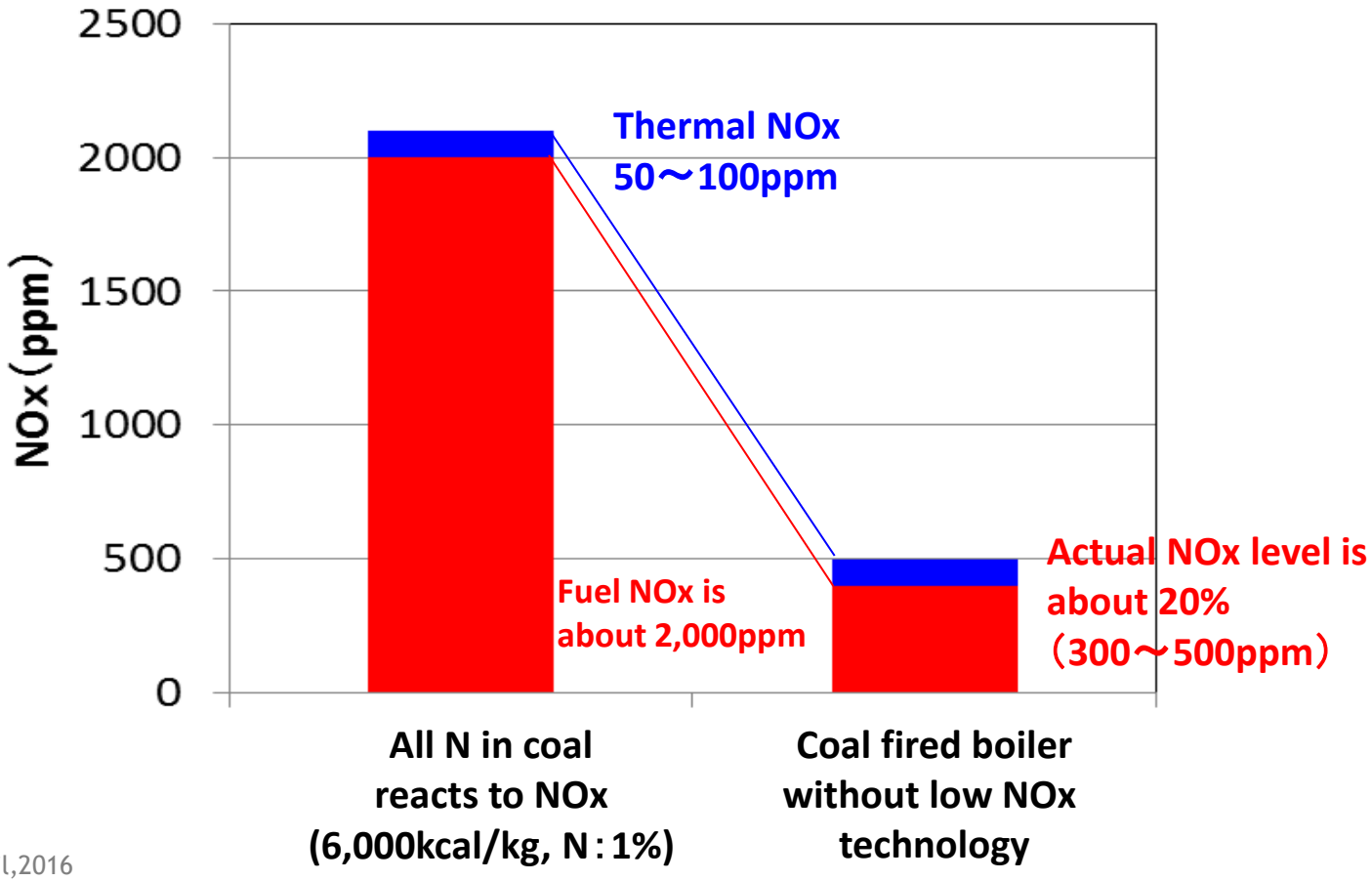
MECHANISM OF NOx CONTROL

MECHANISM OF NOx CONTROL

◎ NOx generation in the coal fired boiler？

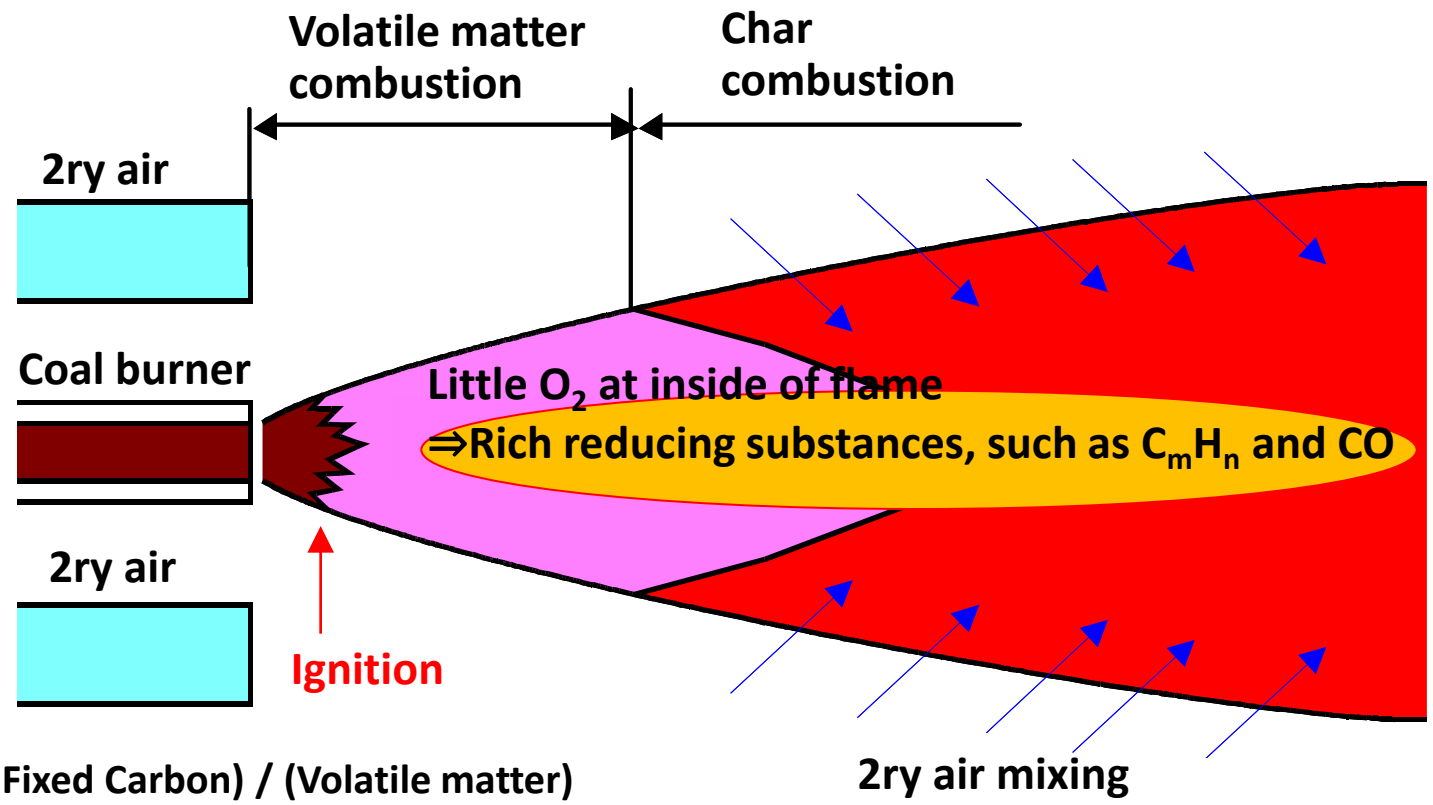
Thermal NOx and Fuel NOx are the main factors of NOx generation...



MECHANISM OF NOx CONTROL

NOx Generation Mechanism on Coal Combustion

⇒ rich reducing substances exist at inside of flame.



Fuel Ratio = (Fixed Carbon) / (Volatile matter)

