

LNB =Low NOx Burner  
SNCR =Selective Non-Catalytic Reduction  
SCR =Selective Catalytic Reduction

## DeNOx Technology

	LNB	SCR	SNCR
Efficiency	50%-60%	50%-90%	30%-50%
Initial Cost	Low	High	Medium
Operation Cost	Low	Medium	Medium
Catalyst	No	Yes	No
Recommend Boiler	PC boiler	Both CFB boiler and PC boiler	CFB Boiler

Emission: <600mg/Nm<sup>3</sup>

Recommend Tech: LNB

Emission: <300mg/Nm<sup>3</sup> and CFB Recommend Tech: SNCR

Emission: <300mg/Nm<sup>3</sup> and PCB Recommend Tech: LNB+SCR

# Low NOx Burner

LNB

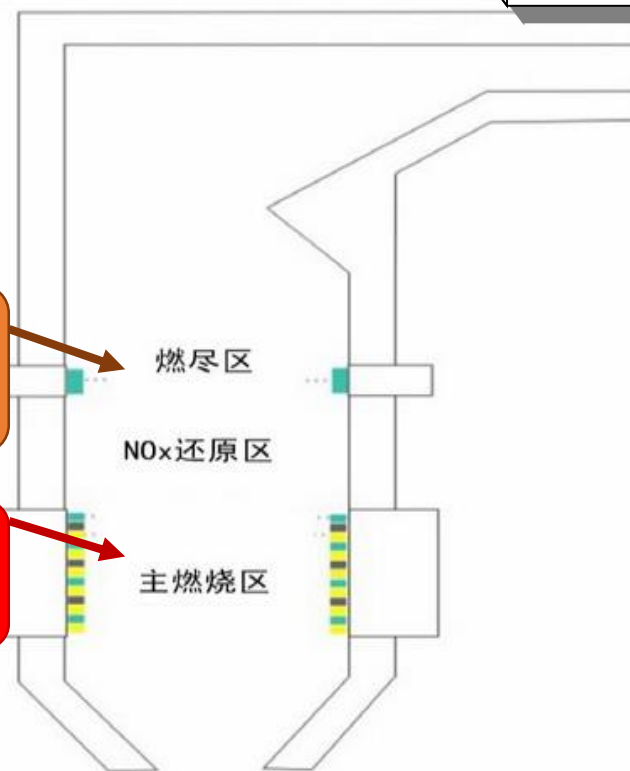


- Boiler outlet reduce to  $100\text{mg}/\text{m}^3$ 
  - Effect depends on type of boilers and type of coals
- Principles
  - Low NOx at lower Temp
  - Double stage combustion

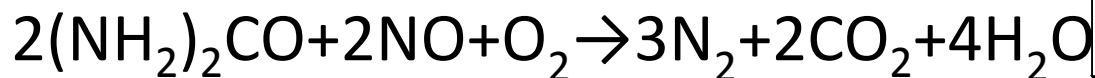
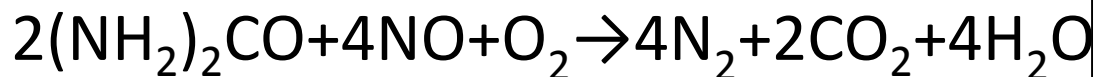


Second  
combustion

First combustion



- Reaction principles:

