FACILITATING
NEW ENVIRONMENT STARNDARDS
FOR COAL BASED THERMAL POWER PLANT

Regulatory Perspective

30th January 2017

Dialogue on Enforcing New Environmental Norms

NEW ENVIRONMENT STANDARDS (Announced on 7th Dec 2015)

(in mg/ Nm³)	OLD NORMS	NEW NORMS				
		Installed before 31.12.2003		Installed after 01.01.2004 & upto 31.12.2016		To be installed from 01.01.2017
Unit Size (in MW)	All	< 500	≥ 500	< 500	≥ 500	All
SO_2	Dispersion through Chimney	600	200	600	200	100
NOx	No Standard	600		300		100
SPM	100	100		50		30
Mercury(Hg)	No Standard	X	0.03	0.03		0.03

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Unit Size (in MW)	All	< 500	≥ 500	< 500	≥ 500	All
Cooling Towers	No standard	• All existing plants with once through cooling to be converted to closed cycle stations cooling by installation of Cooling Towers. • All existing plants to achieve Specific water consumption up to maximum of 3.5 Cu Meter/ MWh within two years • New plants to be installed after 1.1.2017 to meet Specific water consumption up to maximum of 2.5 Cu Meter/ MWh and to achieve zero waste water discharge				

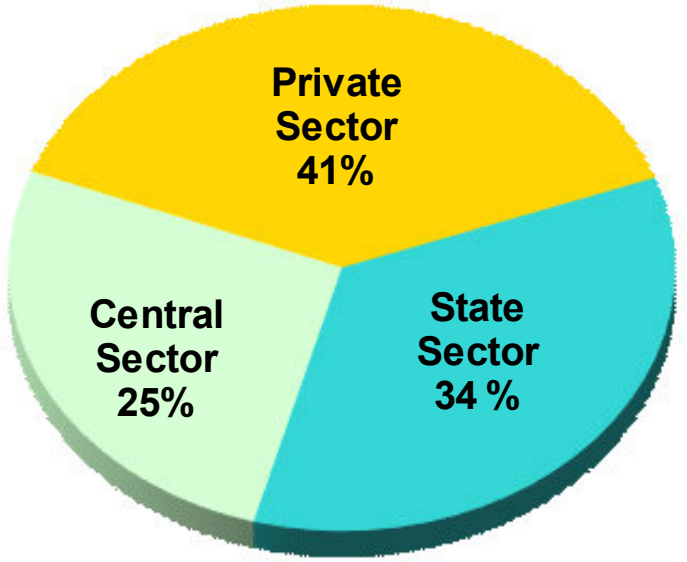
A implementation period of two years from date of publication is provided

Fuel-wise & Sector-wise Capacities

Fuel wise break-up (MW)

Thermal	215168.90	69.7%
Coal	188967.88	61.3%
Gas	25282.13	8.1%
Diesel	918.89	0.3%
Hydro	43139.43	14.2%
Nuclear	5,780	1.9%
Renewable	45916.95	14.2%
TOTAL	310005.28	100.0%

Sector wise break-up (MW)



Total generation in 2015-16 : 1107* BU

(Source-CEA)

INSTALLED CAPACITY (IN MW)

AS ON 30.6.2016

Type	Capacity	Share
Coal	186212.88	61.43%
Gas	24508.63	8.09%
Diesel	918.89	0.30%
Thermal	**211640.40**	**69.82%**
Hydro	42848.43	14.14%
Nuclear	5780.00	1.91%
RES	42849.38	14.13%
Total	**303118.21**	**100.00%**

THERMAL GENERATION – 80% OF TOTAL GENERATION

UNIT SIZE IN INDIA (IN MW)

AS ON 28.2.2016

Unit Size	Installed before 31.12.2003		Installed after 31.12.2003	
	No of Units	Total Capacity	No of Units	Total Capacity
Upto 250 MW	313	47628	110	19014
From 250-500 MW	27	13500	49	15220
More than 500 MW	0	0	137	80495

