Meeting New Environment Norms

- Challenges and Possibilities

Presented by:
A.K.Sinha
General Manager
NTPC Limited
email: aksinha01@ntpc.co.in

Old v/s New Environment Norms

	OLD NORMS	NEW NORMS (mg/Nm^3)				
		Installed before 31.12.2003		Installed after 01.01.2003 & upto 31.12.2016		To be installed from 01.01.2017
Unit Size	All	< 500 MW	≥ 500 MW	< 500 MW	≥ 500 MW	All
SO_2	Dispersion through Chimney	600	200	600	200	100
NOx	No Standard	600		300		100
SPM	100	100		50		30
Mercury	No Standard	x	0.03	0.03		0.03

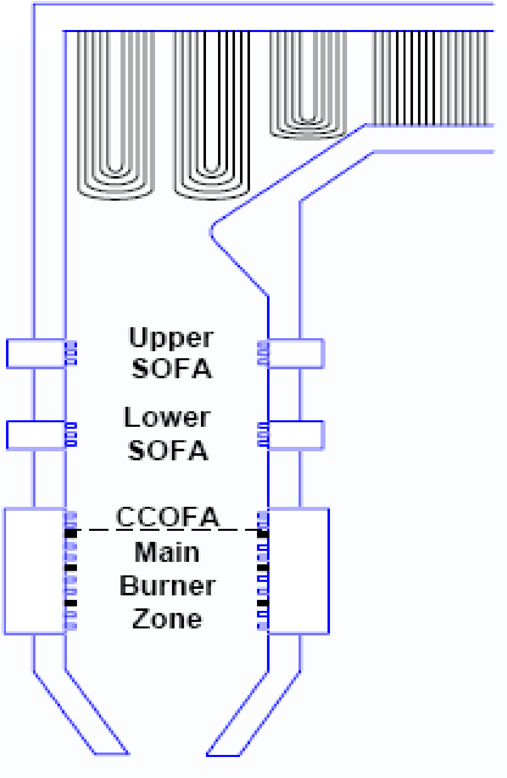
Available Technology Options for Emission Control

DeNOx Technologies

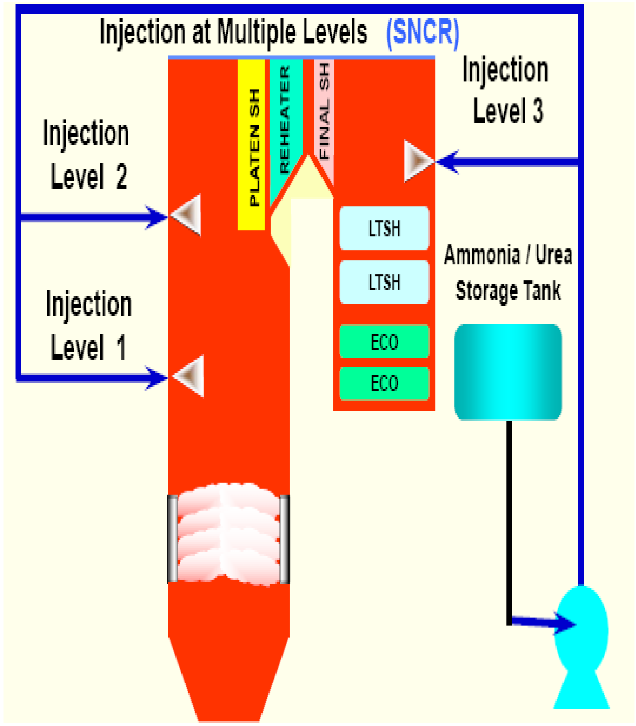
Available Technology	In Combustion	Post Combustion	
	Combustion Modification	Selective Non Catalytic eRduction (SNCR)	Selective Catalytic Reduction (SCR)
Variants & measures to control NOx	Low NOx Burner, Windbox modification, Various type of over fire air	**Reagent:** Anhydrous/Aqueous Ammonia OR Urea	**Catalyst type:** Plate/ Honeycomb **Reagent:** Anhydrous/ Aqueous Ammonia or Urea
Reduction Efficiency	20 – 60 %	25-40 %	90 % & Above
Installation Cost	Low	Moderate	High
Operational Cost	None	High (manly reagent cost)	High (Aux power, reagent cost & catalyst replacement)
Process of NOx reduction	Staging of combustion air	***Using NH_3*** $4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$ ***Using Urea*** $4NO + 2CO(NH_2)_2 + O_2 \rightarrow 4N_2 + 4H_2O + 2CO_2$	$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$ $2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$
Temperature required	NA	870° to 1100°C	300° to 400°C