MECHANISM OF NOx CONTROL

NOx reduction mechanism is based on

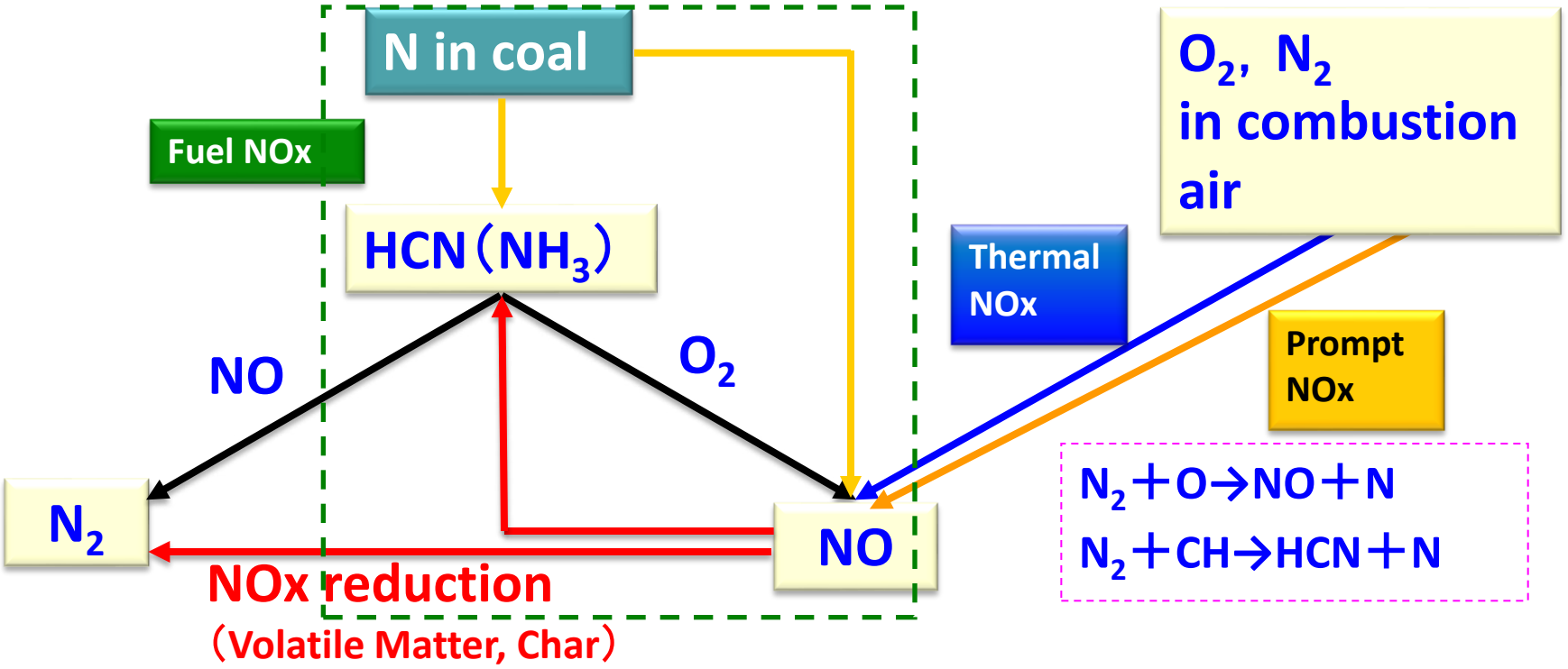
<1> How to reduce NOx formation in the early stage of combustion

