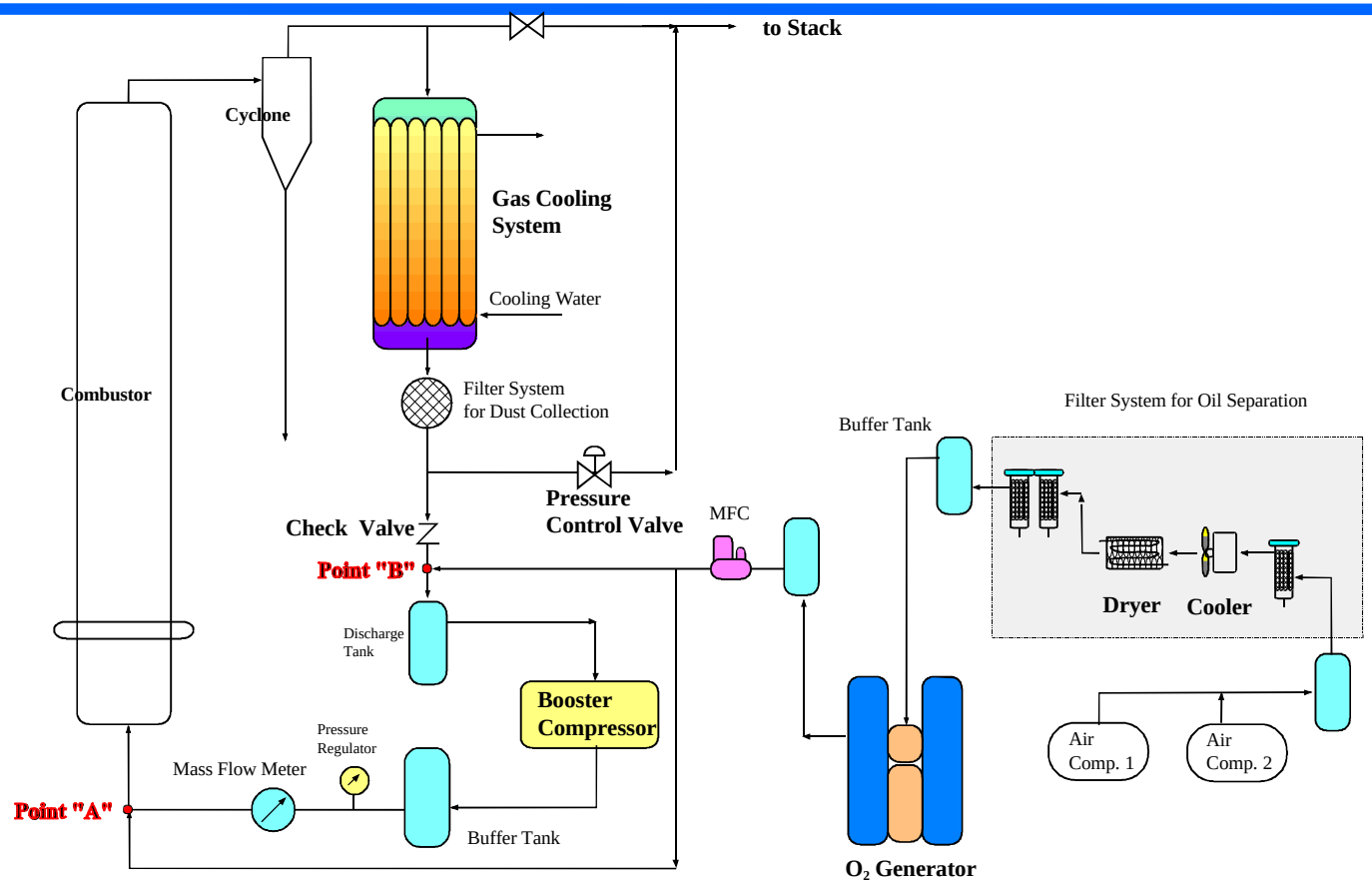
Gyoung Tae Jin, KuenHee Han and Chang-Keun Yi

Korea Institute of Energy Research

PFBC Facility

- Specification
  - Lower Section 0.17m I.D. X 2 m
  - Upper Section 0.25 m I.D. X 3 m
  - Design Coal : Bituminous Coal with HHV of 6,000 Kcal/Kg
  - Maximum Thermal Input ; 0.14 MWt
  - Design Pressure ; 6 atm
  - Design Temperature 850 - 950 ^{o}C

PFBC with Flue Gas Recirculation System



Experiments

- Coal(Datong, China)
- Proximate Analysis
  - Moisture 12.05%
  - VM 29.63%
  - FC 53.10%
  - Ash 5.22%
- Elemental Analysis
  - C 71.20%
  - H 5.30%
  - N 0.74%
  - S 0.28%
  - O 5.21%
- Heating Value 6,090 Kcal/Kg
- Mean Particle Size 0.3 mm

Ash Properties

- Ash 5.22%

SiO_2	41.40%
Al_2O_3	17.79%
Fe_2O_3	28.21%
CaO	6.36%
MgO	2.90%
Na_2O	0.24%
K_2O	2.50%