Source:CEA

IMPACT ON COAL BASED THERMAL PLANTS

- **200000 MW** installed capacity is to be affected including plants under advanced stage of commissioning
- About **80000** MW of total installed capacity of less than 500 MW

COMMERCIAL IMPACT OF ENVIRONMENT STANDARDS

COMMERCIAL AND REGULATORY ISSUES

- Increase in the capital cost and resultant tariffs.
- Increase in additional O&M and consumable expenditure.
- Increase in APC and net heat rate.
- Additional shutdown period
- Relaxation in Availability Norm during implementation period
- Servicing of additional expenditure over the balance useful life

COMMERCIAL IMPACT

Parameters	De-SOx System	De-Nox System	SPM Control System	Cooling Tower Design (CT)
Cap Cost (Rs Cr/MW)	0.5 – 1.2	0.5 – 0.7	0.13	0.25-0.6
APC (%)	1.1% - 1.25% (increase)	0.3% - 0.4% (increase)	0.05% (increase)	0.5% (increase)
O&M Expenses	Will increase due to Limestone	Will increase due to Ammonia/ Catalyst	Equipment maintenanc e	

Impact on Capital Cost is about 1.15 - 2.50 Crore per MW as per industry estimates (about 45-90 Paise/unit).

Challenges before Regulatory Commissions

- To deal with projects
  - Developed under Section 62 of Act 2003-Cost plus tariff
  - Developed under Section 63 of Act 2003 –Competitively bid projects
- Capax may have to be considered under “Change in Law”
- Deterioration in heat rate and AEC may have to be dealt separately

Challenges before Regulatory Commissions

- Assessment of Capax Requirement
  - Project specific
  - Technology specific
  - May have to be dealt on case to case basis
- Technologies available not proven in Indian conditions and for Indian coal
- Choice of Specific technology – to be justified by the developer
- No data available on deterioration of station heat rate and AEC for the specific technology
- Wide variation in capax requirement from project to project
- How to deal with competitive bid projects

COMMERCIAL IMPACT

- Petitions before CERC seeking capitalization of expenditure and revision of tariff on account of implementation of New Environment norms

  - By MPL for Rs 2065.21 Crore (Rs 1.97 Crore/MW)- For De-Sox and De-Nox
  - By CGPL for its Mundra UMPP Rs. 11021 Crore (Rs. 2.675 Crore/MW)- De-Sox, De-Nox and for conversion to closed cycle coolin

COMMERCIAL IMPACT

Estimated Capital Expenditure for Abstract Schemes proposed as per Amendment Rules 2015 in Petition No 72/MP/2016 (By Maithon Power Ltd for its 1050 MW plant)

Sr. No.	Particulars	UoM	Station			
			Base Cost	Insurance and Transportation Cost	Taxes and Duties	Total Cost
1	Limestone FGD Plant	Rs Crores	760.00	53.20	195.17	1008.37
2	Selective Catalytic Reduction (SCR) System	Rs Crores	540.00	37.80	138.67	716.47
3	Electrical System Modification	Rs Crores	16.00	1.12	4.11	21.23
4	Civil Works for FGD Plant	Rs Crores	65.70	4.60	16.87	87.17
5	Civil Works for SCR System	Rs Crores	34.30	2.40	8.81	45.51
6	Initial Spares (at 4% of Plant & Machinery Cost)	Rs Crores	52.64	3.68	13.52	69.84
Total Capex (excluding IDC)		Rs Crores	1468.64	102.80	377.15	1948.59
7	IDC	Rs Crores	116.62			
Total Capex		Rs Crores	2065.21 (Rs. 1.97 Crore/MW)			

IMPLEMENTATION CHALLENGES

- Requirement of Funds to the extent of 3,50,000 Crores
- Implementation difficulties
  - Lack of space and land availability in case of existing plants
  - 2 years insufficient time period for implementation
    - Implementation to be in phased manner
  - Limited availability of Domestic supplier
  - Contractual issues such as guarantees, price etc in case of plants under constructions
- Impact on tariff ranging from 40 to 90 Paise/kWh as it has to be made pass through in under change in law