DeNOx Technologies

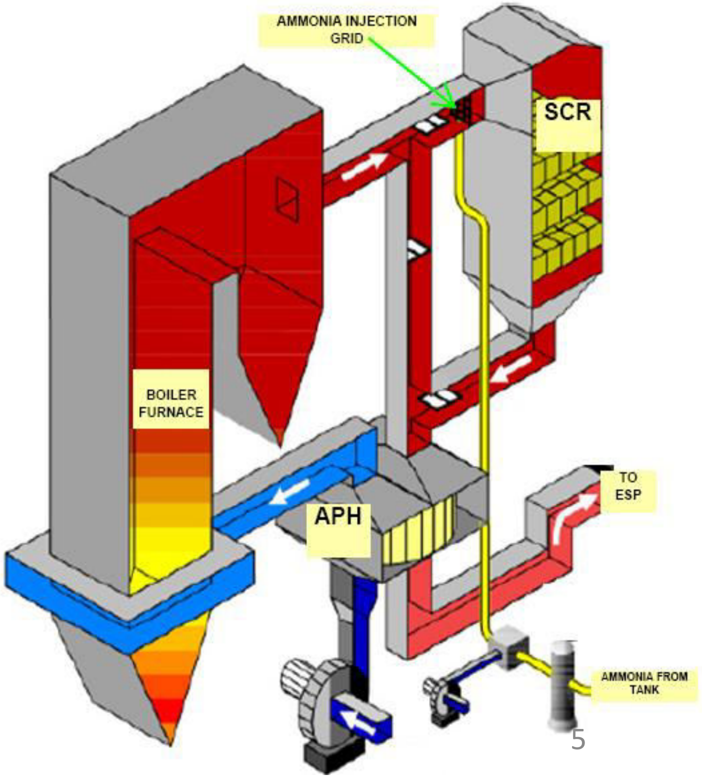
Combustion Modification



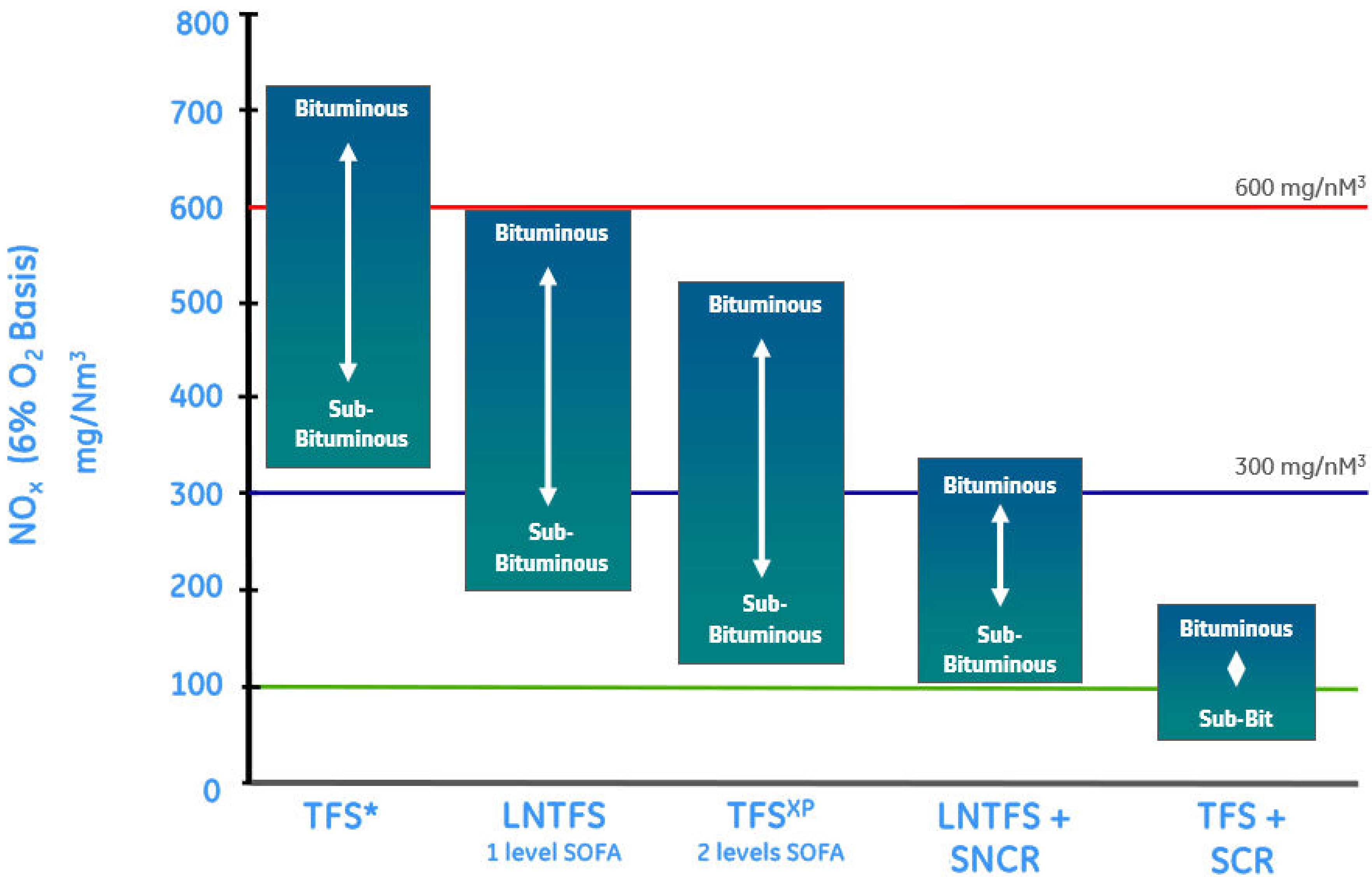
Selective Non-Catalytic Reduction (SNCR)



Selective Catalytic Reduction (SCR)