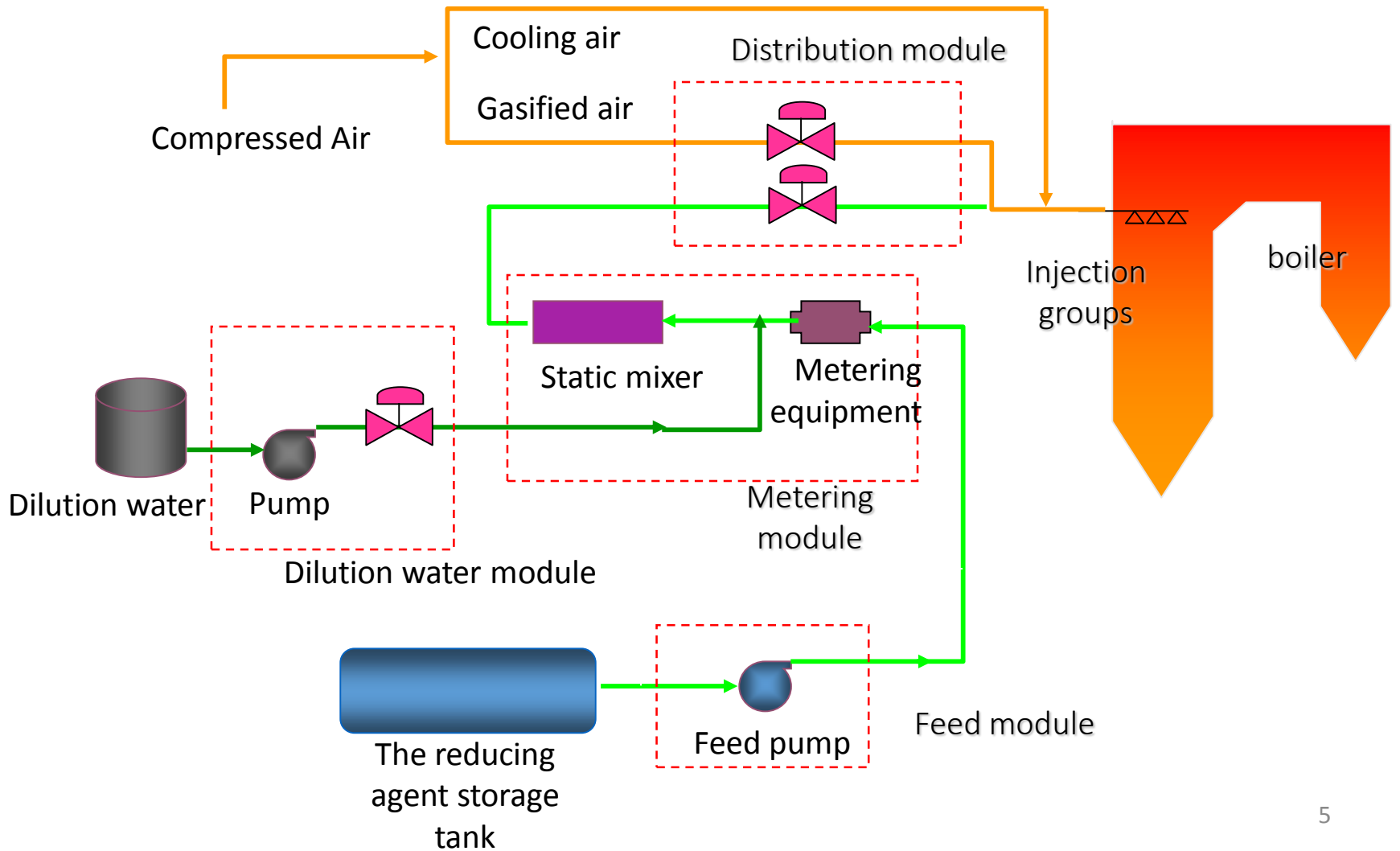


- Reaction temperature: 850 °C ~ 1200 °C
- Reduction agent: Urea, ammonia aque
- Catalyst: No catalyst
- Efficiency: 50%-70% in CFB boiler  
30%-50% in PC boiler