- Ca/S molar ratio = 0.86

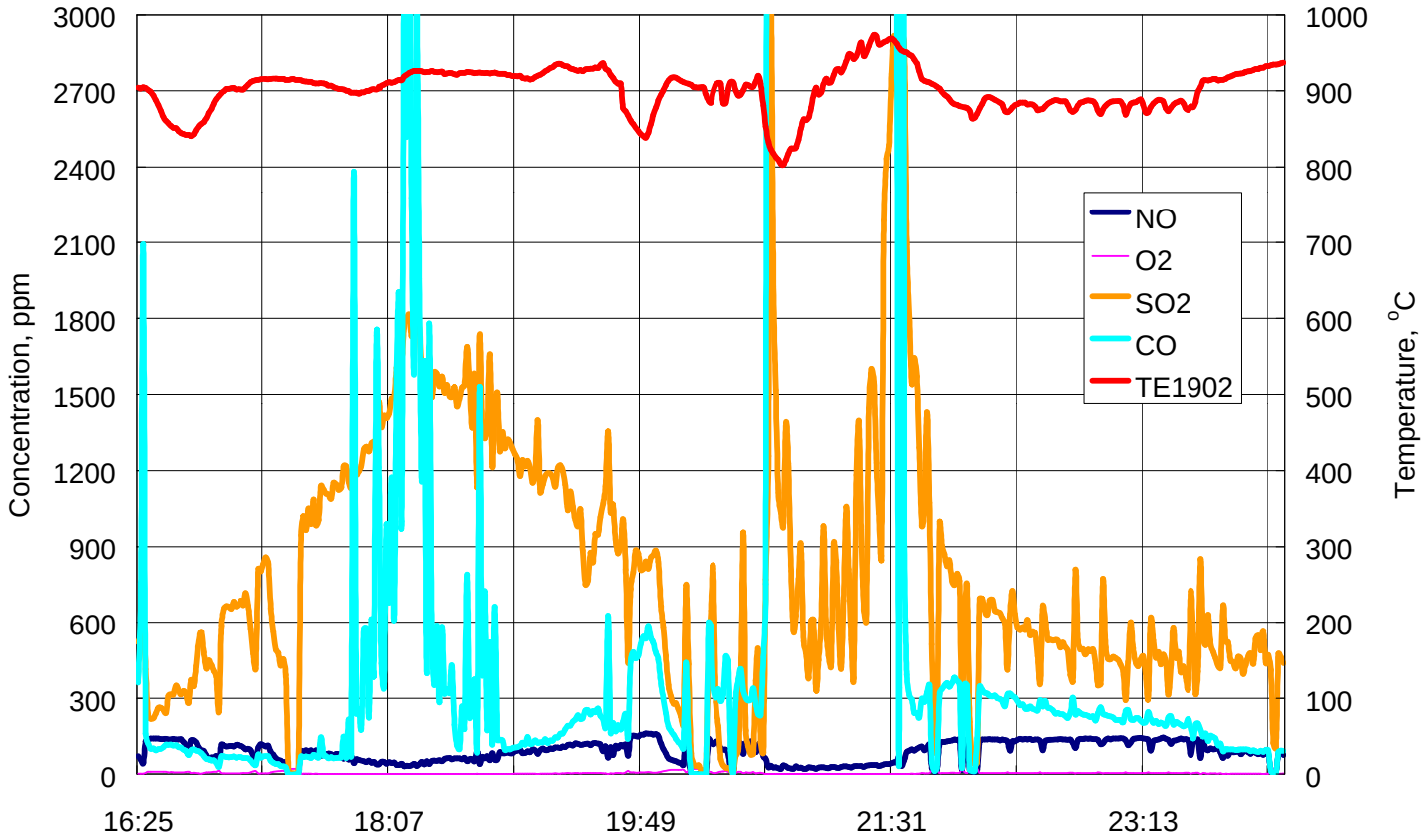
Operating Conditions

- Superficial Gas Velocity(m/sec) = 1.1
- Recirculation Ratio = 0.78
- Pressure ; 4.7 atm
- Bed Temperature(^{o}C) = 900
- Ca/S ratio ; 0.86
- Bed Height : 1.0 m