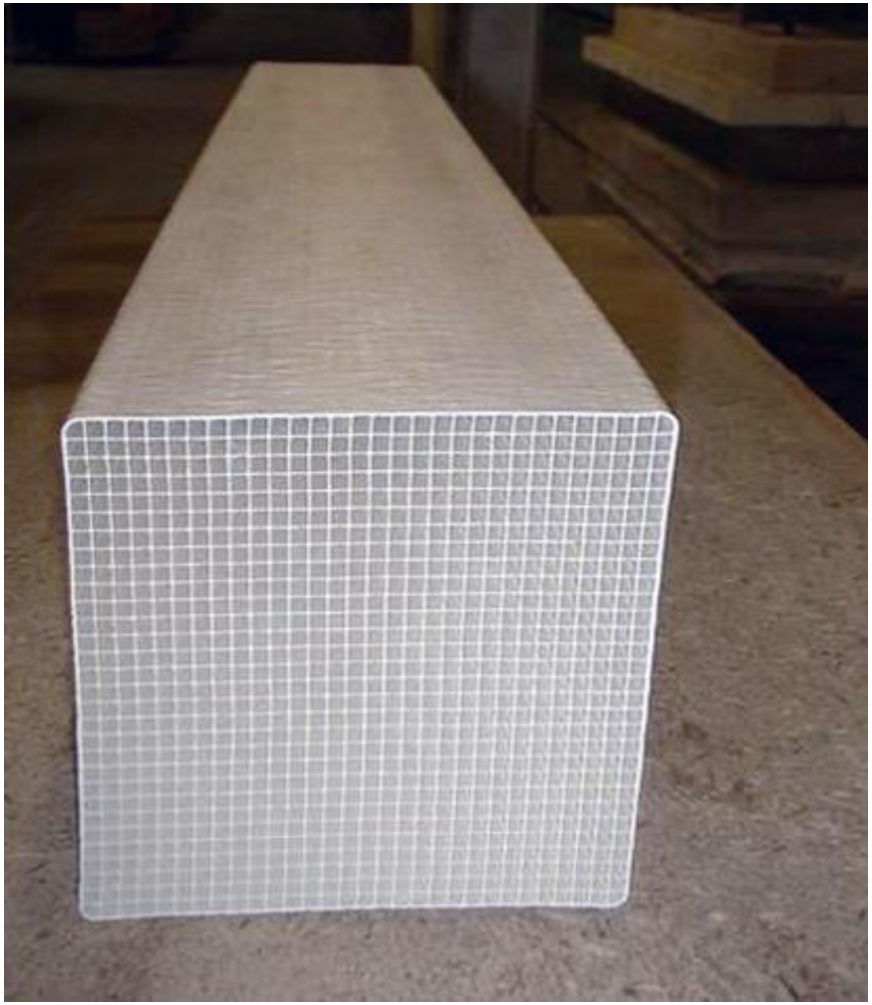


Performance of DeNOx Technologies



Catalyst Type

Plate Type Catalyst



Honeycomb catalyst

Ash Accumulation over SCR Catalyst

- a major challenge in O&M

SCR Catalyst Deactivation

- **Poisoning** by chemical attack (Arsenic, Phosphorus, Heavy Metals)
- **Masking** of catalyst surface by ash
- **Plugging** of catalyst surface pores by fine ash particles