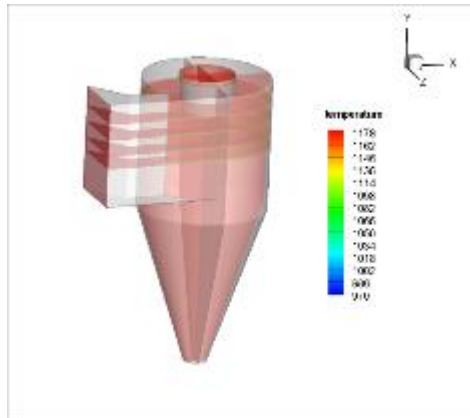
## SNCR



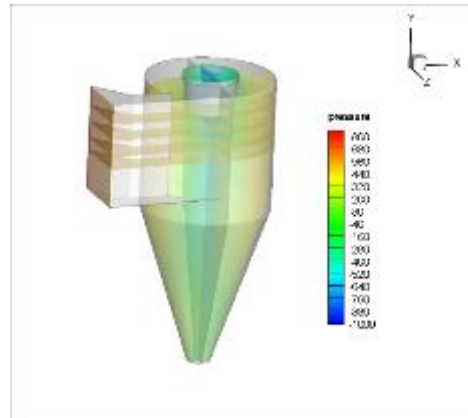
# Process



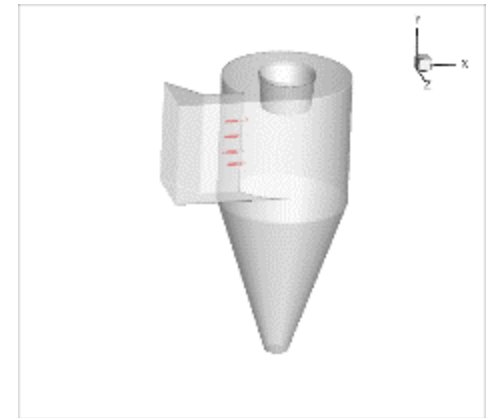
# Operation Status after optimization



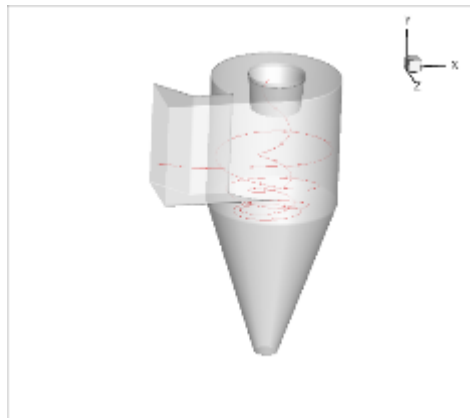
Temp



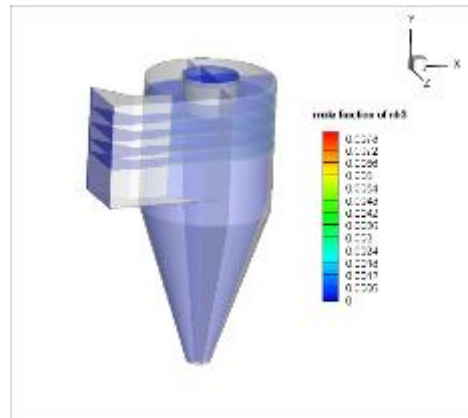
Pressure



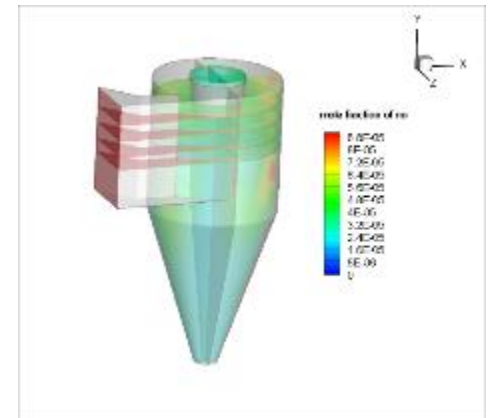
Atomization



Gas Flow Line



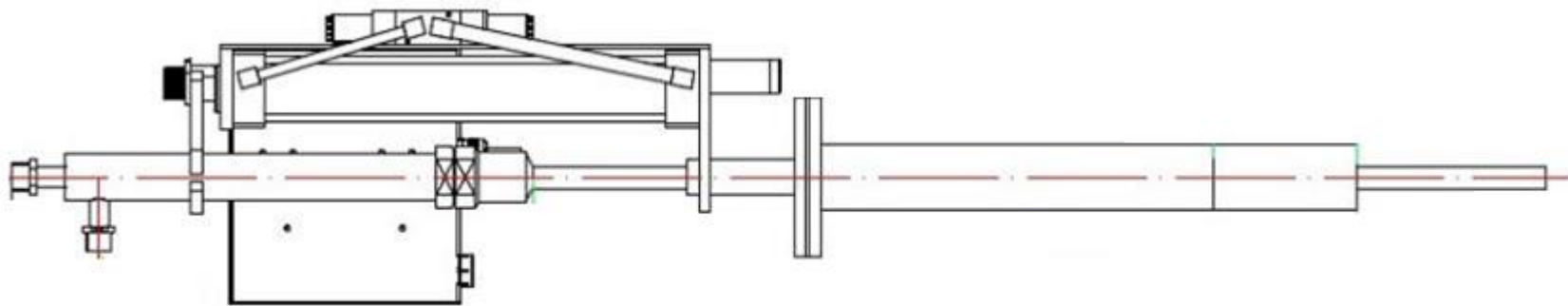
NH<sub>3</sub> Concentration



NO Concentration

## ● Atomized two-fluid injectors

- urea solution goes inner tube.
- Compressed air with the spiral movement goes the other.



# SNCR Projects



Type of Boiler	CFB Boiler
Gas flow	1261453Nm <sup>3</sup> /h
Temp	850~895°C
Inlet NOx	200mg/Nm <sup>3</sup>
Outlet NOx	100mg/Nm <sup>3</sup>
Efficiency	Required: 50% Actual: 70%
NSR	1.4

Shuozhou Power Plant 2 X 350MW SNCR  
Time of Commission: Nov, 2015.



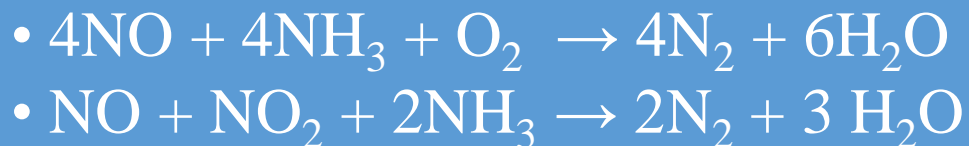
# SNCR Projects



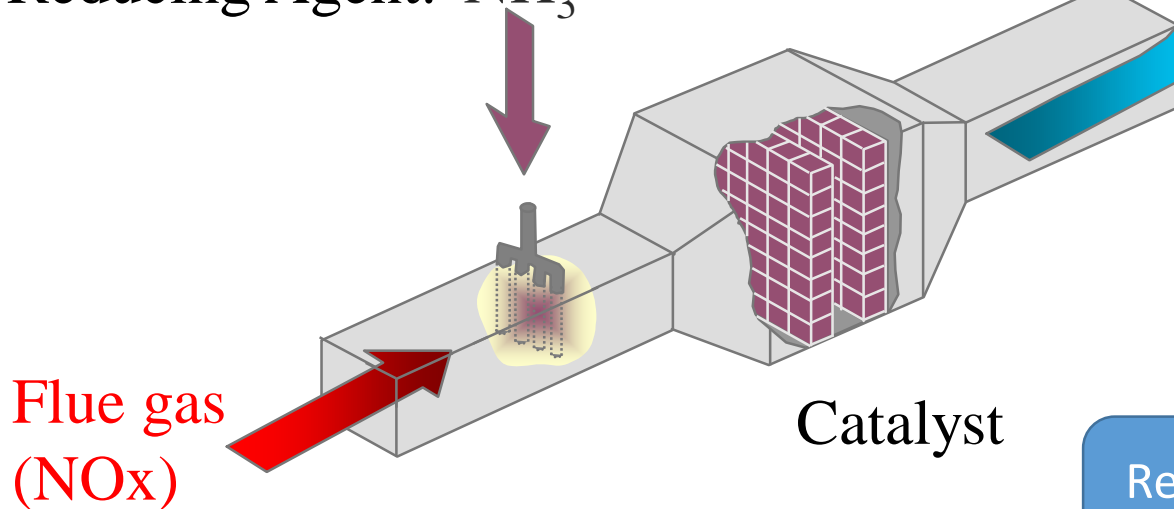
Type of Boiler	PC Boiler
Gas flow	1869261Nm <sup>3</sup> /h
Temp	950~1150°C
Inlet NOx	860mg/Nm <sup>3</sup>
Outlet NOx	600mg/Nm <sup>3</sup>
Efficiency	Required: 30% Actual: 50%
NSR	1.45

Hanfeng Power Plant 2 x 600MW SNCR  
Time of Commission: March, 2016

## • Principle of SCR



Reducing Agent:  $\text{NH}_3$



Recommend Temp:  
 $320^\circ\text{C}$ - $420^\circ\text{C}$

# DeNOx Technology

	LNB	SCR	SNCR
Efficiency	50%-60%	50%-90%	30%-50%
Cost	Low	High	Medium
Catalyst	No	Yes	No
Recommend Boiler	PC boiler	Both CFB boiler and PC boiler	CFB Boiler