Issues to be considered by Govt

- To exempt plants having residual life of 10 years or less after R&M and life extension/ Exempt all plants Commissioned prior to 1.1.2004
- The plants may be exempted to the extent of space constraint
- Plants under construction or advanced stage of commissioning in next 3-4 years should be allowed retrofits after commissioning. New norms for new stations should be made applicable from 1.1.2020.
- Phased implementation in next 5- 10 years
- Specific water consumption norms of 2.5 Cu M/MWh should be increased to 3.0 Cu M/MWh with FGD
- To exempt coastal plants from installing closed cycle cooling system
- Estimated investment requirement (Rs 2 Cr/MW) and resultant impact on tariff being high (45-90 paise/kWh), Central Financial Assistance need to be provided (Part funding).
- Need to enhance domestic capability of equipment supply by way of technology transfer

Thank You

OVERVIEW OF TECHNOLOGY

TECHNOLOGY FOR SOX AND NOX CONTROL

New Environment Standards requires implementation of new technologies at existing thermal power plants:

De-SOX /Flue Gas desulfurization (FGD)

- **WET LIME STONE PROCESS**
- SPRAY DRY SCRUBBER
- SEA WATER SCRUBBING (Coastal Plants)

Preferred Technology

De-NOX

- COMBUSTION CONTROL
- **SELECTRIVE CATALYST REDUCTION (SCR)**
- SELECTRIVE NON CATALYST REDUCTION (NSCR)

TECHNOLOGY FOR SPM, MERCURY REMOVAL AND WATER CONSUMPTION CONTROL

New Environment Standards requires implementation of new technologies at existing thermal power plants:

SPM Control

- MODIFICATION/RENOVATION OF ESP
- ADDITION OF ESP
- UPGRADATION OF CONTROL SYSTEM

Mercury Control

- HIGH OXIDATION CATALYST WITH NH4CL INJECTION

Water Consumption Control

- Change of cooling tower design

ISSUES IN IMPLEMENTION OF DE-SOX TECHNOLOGY

ISSUES IN IMPLEMENTION OF DE-SOX TECHNOLOGY

- **Investment**
  - Industry estimates of DeSOx system will be in the range of Rs. 0.5 to 1.2 Cr./MW.
- **Implementation Period**
  - Retrofitting of DeSOx system in existing plants, after placement of order may take about 2.5 to 3 years time. For stations with more than one unit the time required for implementation will increased as shutdown of whole station is not possible
  - Shut down period required for retrofitting is around 4 to 6 months.
  - Technology not proven for Indian coal
  - **Increase in Aux. Power Consumption (APC)**

ISSUES IN IMPLEMENTION OF DE-SOX TECHNOLOGY

- **Increase in O&M Cost**
  - O&M cost will increase due to additional equipment maintenance and various consumables like Lime stone/lime etc
- **Space Requirement**
  - Space for DeSOx installation may not be available in all the units.
- **Disposal of by-product**
  - The by-product is gypsum. Disposal of by-product will be a challenge due to quality & quantity. By-product may required to be disposed in a dyke for which additional land will be required .

ISSUES IN IMPLEMENTION OF DE-NOX TECHNOLOGY

ISSUES IN IMPLEMENTION OF DE-NOX TECHNOLOGY

- **Investment**
  - **Industry estimates** of De-NOx system (SCR) will be in the range of Rs. 0.5 to 0.70 Cr/MW.
- **Implementation Period**
  - Installation of SCR system in existing plants, after placement of order may take about 2 to 3 years time. For stations with more than one unit the time required for implementation will increased as shutdown whole station is not possible
  - Shut down period required for retrofitting is around 4 to 6 months.
- **Increase in Aux. Power Consumption (APC)**

ISSUES IN IMPLEMENTION OF DE-NOX TECHNOLOGY

- **Increase in O&M Cost**
  - O&M cost will increase due to additional equipment maintenance and various consumables like Lime ammonia which may vary depending on ash content in coal.
- **Space Requirement**
  - Space for DeNOx installation may not be available in all the existing units.
- **Availability of DeNOx technology for high ash Indian coal**
  - The SCR technology not proven and is yet to be established for high ash & high abrasive Indian coal