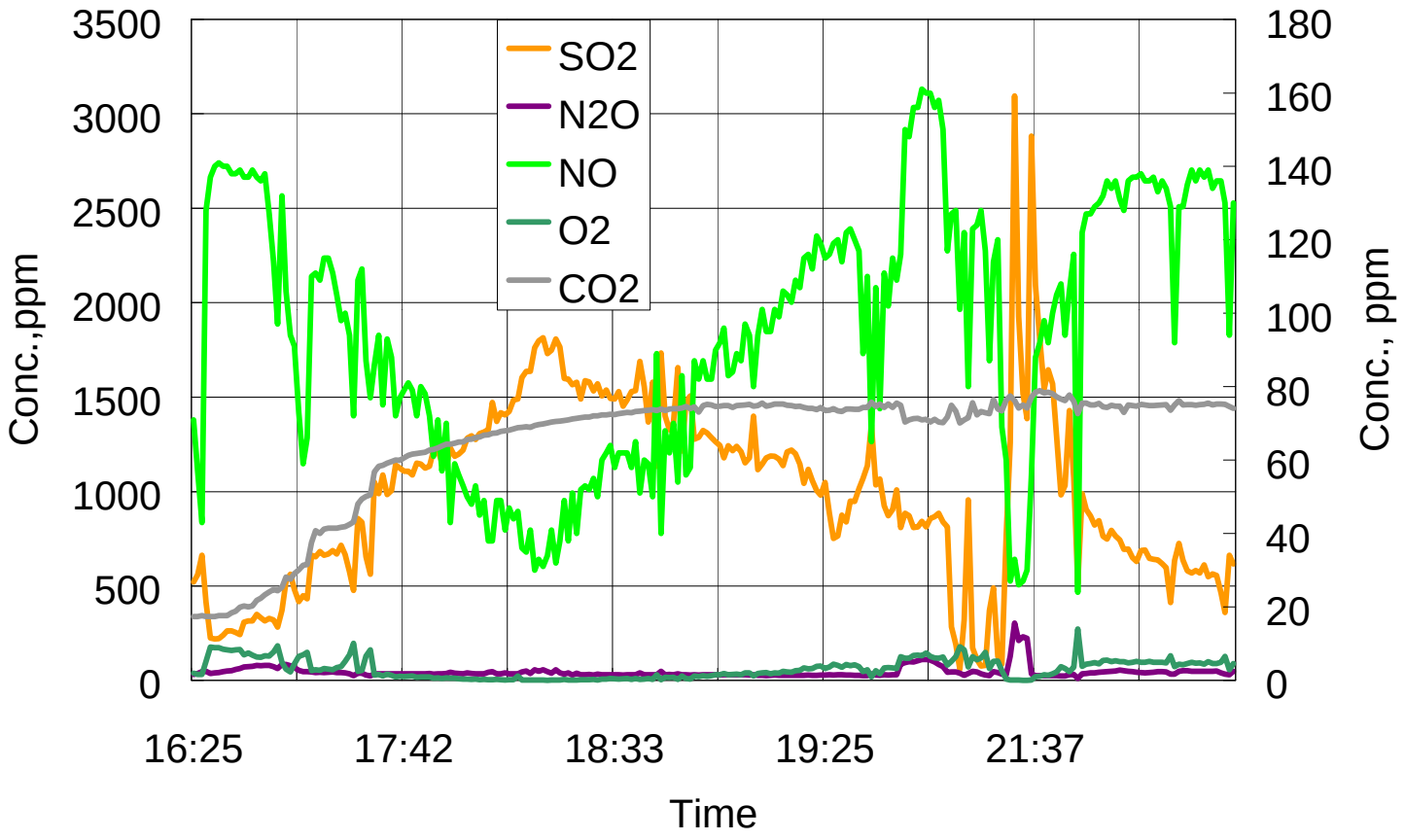
Objectives

- Prove the Concept of Flue Gas Recirc.
  - to decrease the air pollutants
  - to increase the thermal efficiency
  - to understand the emission characteristics
- Increase the Operation Flexibility
  - to control the oxygen concentration
  - to increase the gas velocity by increasing recirculation rate