Emission: <600mg/Nm<sup>3</sup>

Emission: <300mg/Nm<sup>3</sup> and CFB

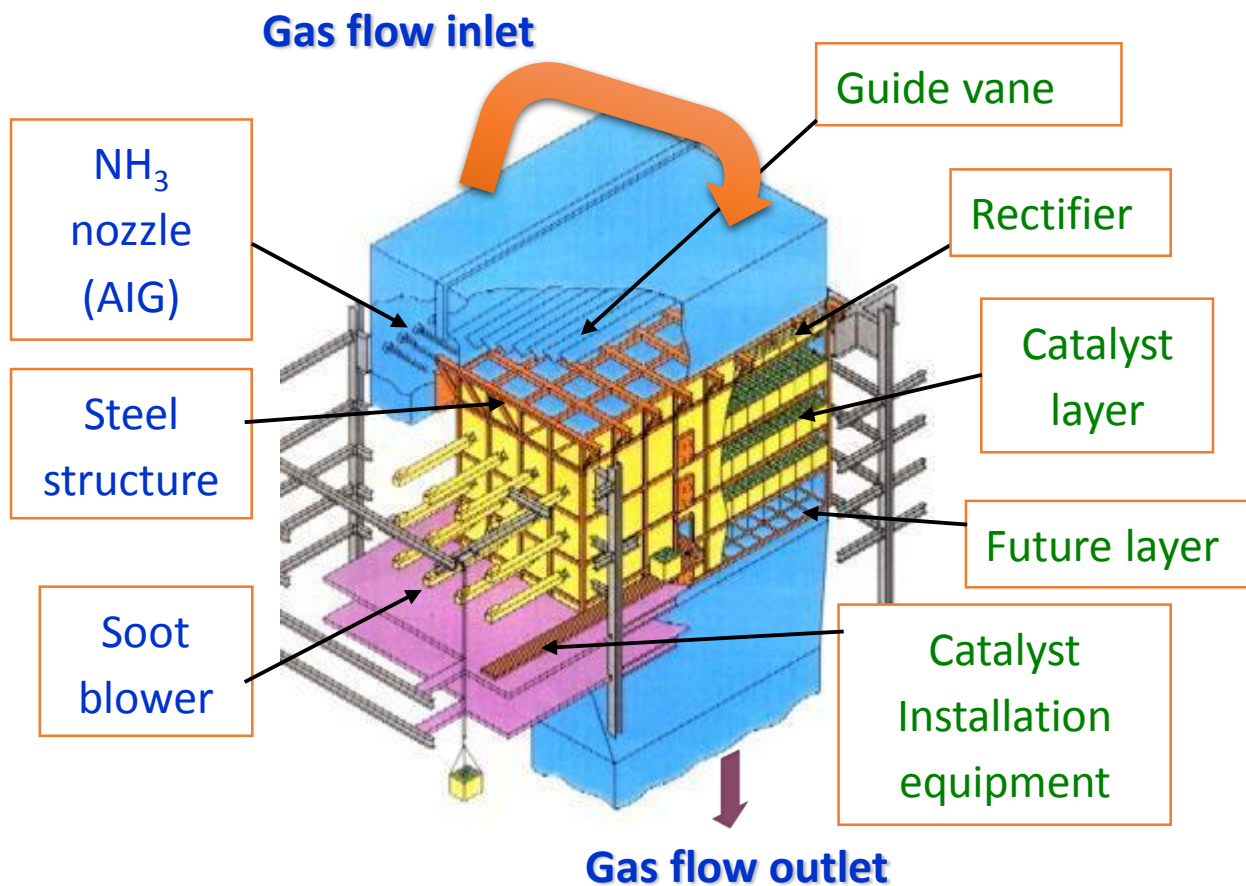
Emission: <300mg/Nm<sup>3</sup> and PCB

Recommend Tech: LNB

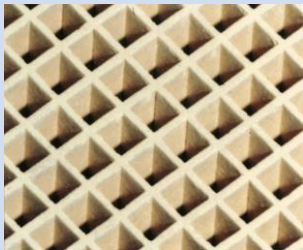
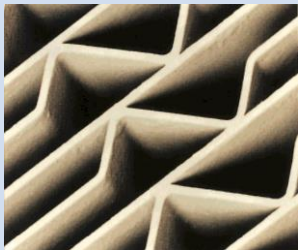
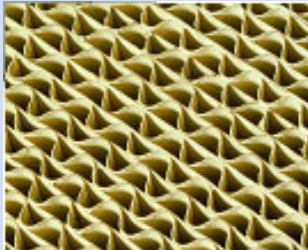
Recommend Tech: SNCR

Recommend Tech: LNB+SCR

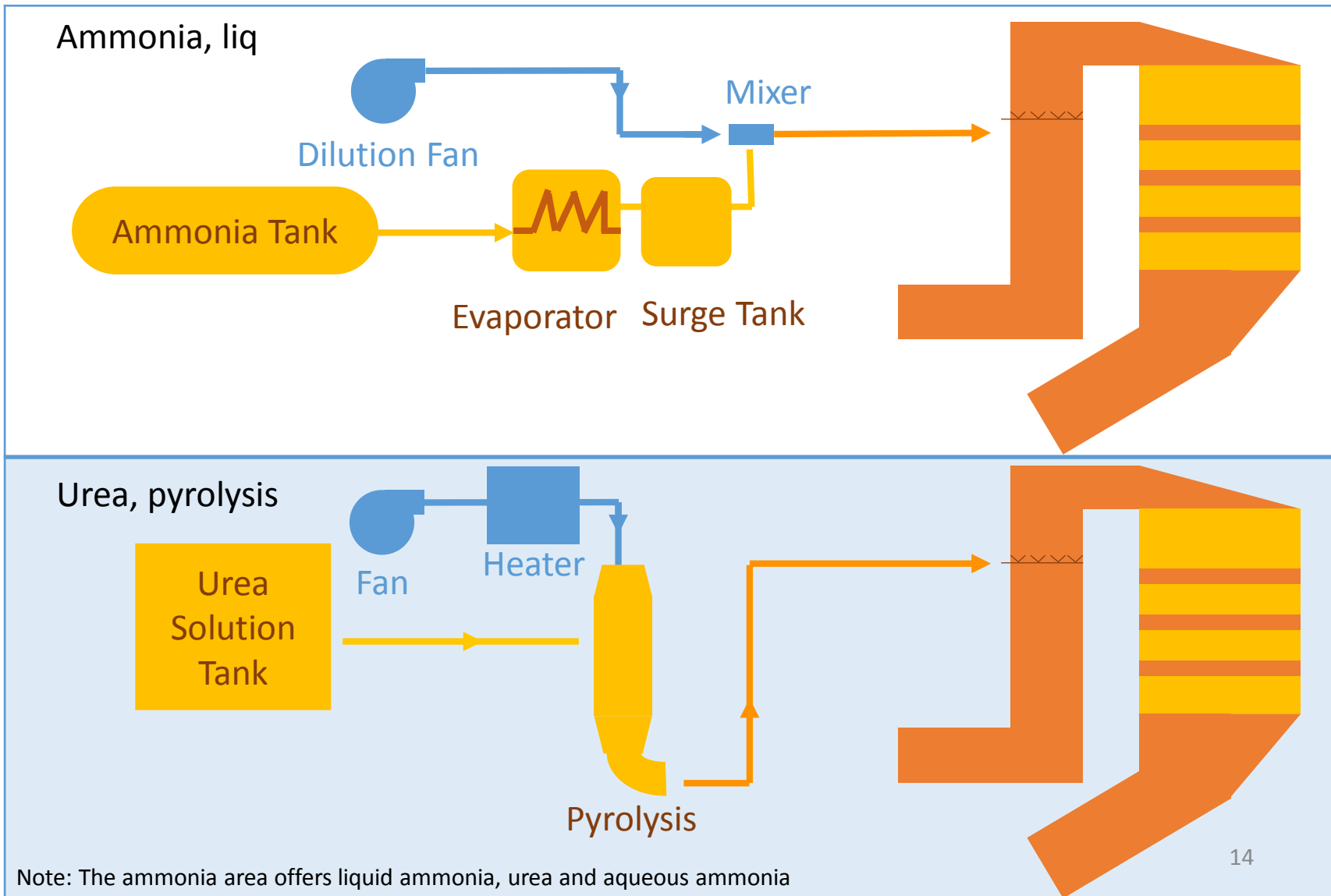
- ✓ Vertical arrangement is adopted on PC boiler to prevent ash accumulation.