- **Sintering** causing alteration of catalyst pore structure (due to exposure to high temperatures beyond 450^{O}C

SCR Catalyst Erosion

- **High ash**
- **Erosive Content of Ash** (Silica + Alumina, typically > 85% for Indian coal ash)
- **Ash particle size and shape**
- **Plugging susceptibility of catalyst**

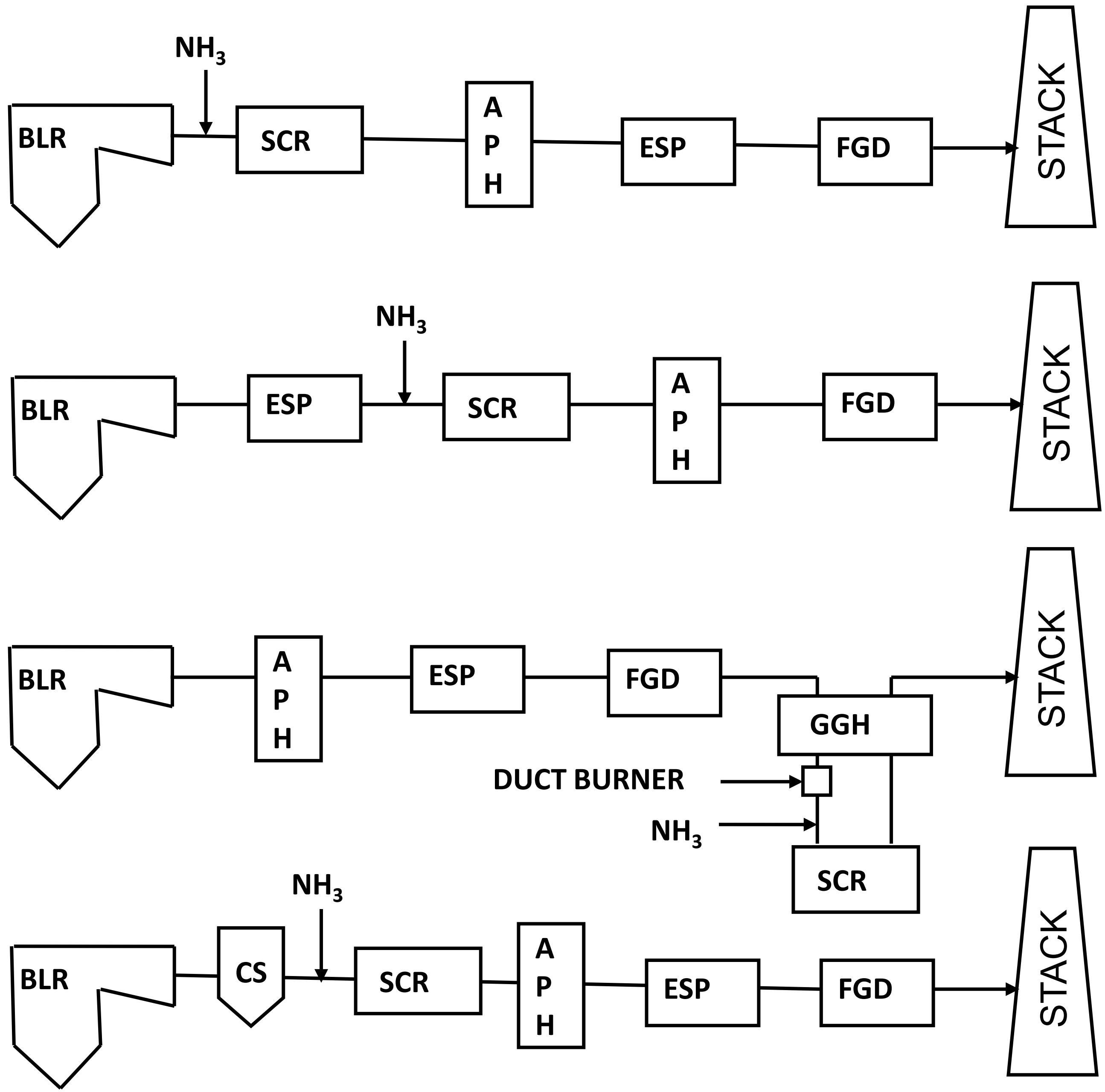
Possible SCR Configuration to deal with high ash