ISSUES IN IMPLEMENTION OF SPM CONTROL TECHNOLOGY

ISSUES IN IMPLEMENTION OF SPM CONTROL SYSTEM

- **Investment**
  - Industry estimates of SPM control system will be in the range of Rs. 0.13 Cr/MW.
- **Implementation Period**
  - Installation of augmentation of ESP in existing plants, after placement of order may take about 30-36 months.
  - Shut down period required for one unit retrofitting is around 45 days (2 months).
- **Increase in Aux. Power Consumption (APC) –** Industry estimates is about 0.05%.
- **Increase in O&M Cost**
  - O&M cost will increase due to additional equipment maintenance.

ISSUES IN IMPLEMENTION OF WATER CONSUMPTION CONTROL SYSTEM

ISSUES IN IMPLEMENTION OF CONTROLLING WATER CONSUMPTION

- **Investment**
  - Industry estimates for installation of close cycle cooling tower will be about Rs. 0.25 to 0.6 Cr/MW.
- **Implementation Period**
  - Total time for implementation to convert cooling tower system in one unit is around 30 month based on the technology.
  - Shut down period required for conversion is 3 to 6 months.
- **Increase in Aux. Power Consumption (APC) –** Industry estimates is about 0.5%.
- **Increase in O&M Cost**
  - O&M cost will increase due to additional equipment maintenance.

ISSUES IN IMPLEMENTION OF WATER CONSUMPTION CONTROL SYSTEM

- **Increase in Water Requirement**
  - Make up water requirement will increase due to increase in evaporation loss.

- **Additional Space Requirement**
  - Large space will be required for installation of cooling towers.

IMPLEMENTION OF MERCURY CONTROL SYSTEM

IMPLEMENTION OF MERCURY CONTROL SYSTEM

❖ This may be integrated with part of De-Sox technology

Form of vapor phase mercury (Speciation)

Elemental Mercury - Hg^0

Oxidized Mercury - Hg^{++}

The form of mercury in the flue gas is critical to performance of emissions control systems.

- **Elemental Mercury: Hard to remove from flue gas**
- **Oxidized Mercury: Easier to remove from flue gas (downstream ESP, FGD)**

BASIC PRINCIPLE - FGD

FGD process typically involve SOx scrubbing with a alkali solid or solution

$CaCO_3 + SO_2 \rightarrow CaSO_3 + H_2O$

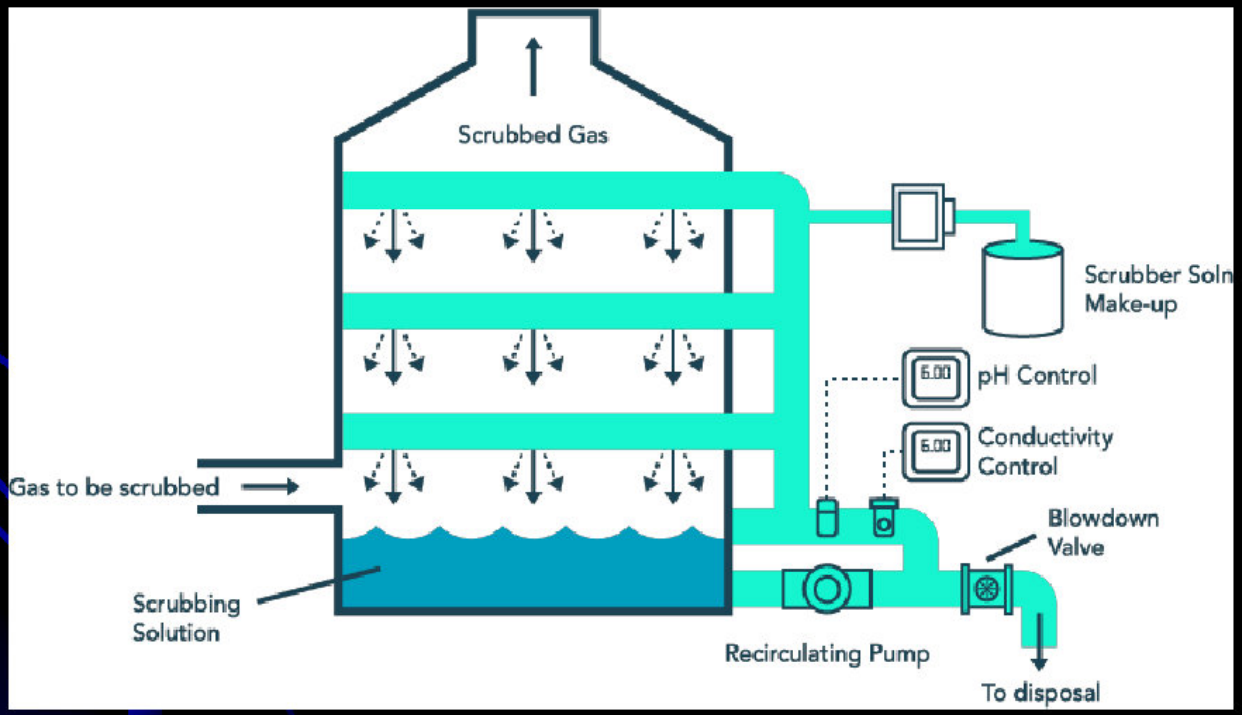
$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$