# Catalyst

	honeycomb	Plate	Corrugated plate
Types			
specific surface area	1.5~1.8	1	1.27
Open porosity	80%	87%	75%
Anti plugging	medium	good	medium
Abrasion resistance	good	good	medium
Pressure Drop	1.12	1	1.48
Global Share	≈65%	≈33%	rare

# Process

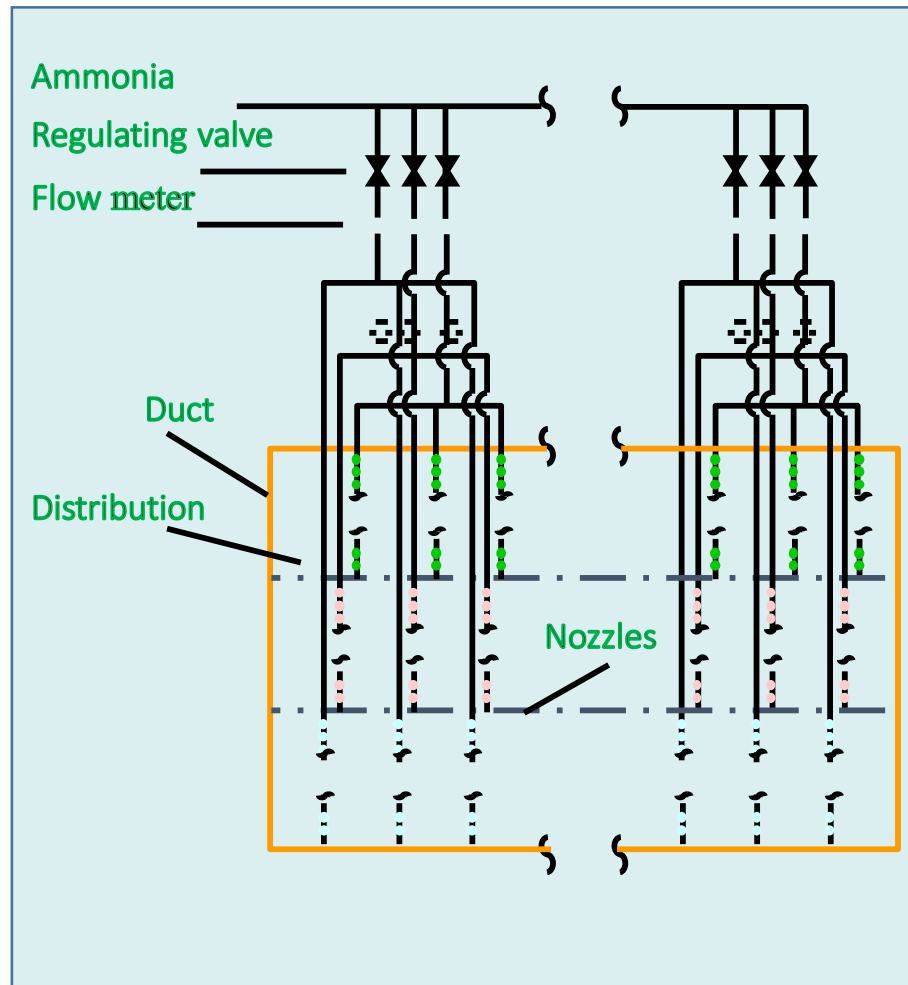
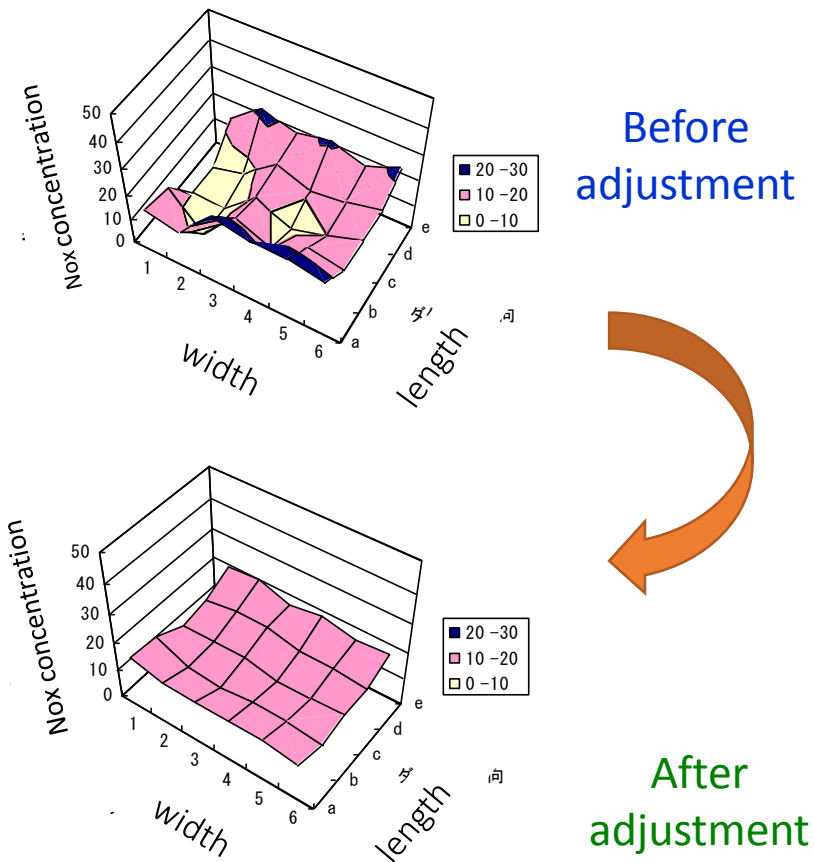