High Dust SCR

Low Dust SCR, Hot ESP

Lowest Dust, Cold End SCR

Low Dust SCR



DeNOx Technologies

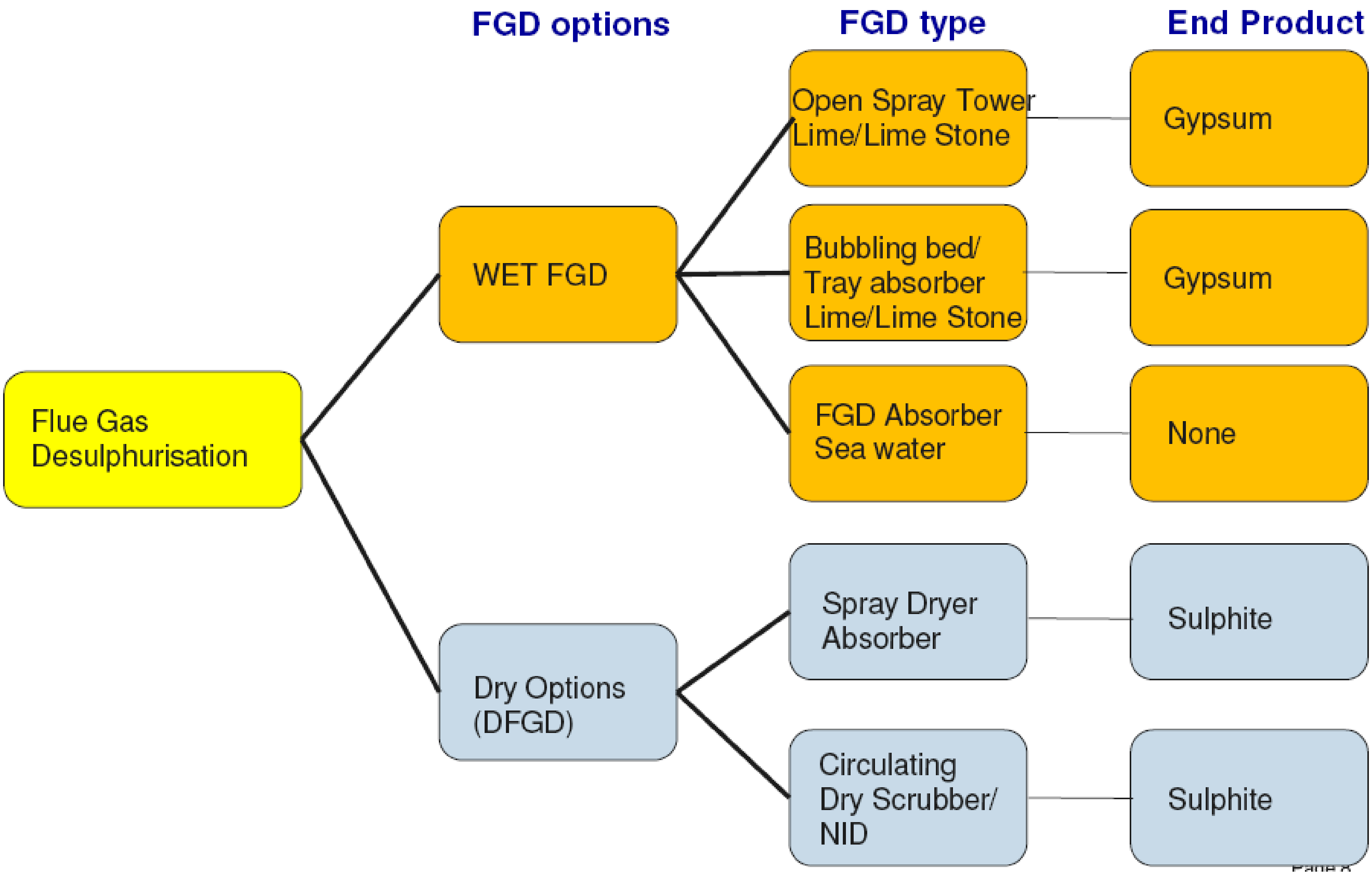
Challenges

- DeNOx technology is yet to be established for high and erosive ash coals
- Technology proven only upto dust load of 30-40 gm/Nm^3 against our requirement of 80-90 gm/Nm^3
- SCR catalyst is and extremely fast moving highly expensive item (life expectancy 1.5 - 2 yrs)
- Very limited SCR catalyst suppliers worldwide, none in India

Way Forward

- A cautious approach needs to be adopted rather than embarking upon hurriedly
- Pilot slip stream tests with India coals will provide quick learning opportunity both to the manufacturers as well as the plant operators
- Cyclone dust separators upstream of SCR could be a good approach to start with
- Rapid indigenization of catalyst manufacturing a must for long term sustenance