<2> Promote reduction reaction from NOx to HCN / NH3 as intermediary compounds

<3> Decrease re-formation of NOx from HCN / NH3

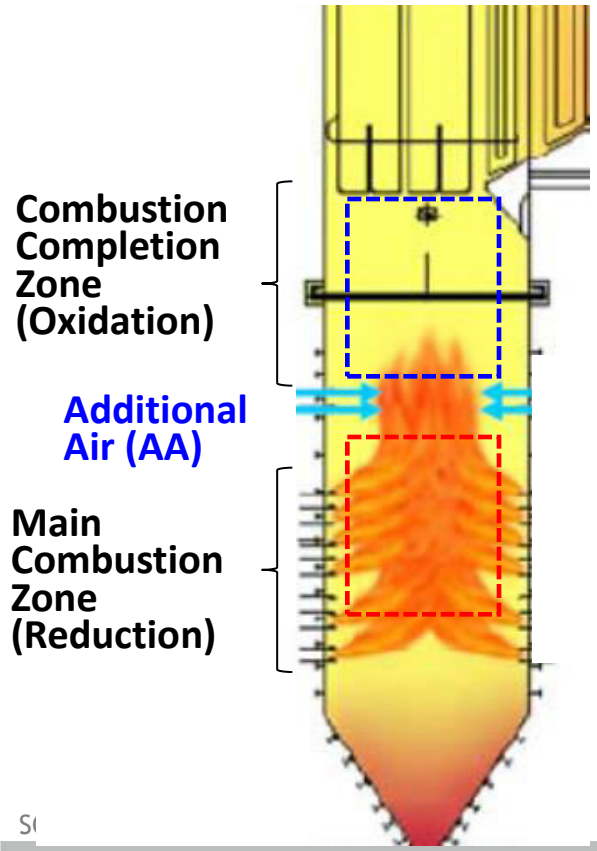
MECHANISM OF NOx CONTROL

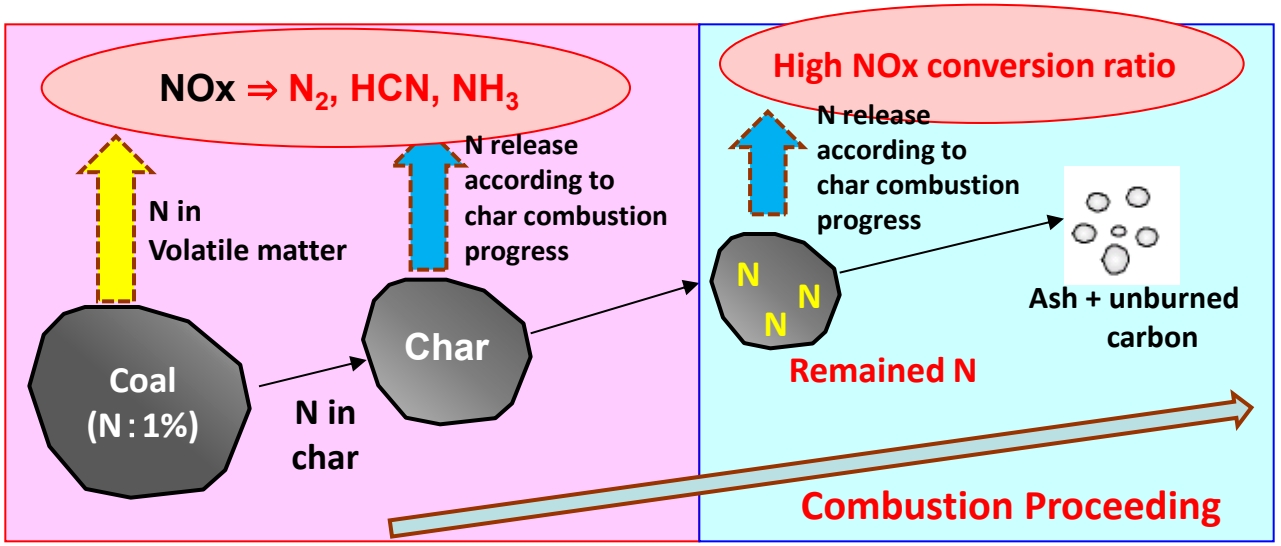
- NOx level is about 2,000 ppm in case all of N in coal reacts to NOx.
  ⇒ Fuel NOx governs NOx generation
- NOx level is about at most 500ppm without low NOx technology.
  ⇒ NOx reduction occurs with reducing substances released from coal.
  ⇒ The main point for low NOx combustion is how to reduce NOx efficiently.

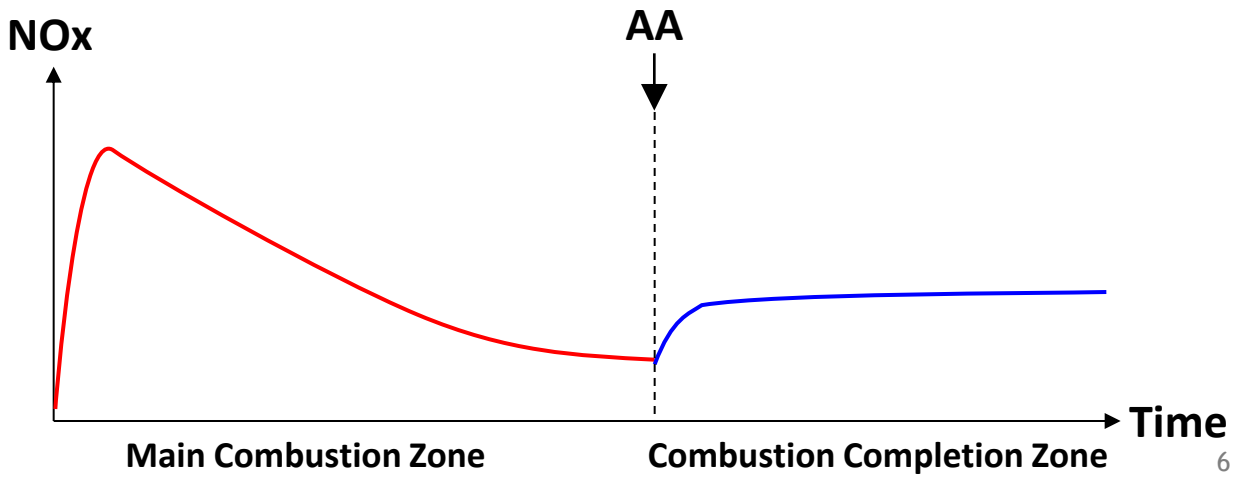


MECHANISM OF NOx CONTROL

- NOx profile :main combustion zone and combustion completion







MECHANISM OF NOx CONTROL

◎NOx reduction basic concept（MACT）

- It is important to keep reduction condition on main combustion zone by additional air (AA).
- Theoretically, NOx is reduced enough at burner zone air ratio under 1.0.
  1) Lower temperature is effective for decreasing NOx generation in oxidation condition.
  2) Higher temperature is effective for reducing NOx in reduction condition.