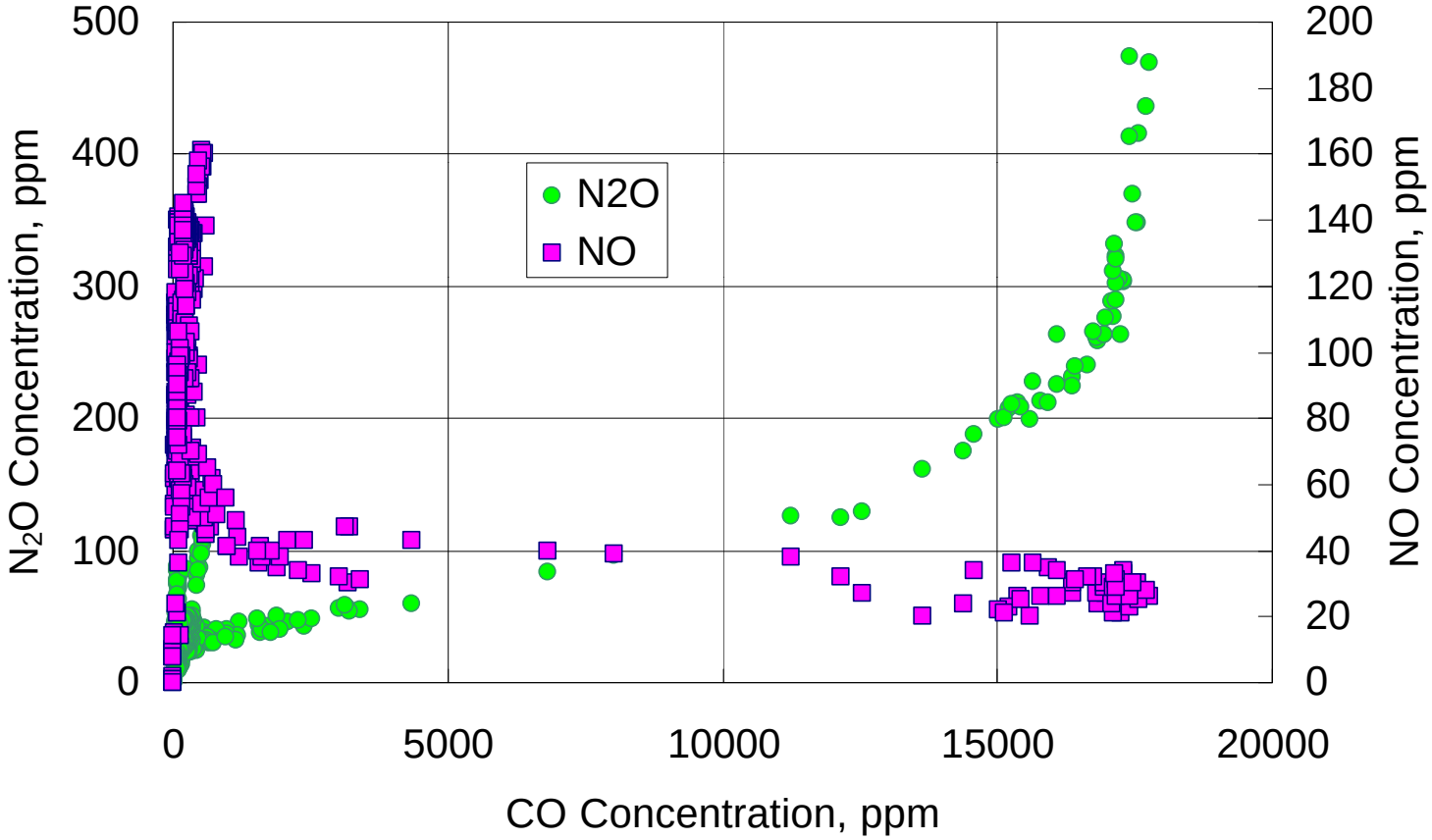
Temperature and Pollutant Gas Profile



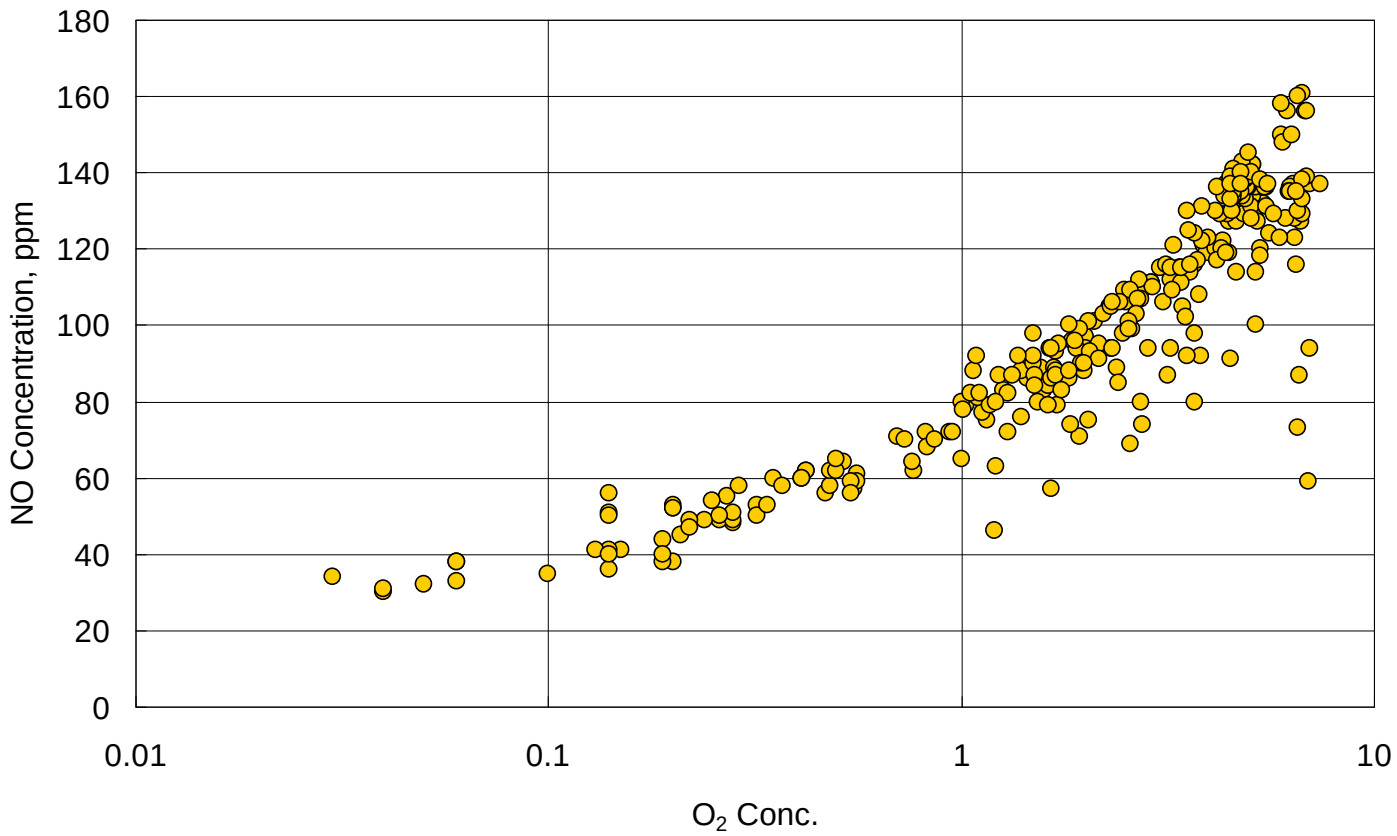
CO_2 Gas Concentration