Note: The ammonia area offers liquid ammonia, urea and aqueous ammonia

## SCR Reduction Agent

	Ammonia, liq	Urea, pyrolysis	Urea, hydrolysis	Ammonia, aqua
Response	Very fast	Very fast	Medium	Fast
Cost	Medium	High	High	Medium
Running Pressure	High	Atm	Medium	Atm
Ammonia Concentration	100%	<5% after dilution	~37% after hydrolysis, <5% after dilution	~25-28%
Safety	Low	High	Medium	Medium
Access	Easy	Easy	Easy	Hard
Domestic Share	~40%	~35%	~15%	~5%

## Advantage: Balance Adjustment of Injected $\text{NH}_3$



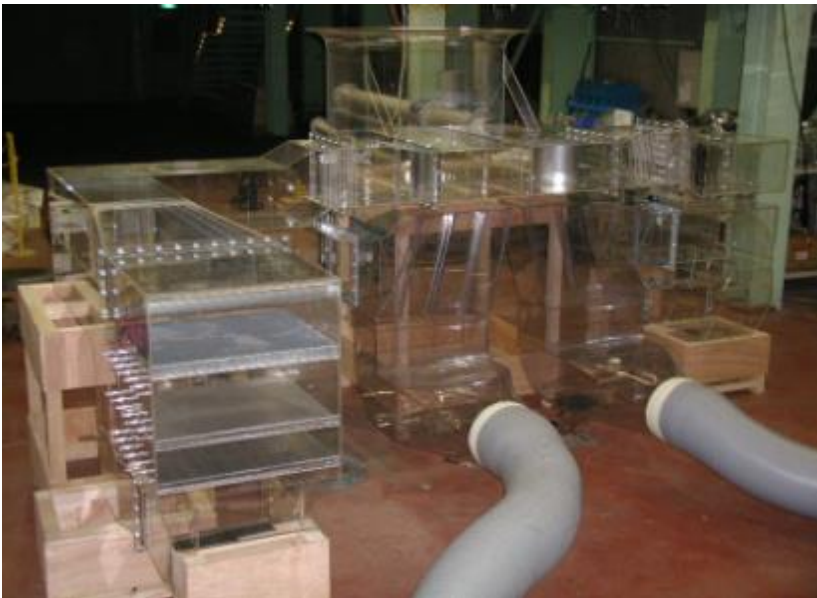
NO<sub>x</sub> distribution across the duct (at SCR outlet)

Ammonia Injection Grid

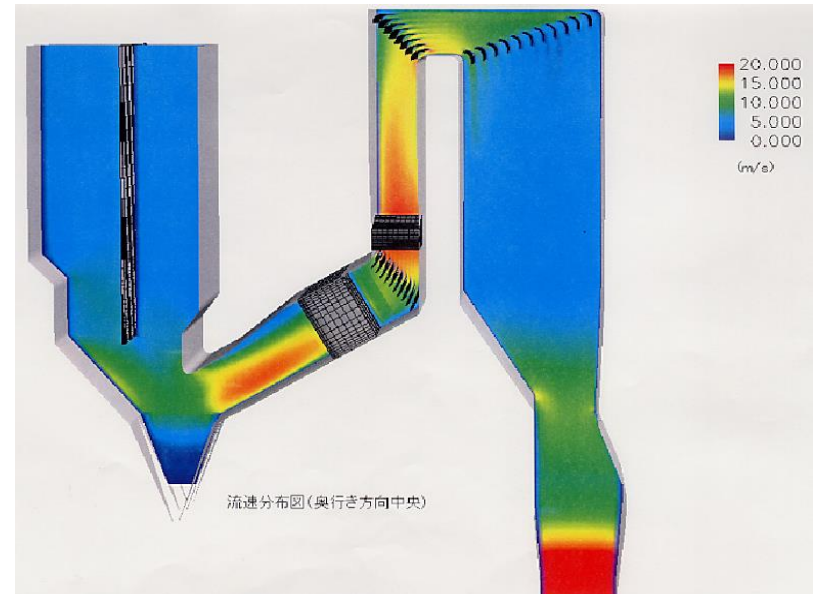


## Advantage: Flow Pattern Simulation of SCR

- ✓ Simulation shows the flow pattern and ash accumulation, So Optimization of SCR arrangement and prevention of ash accumulation possible