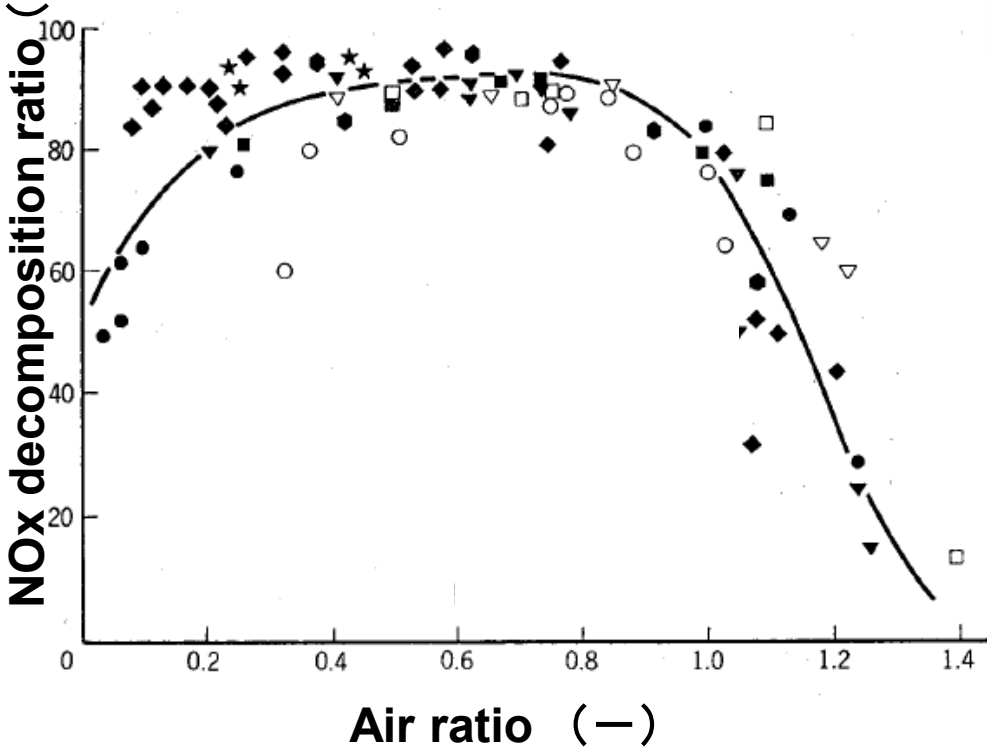


Fig. Lab.-scale test result for NOx reduction with coal.