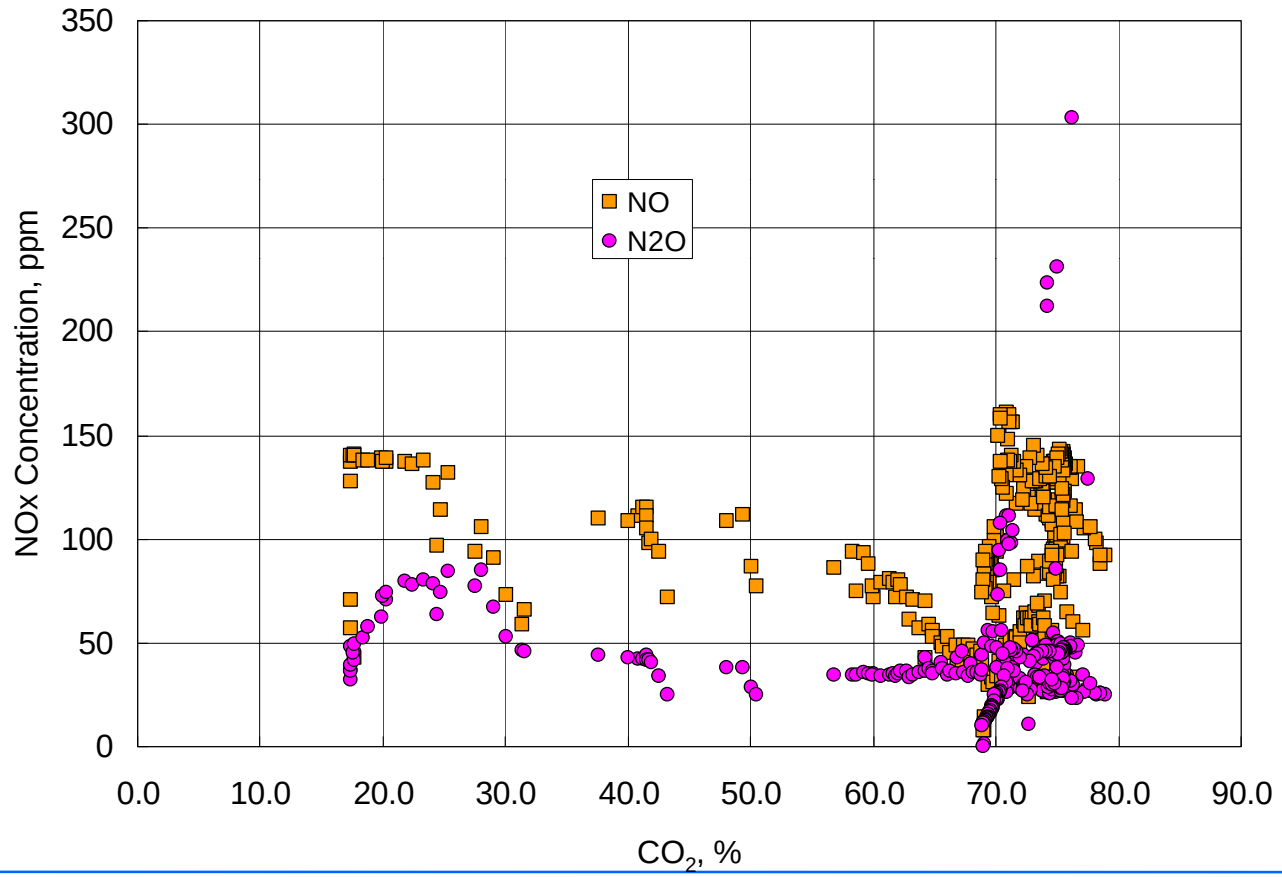
NOx with CO Concentration



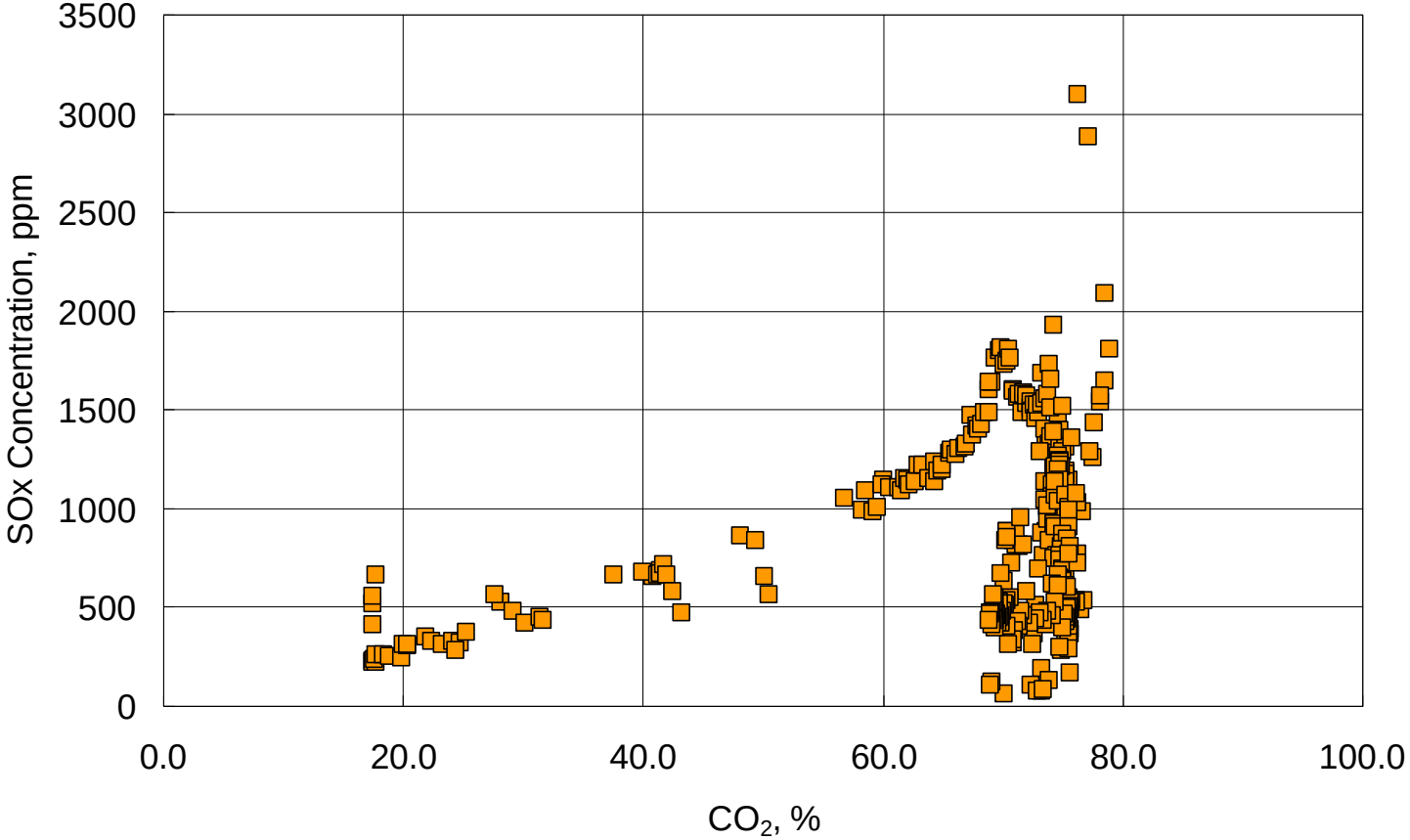
NOx with O_2 Conc.



