Hybrid DeNOx

A Cost-Effective NOx Reduction Solution for Small & Medium Boilers

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LP AMINA WAS ESTABLISHED WITH A MISSION TO SERVE AS AN INTEGRATED PLATFORM TO DEVELOP AND DEPLOY CLEAN COAL SOLUTIONS GLOBALLY.

- **125+** Full time employees, on 3 continents
- **8** Locations worldwide, with activities in the US, Europe and Asia
- **10+** Patents, focused on coal / biomass conversion and pollution control
- **40+** Projects completed in last 5 years
- **15** Provinces and municipalities in China served to date
- **10GW** Of power plants retrofitted with pollution controls

**Strategic partnership with Bayer to develop coal utilization technologies**

**The State of Wyoming co-funded LP Amina’s Coal to Chemicals technology**

**West Virginia University participates in the research of LP Amina’s C@C technology**

**LP Amina is a founding member and co-chair of the US-China Energy Cooperation Program (ECP)**

**LP Amina is a founding member of the US-China Clean Energy Research Center (CERC)**
LP AMINA OFFERS A RANGE OF SOLUTIONS FOCUSED ON NOx REDUCTION FOR COAL AND GAS POWER AS WELL AS ADVANCED COAL UTILIZATION (COAL TO CHEMICALS)

Low NOx Burners  HybridLNB/SNCR/SCR  Direct Injection SCR  Advanced Coal Tech.

- LP Amina is market leader in pre-combustion De-NOx solutions via in-furnace optimization in China
- 25+ Projects at major Chinese clients including China Huaneng Group, Guangzhou Yuedian Group, Datang Group

- Proprietary technology developed by LP Amina
- Combines benefits of several De-NOx technologies and brings superior De-NOx results at affordable price
- Installed at multiple units at Yixing Power in Jiangsu with 80% NOx reduction

- Proprietary technology developed by LP Amina
- LP Amina was able to reduce NOx by over 80% with slip below 2 ppm
- More efficient, direct injection SCR uses significantly less energy and is cheaper to build

- Innovative process to co-produce electric power and high-value chemicals
- Extraordinary economics and environmental impact improvement from systems perspective
- Piloted in Shanxi, China; to be fully operational Q4 ‘14

Company Overview

Shajiao Power Plant, Shenzhen  Yixing Power, Jiangsu  Jingfeng Power, Beijing  Hepo Facility, Shanxi
LP Amina’s Hybrid De-NOx Technology is to combine strengths of LNB, SNCR and SCR technologies, leveraging relative advantages of each.
LP AMINA’S FIRST HYBRID TECHNOLOGY WAS INSTALLED ON YIXING UNION’S UNITS 5/6 IN CHINA’S JIANGSU PROVINCE, TOTAL 80% OF THE NOX REDUCTION WAS ACHIEVED

Yixing Union Units 5 and 6 Project Overview

Units Overview:
• Power generation capacity: 2 x 50 MW
• Combustion type: T-Fired
• Fuel: Bituminous coal

Scope:
• SOFA and Low NOx Firing Systems
• Proprietary SNCR/SCR Hybrid
• Patented coal classifiers

Results:
• NOx reduced from 0.44 to 0.08 lb/MMBTu
• LOI below 1.5%
• Expanded fuel flexibility
• Increased unit efficiency
• Significant cost reduction due to the large savings in ammonia and catalysts
• Currently working on few more units for Yixing
IN HYBRID ARRANGEMENT, AMMONIA INJECTORS ARE INSTALLED IN UPPER FURNACE, AND ONE (OR MORE) IN-DUCT CATALYST INSTALLED IN BOILER REAR PASS

Schematical Arrangement of In-Duct SNCR & SCR

Concentrated urea reagent

Chemical Injection

\[ \text{800} - \text{1,100 °C} \]

\[ \text{N}_2 \]

\[ \text{NO}_x \]

Boiler Rear Pass

One or several layers of catalyst installed induct; each 2-3 meters thickness

Upper APH

Upper Economizer

Lower APH

Lower Economizer

= Sonic horns, soot blowers
IN HYBRID ARRANGEMENT, AMMONIA INJECTORS ARE INSTALLED IN UPPER FURNACE, AND ONE (OR MORE) IN-DUCT CATALYST INSTALLED IN BOILER REAR PASS

Advantages

- Can achieve **significant NOx reduction**, especially when combined with LNB
- **Lower capital** cost than SCR (smaller catalyst volume, installed in-duct)
- **No significant slip** issues because catalyst cleans up excess ammonia

Constraints

- Boilers require adequate **in-duct space** for catalyst installation
- Requires **EPC with know-how** of all three technologies: LNB, SNCR, SCR

Applicability

**Small Units**

- Smaller units utilize LNB and (S)OFA, **but still need additional NOx reduction**
  - SCR too expensive/ too large for some units
  - SNCR might not provide effective NOx reduction without large amount of slip

**Medium Units (50-300 MW)**

- LNB
- SCR

**Large Units**
Open space between economizer collection header and top of air preheater.

Retrofitted by LPA (Q3 2013)
LNB – 40% reduction (200 mg/Nm$^3$)
SNCR – 30% reduction (200 mg/Nm$^3$)
SCR – 50% reduction (100 mg/Nm$^3$)
Split economizer / air preheater allows for easier installation of SCR reactor.

**Proposed solution**
- **SNCR** – 40% reduction (250 mg/Nm$^3$)
- **SCR** – 60% reduction (100 mg/Nm$^3$)

**Available Space**
(1 or more layers of catalyst + sonic horns)
Proposed solution
SNCR – 40% reduction (166 mg/Nm$^3$)
SCR – 40% reduction (100 mg/Nm$^3$)

Available Space TOO HOT
• Move economizer, APH upwards.
• Create new space below in correct temperature zone.
• Install 1 layer of catalyst + sonic horns

Harder installation than other examples because of lack of space in correct temperature zone.