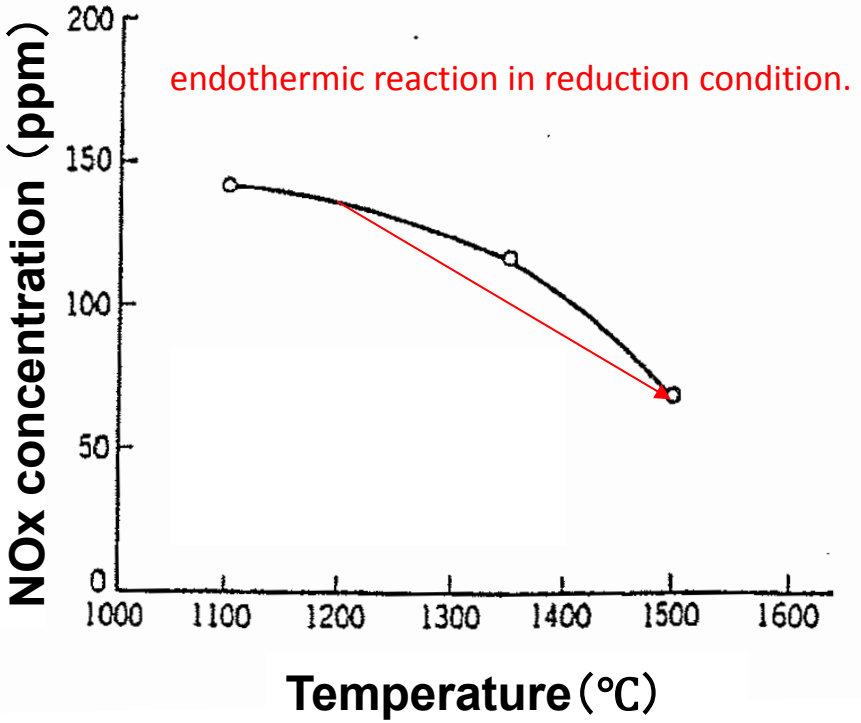
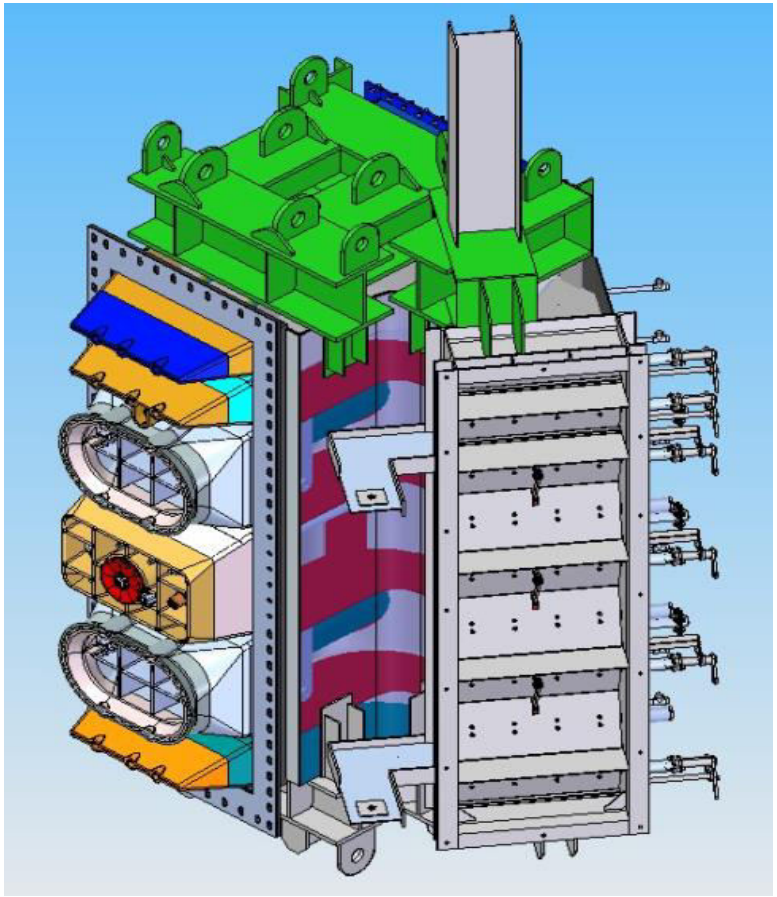
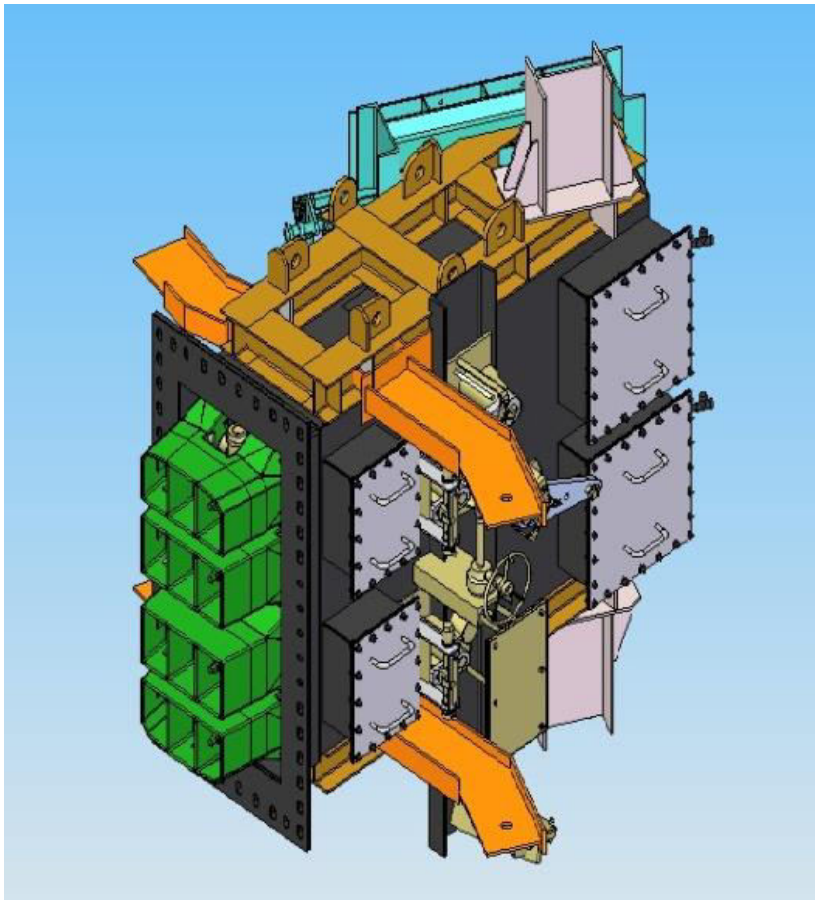


Fig. Lab.-scale test result for NOx generation on reduction condition.