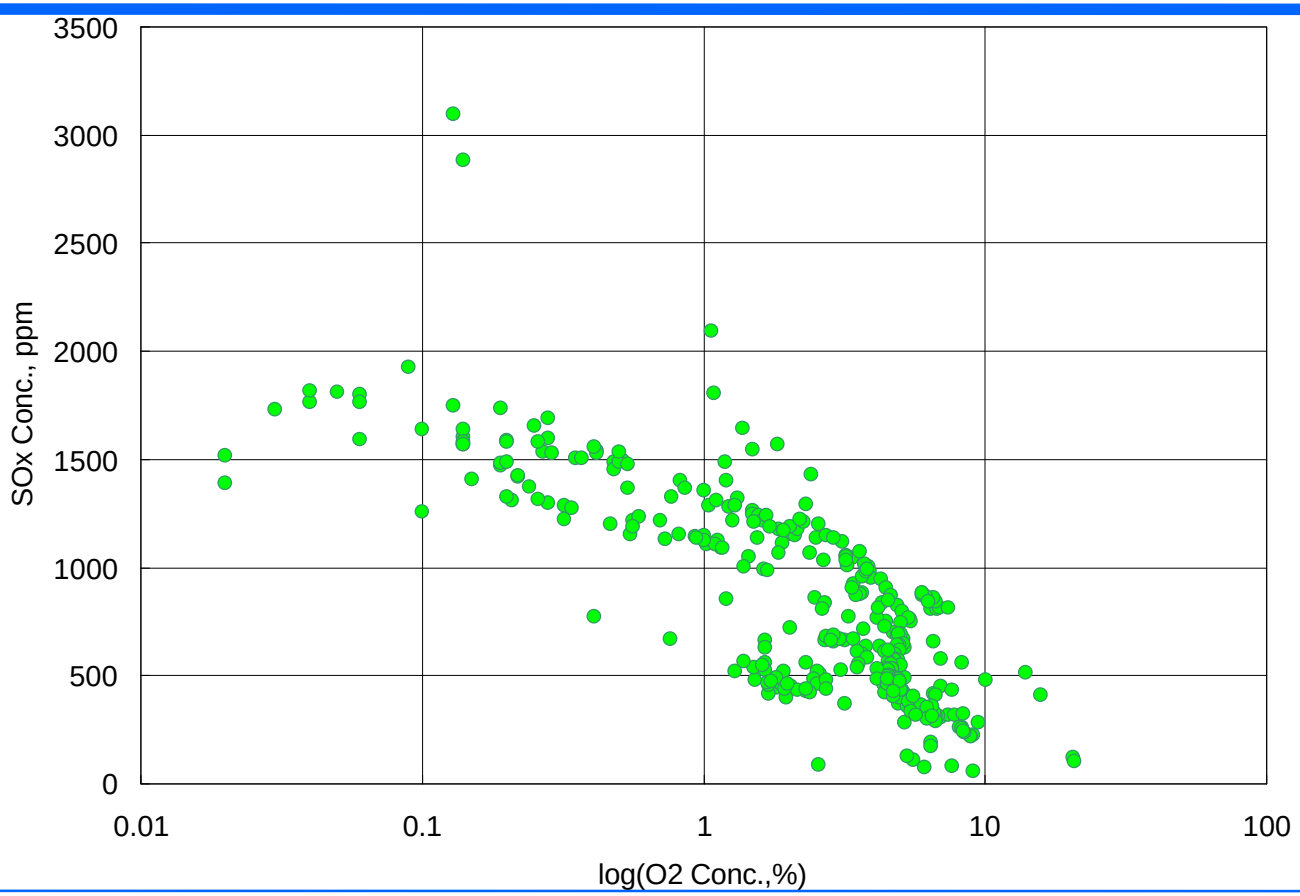
NOx vs. CO_2


350
300
250
200
150
100
50
0
NOx Concentration, ppm
NO
N2O
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
CO2, %