$Mg(OH)_2 + SO_2 \rightarrow MgSO_3 + H_2O$

$2NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$

A natural alkaline usable to absorb SO_2 is seawater.

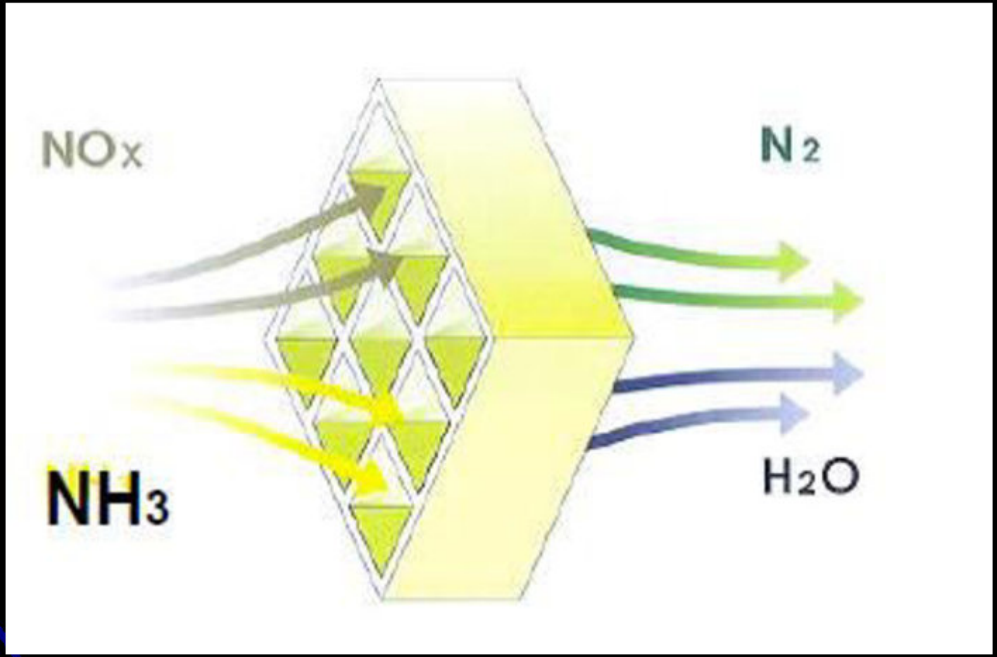
Generally Calcium based alkali are used in the form of lime or limestone.
Seawater is also used wherever feasible in coastal regions.