Cold Flow Distribution model test



Computational flow pattern simulation

**Advantage: No Plugging in a Long Run**



**Optimized SCR Arrangement**  
**Catalyst Layer after 2-year Running**  
**( 300MW coal boiler)**



Songyu Power Plant 2X300MW  
Retrofitting project, First Domestic SCR

Time of Commission: 2006

<b>Boiler Type</b>	PC Boiler
<b>Gas Flow</b>	977077Nm <sup>3</sup> /h
<b>Temp°C</b>	380
<b>NOx Inlet</b>	450-707mg/Nm <sup>3</sup>
<b>NOx Outlet</b>	-
<b>DeNOx Efficiency</b>	60%
<b>SO<sub>2</sub> to SO<sub>3</sub></b>	<1
<b>Ammonia slip</b>	3ppm
<b>Ash Concentration</b>	26g/Nm <sup>3</sup>



Puqi Power Plant 2X1000MW  
New Project, High Ash  
Time of Commission: Oct, 2012

<b>Boiler Type</b>	PC Boiler
<b>Gas Flow</b>	2938320Nm <sup>3</sup> /h
<b>Temp°C</b>	378
<b>NOx Inlet</b>	450mg/Nm <sup>3</sup>
<b>NOx Outlet</b>	90mg/Nm <sup>3</sup>
<b>DeNOx Efficiency</b>	80%
<b>SO<sub>2</sub> to SO<sub>3</sub></b>	<1
<b>Ammonia slip</b>	3ppm
<b>Ash Concentration</b>	41g/Nm <sup>3</sup>



Yaomeng Power Plant 2X600MW  
Retrofitting Project, High Ash  
Time of Commission: Jan, 2013

Boiler Type	PC Boiler
Gas Flow	1923400Nm <sup>3</sup> /h
Temp°C	377
NOx Inlet	400mg/Nm <sup>3</sup>
NOx Outlet	80mg/Nm <sup>3</sup>
DeNOx Efficiency	80%
NH <sub>3</sub> /NOx	0.82
SO <sub>2</sub> to SO <sub>3</sub>	<1
Ammonia slip	3ppm
Ash Concentration	57.9(79)g/Nm <sup>3</sup>



Waigaoqiao 2 Power Plant 2X900MW  
Retrofitting Project

<b>Boiler Type</b>	PC Boiler
<b>Gas Flow</b>	2575872Nm <sup>3</sup> /h
<b>Temp°C</b>	376
<b>NOx Inlet</b>	450mg/Nm <sup>3</sup>
<b>NOx Outlet</b>	80mg/Nm <sup>3</sup>
<b>DeNOx Efficiency</b>	Required 82.2% Actual 92.5%
<b>SO<sub>2</sub> to SO<sub>3</sub></b>	<1
<b>Ammonia slip</b>	3ppm
<b>Air Preheater</b>	retrofitted
<b>IDF</b>	retrofitted
<b>Boiler steel structure</b>	Checked

# De-NOx Ref. (Partial)

No.	Project Name	Capacity	Efficiency	Operation Commencement
1	Songyu Power Plant II #3、#4 Fujian	300MW	≥60	2005
2	Songyu Power Plant I #1、#2 Fujian	300MW	≥60	2006
3	Pinghai Power Plant #1、#2 Guangdong	1000MW	≥50	2008
4	Caofeidian Power Plant #1、#2 Hebei	300MW	≥50	2008
5	Caojing Power Plant #1、#2 Shanghai	1000MW	≥80	2009
6	Nanjing Chemical Park #1、#2 Jiangsu	300MW	≥70	2008
7	Pengcheng Power Plant III #1、#2 Jiangsu	1000MW	≥70	2009
8	Guangzhou Huarun Power Plant #3、#4	330MW	≥80	2008
9	Yuzhou Power Plant II #3、#4 Henan	660MW	≥80	2008
10	Wujing Power Plant #8、#9 Shanghai	300MW	≥80	2009
11	shajiao Power Plant #6、#7 Guangdong	1000MW	≥80	2010
12	Shashui Power Plant #1、#2 Guangdong	600MW	≥80	2010
13	Shidongkou Power Plant II #3、#4 Shanghai	660MW	≥60	2009
14	Shijiazhuang Thermal Power Co., Ltd. #1、#2 Hebei	330MW	≥80	2010
15	Xinhai Power Plant #1、#2 Jiangsu	1000MW	≥80	2010
16	Datang Linzhou Power Plant #1、#2	350 MW	≥50	2009
17	Weijiamao Power Plant #1、#2	660MW	≥80	2009
18	Houma Power Plant #1、#2 ShanXi	300MW	≥70	2014
19	Xinmi Power Plant II #1、#2 Henan	1000MW	≥70	2011
20	Yuedian Dapu Power Plant #1、#2 Guangdong	660MW	≥80	2010
21	Zhoukou Longda Power Plant #1、#2	300MW	≥80	2014
22	YANGXI Power Plant I #1、#2 Guangdong	600MW	≥70	2010
23	Huaneng (Nantong) Power Plant III #1、#2	1000MW	≥80	2014
24	Yantai Power Plant #1、#2 Shandong	660MW	≥80	2014
25	Qingshuichuan Power Plant #1、#2 Shanxi	1000MW	≥80	2014
26	Puqi Power Plant #1、#2 Hubei	1000MW	≥80	2012
27	Wujin No.2 Power Plant #1 Shanghai	600MW	≥80	2011
28	Liuan Power Plant #3 Anhui	660MW	≥70	2012
29	YANGXI Power Plant I #3、#4 Guangdong	660MW	≥80	2015
30	Xinhu Power Plant#1、#2 Xinjiang	350MW	≥60	2013
31	Jiaozuo Power Plant#1、#2	350MW	≥80	2012
32	Longquan Power Plant#1、#2 Henan	660MW	≥80	2013