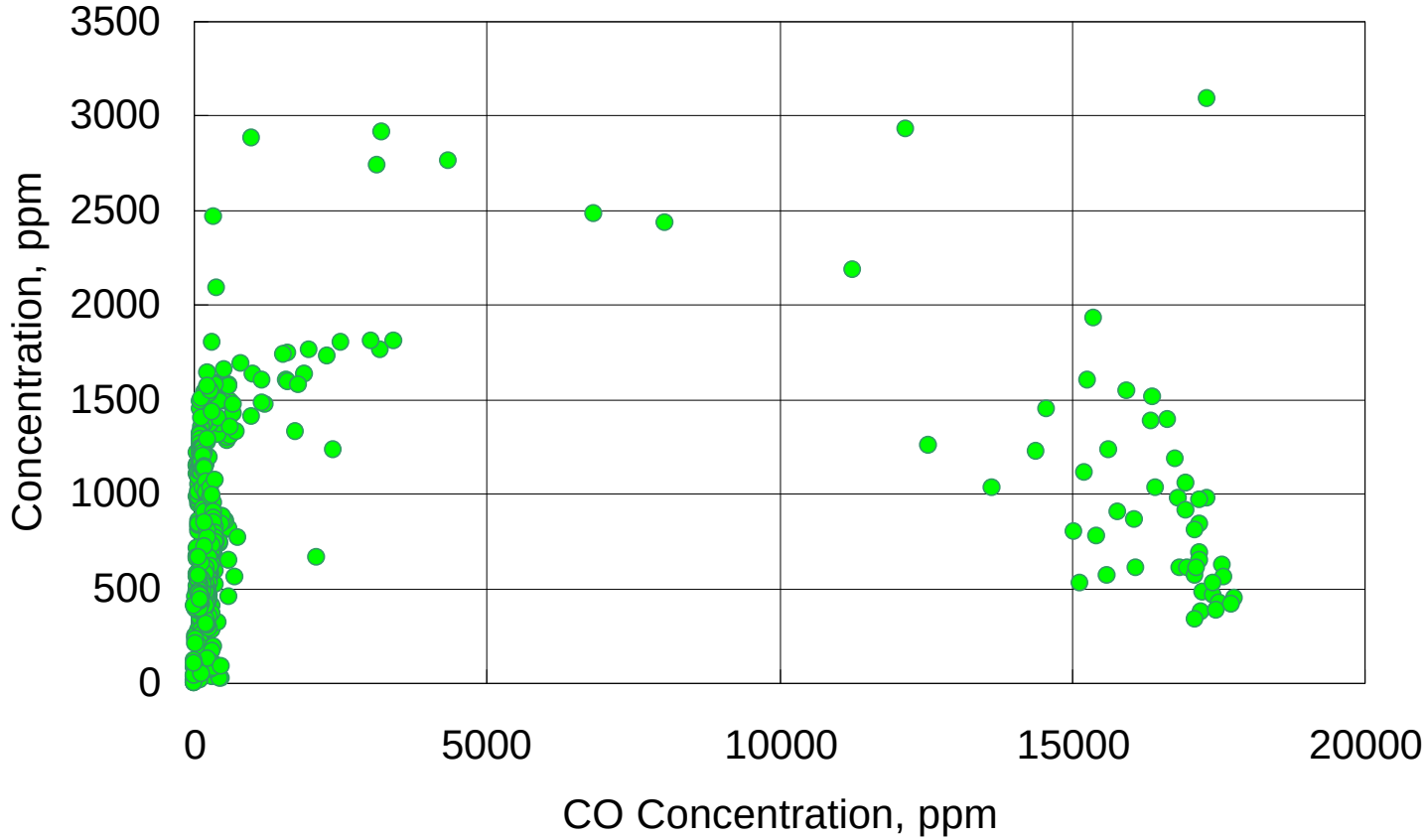
SO_2 vs. CO_2


3500
3000
2500
2000
1500
1000
500
0
SOx Concentration, ppm
0.0
20.0
40.0
60.0
80.0
100.0
CO2, %