MECHANISM OF NOx CONTROL



MAIN WINDBOX



AA PORT WINDBOX

OPERATIONAL EXPERIENCE

OPERATIONAL EXPERIENCE

Unit	Country	Output	Operation
K Plant	Japan	450t/h	1996
M1 Plant	Japan	1,000MW	1998
N1 Plant	Japan	460t/h	2000
T2 Plant	Japan	700MW	2000
K1 Plant	Japan	700MW	2002
H5 Plant	Japan	600MW	2004
Ma1 Plant	Japan	900MW	2004
B1,2 Plant	Thailand	700MW	2006, 2007
P1 Plant	Mexico	651MW	2010
P3 Plant	Indonesia	866MW	2012
H6 Plant	Japan	600MW	2013
R1 Plant	India	700MW	2014
N1,2 Plant	India	660MW	2014, 2015
K8 Plant	India	660MW	2015

OPERATIONAL EXPERIENCE

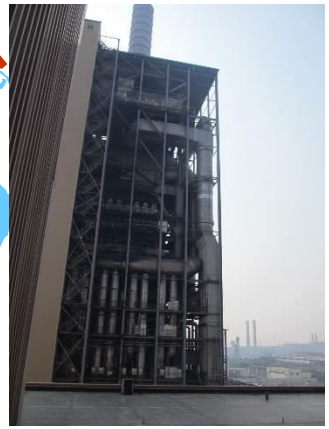
Domestic plant
J525MW x 1 (2012)
543℃

Domestic plant H5
600MW x 1 (2014)
604/602℃

License to MHPS-AEE

License to Chinese boiler maker

Chinese plant Z1&Z2
700MW x 2 (2013)
541/568℃



Chinese plant B3
350MW x 1
541/541℃ (2014)

Chili plant N1&N2
130MW x2 (2014)

Mexican plant C2
350MW x 1 (2013)
541/541℃

OPERATIONAL EXPERIENCE

2 x 700 MW NABHA POWER PLANT, RAJPURA, PUNJAB

POST COMBUSTION CONTROL

POST COMBUSTION CONTROL

As per Ministry of Environment, Forest and Climate Change Notification dated Dec 7, 2015

S.N.	TPP Installation Period	NOx requirement	Deadline
1	Before Dec 31, 2003	600 mg/Nm^3	Within 2 year from notification
2	Between Jan 01, 2004 to Dec 31, 2016	300 mg/Nm^3	Within 2 year from notification
3	From Jan 01, 2017	100 mg/Nm^3	Must meet upon completion