# De-NOx Ref. (Partial)

No.	Project Name	Capacity	Efficiency	Operation Commencement
33	Shenhua Power Plant#1、 #2 Xinjiang	350MW	≥80	2012
34	Turkey ( IZDEMIR ) Power Plant#1	350MW	≥60	2013
35	Kuishan Petrochemical #1、 #2 Xinjiang	350MW	≥80	2013
36	Wanxiang Shanshan Shaerhu #1、 #2 Xinjiang	350MW	≥80	2013
37	Wanxiang Shanshan Kumutage #1、 #2 Xinjiang	350MW	≥80	2013
38	Bao Steel Power Plant #3	300MW	≥80	2013
39	Guotou Qinzhou Coal-fired Power Plant II #1、 #2	1000MW	≥80	2014
40	Beihai Power Plant II #1、 #2	660MW	≥80	2014
41	Pingshan Power Plant I #1、 #2 Anhui	660MW	≥80	2014
42	Tianji Power Plant II #1、 #2 Anhui	660MW	≥80	2014
43	Yongxin II #1、 #2 Vietnam	622MW	≥72	2014
44	Waigaoqiao No.2 Power Plant #1、 #2 Shanghai	900MW	≥80	2014
45	Huadian Shuozhou I #1、 #2	300MW	≥80	2014
46	Puqi Power Plant I #1、 #2 Hubei	300MW	≥80	2014
47	Xutang Power Plant #4、 #5 Jiangsu	300MW	≥80	2014
48	Huaneng Rizhao Power Plant #3、 #4	600MW	≥80	2013
49	Zhongdiantou Yaomeng Power Plant #5、 #6	600MW	≥80	2014
50	Huilai Power Plant #1、 #2 Guangdong	600MW	≥80	2014
51	Tumushuke Power Plant #1、 #2 Xinjiang	350 MW	≥80	2014
52	Jiangzuo Power Plant #1、 #2	660 MW	≥82	2014
53	Shengli No.2 Power Plant #1、 #2	30 MW	≥80	2014
54	Wujin No.2 Power Plant #2 Shanghai	600MW	≥80	2013
55	Tianye Thermal Power Plant III #1、 #2 Xinjiang	330 MW	≥80	2014
56	Huaihu Tianji Power Plant #1、 #2	630 MW	≥80	2014
57	Guowang Power Hami Power Plant #1、 #2	630 MW	≥80	2014
58	Guowang Power Hami Power Plant #3、 #4	660 MW	≥80	2014
59	Ningxia Petrochemical 45/80 fertilizer	15 MW	≥80	2013
60	Zhongdiantou Power Plant #1、 #2 Xining	660 MW	≥80	2014
61	Fengcheng II Power Plant #5、 #6 Jiangxi	660 MW	≥80	2015
62	Shazhou Power Plant II #1、 #2 Jiangsu	1000 MW	≥80	2015
63	Shengli Power Plant II #3	15 MW	≥80	2014



# De-NOx Ref. (Partial)

No.	Project Name	Capacity	Efficiency	Operation Commencement	Note
64	Huanggang Dabieshan Power Plant #1、#2	640 MW	≥80	2014	
65	Zhongneng Silicon Power Plant #1 Jiangsu	350 MW	≥80	2014	
66	Tianfu Power Plant #1、#2 Xinjiang	660 MW	≥80	2015	
67	Bao Steel Power Plant #3	350 MW	≥80	2015	
68	Changzhi Xinlong Power Plant (SNCR) #1、#2	330 MW	≥55	2015	SNCR
69	Datang Huainan Luohe Power Plant #1、#2	300 MW	≥80	2015	
70	Henglian Wucaiwan Power Plant I #1、#2 Xinjiang	660 MW	≥80	2015	
71	Guowang Power Yili Power Plant #1、#2	350 MW	≥80	2015	
72	Huadian Lu An Power Plant #4 Anhui	660 MW	≥80	2015	
73	Huadian Shaoguan Power Plant(SNCR) #1、#2	330 MW	≥50	2014	SNCR
74	Huadian Nanjiang Thermal Power Plant II#1、#2 Tianjin	150 MW	≥50	2014	
75	Yuanyanghu Power Plant #1、#2	1000 MW	≥80	2015	
76	Xinpu Chemical Power Plant #1、#2	400t/h	≥70	2015	
77	Huadian Changde Power Plant #1、#2 Hunan	660 MW	≥80	2015	
78	Zhuzhou Youxian Power Plant #1、#2 Hunan	600 MW	≥80	2015	
80	Zhongji Fushun Thermal Power Plant #1、#2	300 MW	≥80	2015	
81	Jiarun Power Plant #1、#2 Xinjiang	350 MW	≥80	2015	
82	Liaoning Huajin Dahua Power Plant #4	410t/h	≥80	2015	
83	Tianye (Tianneng) Power Plant #11、#12 Xinjiang	300 MW	≥80	2015	
84	Datang Binzhou Power Plant I #1、#2	300 MW	≥80	2015	
85	Huangpu Power Plant #1、#2	400 MW	≥80	2015	
86	Zhangze Power Plant #1、#2 Shanxi	1000 MW	≥80	2015	
87	Huajin Tonghua Power Plant #1 Liaoning	410t/h	≥50	2015	
88	Tianneng Chemical Thermal Power Plant #1、#2	300 MW	≥80	2015	
89	Jiaozuo Jinguan Jiahua Power Plant #1、#2	130 MW	≥80	2015	
90	Jiarun Power Plant #1、#2 Xinjiang	350MW	≥80	2015	
93	Zhongneng Silicon Industry Power Plant #1 Jiangsu	350MW	≥80	2015	
96	Huadian Xinzhou Guangyu Power Plant II #1、#2	350MW	≥80	2015	
97	Yuantianhua Power Plant #1、#2	220t/h	≥60	2015	SCR+SNCR
98	Huaneng Nanjing Chemical Industry Park Power Plant #1、#2、#3	480t/h	≥87	2015	
99	Huaneng Hanfeng Power Plant #1、#2	660MW	≥60	2015	SNCR
101	Huaneng Chaohu Power Plant II #1、#2	660MW	≥60	2015	