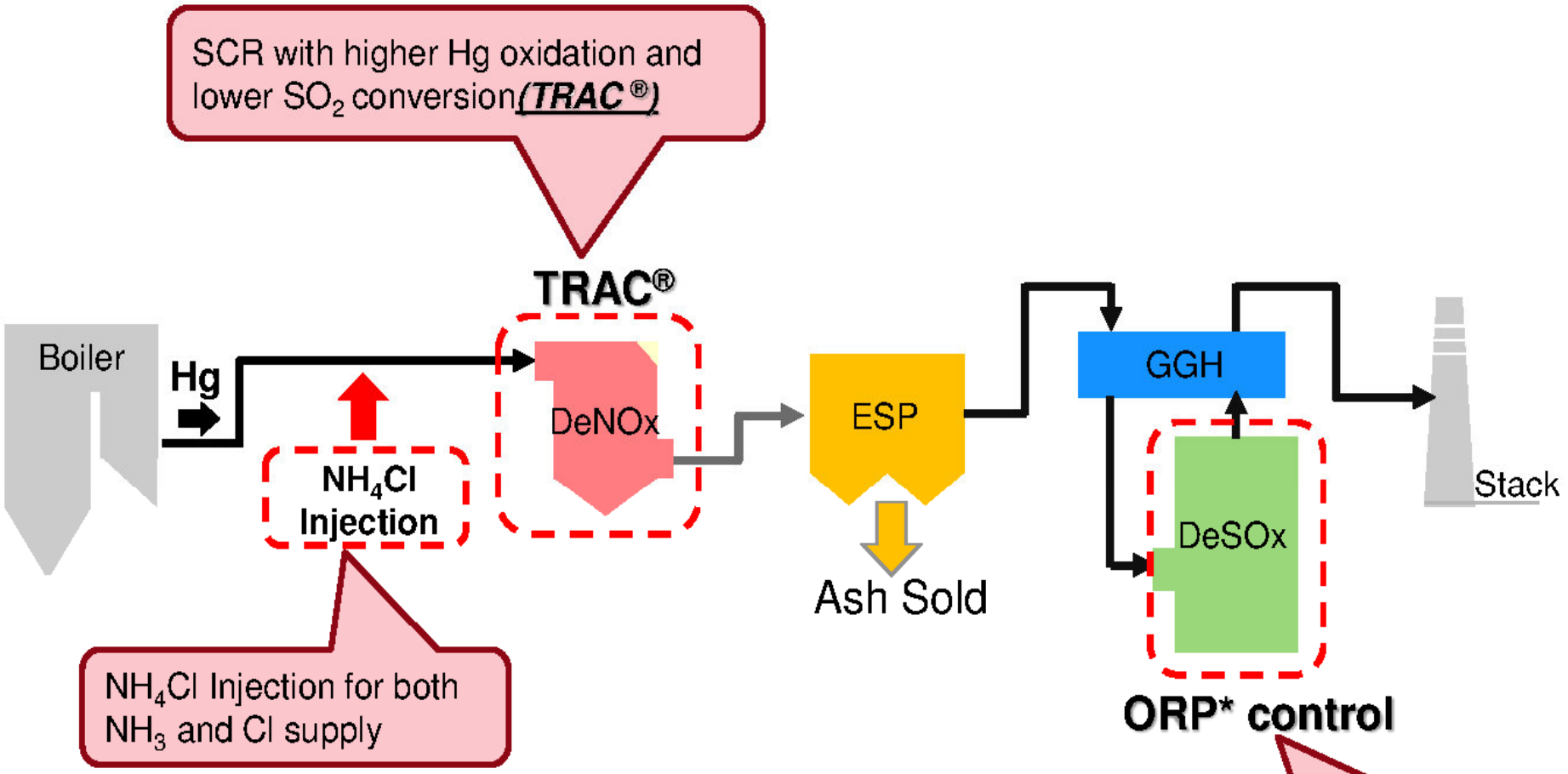
BASIC PRINCIPLE-DeNOx

DE-NOx process typically involve reaction of NOx with ammonia

$$4\,NO + 4\,NH_3 + O_2 \rightarrow 4\,N_2 + 6\,H_2O$$
$$2\,NO_2 + 4\,NH_3 + O_2 \rightarrow 3\,N_2 + 6\,H_2O$$



Mercury Removal Technology
~ Hg removal in TRAC® with NH_4Cl Injection~



***ORP: Oxidation-Reduction Potential**