POST COMBUSTION CONTROL

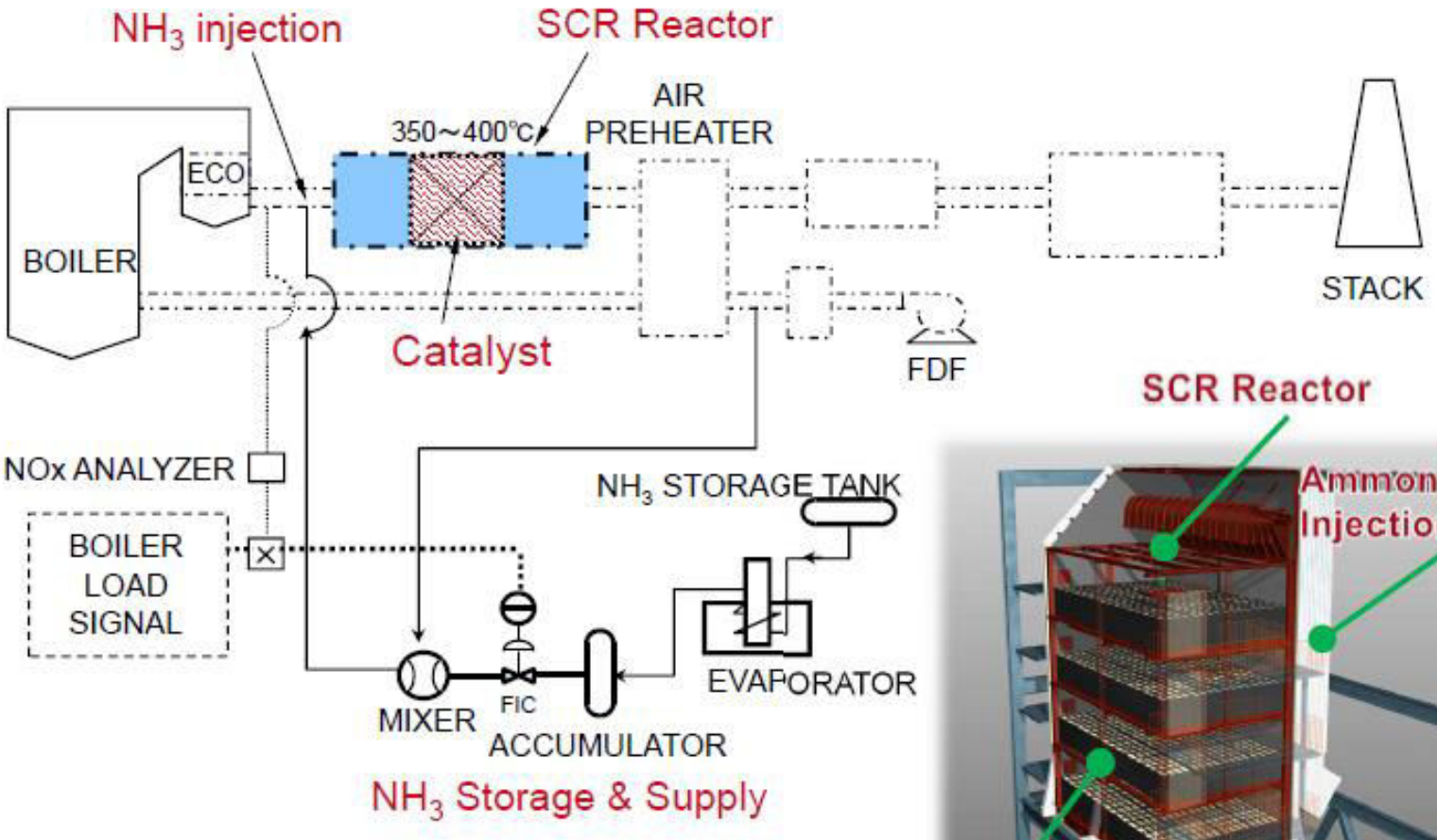
Post combustion control methods used to reduce NO_X to molecular nitrogen through catalytic conversions:

<1> Selective Non-Catalytic Reduction (SNCR)
<2> Selective Catalytic Reduction (SCR)

The selective catalytic reduction process removes nitrogen oxides (NO_X) from flue gases by injecting ammonia (NH_3) into the flue gas and passing the well mixed gases through a catalyst bed. NO_X reacts with NH_3 in the presence of the catalyst to produce nitrogen (N_2) and water (H_2O) as shown in the following equation

$4NO + 4NH_3 + O_2 = 4N_2 + 6H_2O$

POST COMBUSTION CONTROL



POST COMBUSTION CONTROL

<1> SCR De NOx reactor including catalyst

<2> Ammonia storage facilities

<3> Ammonia loading and unloading facilities

<4> Ammonia gas preparation

<5> Air pre-mixing system

<6> Ammonia injection grid

<7> Soot blowers

<6> Control system

CHALLENGES IN INSTALLATION OF SCR

S No	Requirement	Remarks
1	SCR is to be located upstream of the Air Preheater	Tight layout especially in existing plants
2	High dust burden in Indian coals	Catalyst plugging and erosion of catalysts is a matter of concern
3	Formation of ammonium bisulphate	Fouling and plugging of Air preheater
4	Hazardous nature of Ammonia	Safety issue
5	Availability of ammonia	Vendors to be identified
6	Disposal of spent catalyst	Catalyst Life cycle management
7	Pressure drop across SCR	Fans need to be resized
8	Low load operation to avoid ammonium bi-sulphate formation	Layout requirements for economiser gas bypass to be considered.

CONCLUSION

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- New Emission Norms 2015

- Advanced Combustion Technology for Coal Combustion
  - CCF — Uniform Firing in Furnace
  - PM Burner — Low NOx Burner
  - MACT — NOx Removal System in Furnace
  - MRS Mill — High Performance Vertical Mill

- Advanced Low NOx combustion technologies can help in the optimization of post combustion control (SCR) technology

L&T-MHPS BOILERS