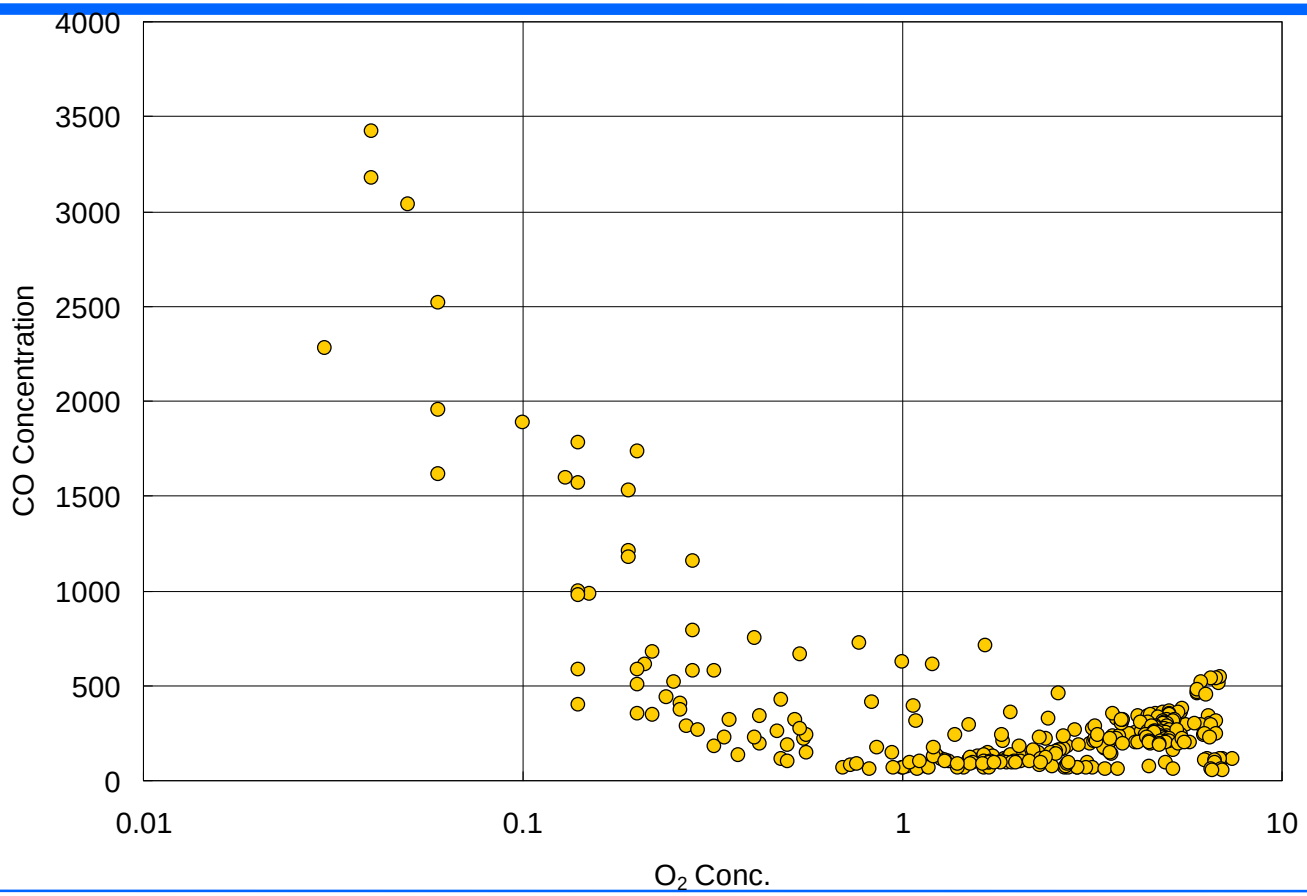
SO_2 vs. O_2 Concentration



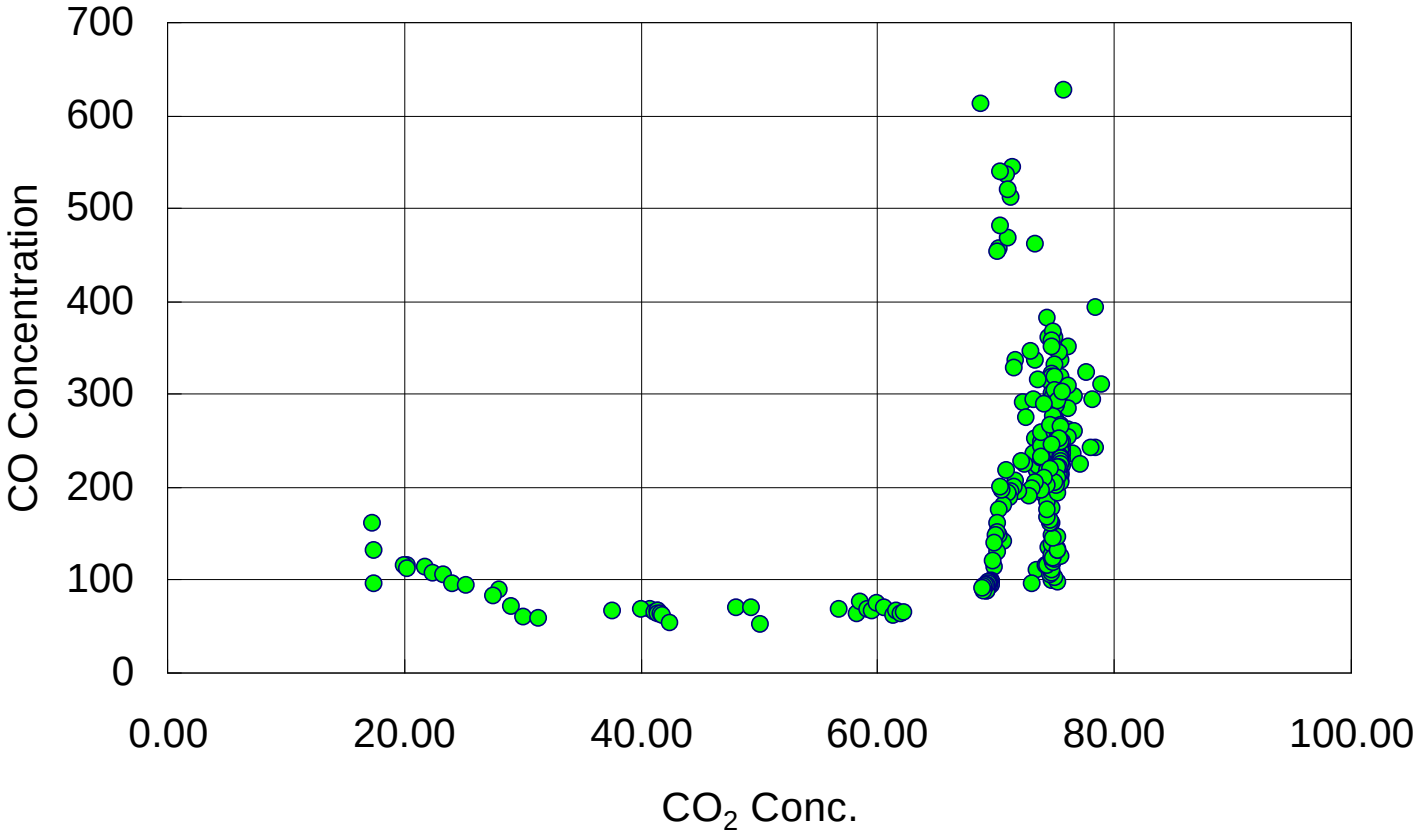
SO_2 vs. CO


3500
3000
2500
2000
1500
1000
500
0
Concentration, ppm
0
5000
10000
15000
20000
CO Concentration, ppm

CO vs. O_2 Concentration



CO vs. CO_2


700
600
500
400
300
200
100
0
CO Concentration
0.00
20.00
40.00
60.00
80.00
100.00
CO2 Conc.

Conclusion(I)

- Oxygen of 83% mixed with Flue Gas and supplied to PFBC for oxidant, the concentration of CO_2 in flue gas is about to 78%
- NO is decreased from 160 to 30 ppm and N_2O is increased from 30 to 400 ppm with increase of the CO concentration
- NO is increased up to 160 ppm with the increase of the oxygen concentration in flue gas
- N_2O is little affected with oxygen concentration
- NOx(NO & N_2O) is no related with CO_2 concentration.

Conclusion(II)

- SO_2 concentration is increased with the increase of the CO_2 concentration
- For sulfur retention, minimum oxygen concentration in flue gas is required
- In flue gas recirculation condition, CO concentration is higher than that of no flue gas recirculation condition
- It seems to be a relation between [CO] and [CO_2], further investigation is need to figure out these relationship

Further Works

- Change the O_2 Concentration
- Effect of the Recirculation Rate
- Compare the before Experiments
  - Bed Height 2.0 m,
  - Pressure 6.0 atm
  - Sorbent Effect
- Various Operating Conditions