DeSOx Technologies



DeSOx Technologies

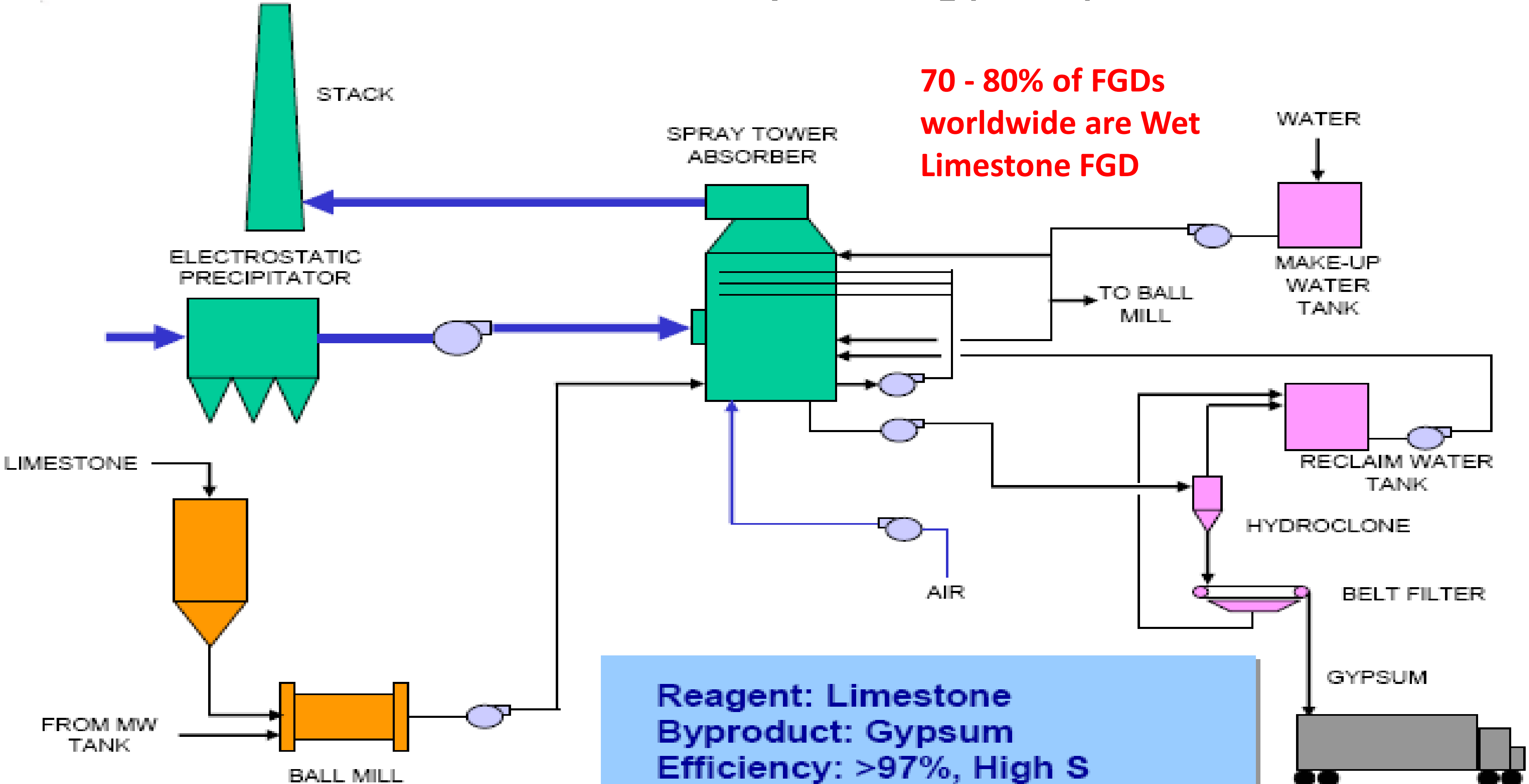
Parameters	WET Limestone FGD	DRY FGD (SDA/CDS/NID)
Commercially Available Range	~ 1,100 MWe	~ 300-400 MWe single absorber.. For NID each module of 75 MWe
SO2 removal efficiency	Upto 99 %	up to 99 % (90-95 % for SDA)
Installation Cost (ZLD & Chimney lining cost incl.)	High	Low
Operating Cost	Moderate	High
Sorbent	CaCO3 (limestone)	CaO / Ca(OH)2
Sorbent costs (Rs/ton)	~ 2000	~ 6000
Water consumption	1.0 with GGH 1.4without GGH	0.7
Auxiliary Power Consumption	High with GGH Moderate without GGH	Moderate
Flue gas temperature at FGD outlet	Saturation temperature 50 – 60 °C (Without GGH)	75 – 85 °C
SO3 removal	< 40 %	> 98 %
Condition of existing stack	Existing stack to be modified in all cases	Existing stack can be used without modification

DeSOx Technologies

Parameter	WET Limestone FGD	DRY FGD (SDA/CDS/NID)
FGD by-product disposal	Gypsum is produced which is saleable when limestone purity is > 90%. & emission from ESP < 50 mg/Nm3	Product for disposal (CaSO3/CaSO4). Space required for disposal
Waste water	Waste water generated which needs to be treated for Zero liquid discharge (ZLD)	Waste water free system and can also utilise waste water from other sources.
Erection period	~ 30 Months	~ 24 Months

DeSOx Technologies

Wet Limestone Slurry Scrubbing (WFGD)



70 - 80% of FGDs worldwide are Wet Limestone FGD

Reagent: Limestone
Byproduct: Gypsum
Efficiency: >97%, High S

- Primary reactions (absorption/neutralization)

$SO_2(g) + H_2O(l) \longrightarrow H_2SO_3(l)$

$CaCO_3(s) + H_2SO_3(l) \longrightarrow CaSO_3 + CO_2(g) + H_2O\ (l)$

- Secondary reactions (forced oxidation/crystallization)

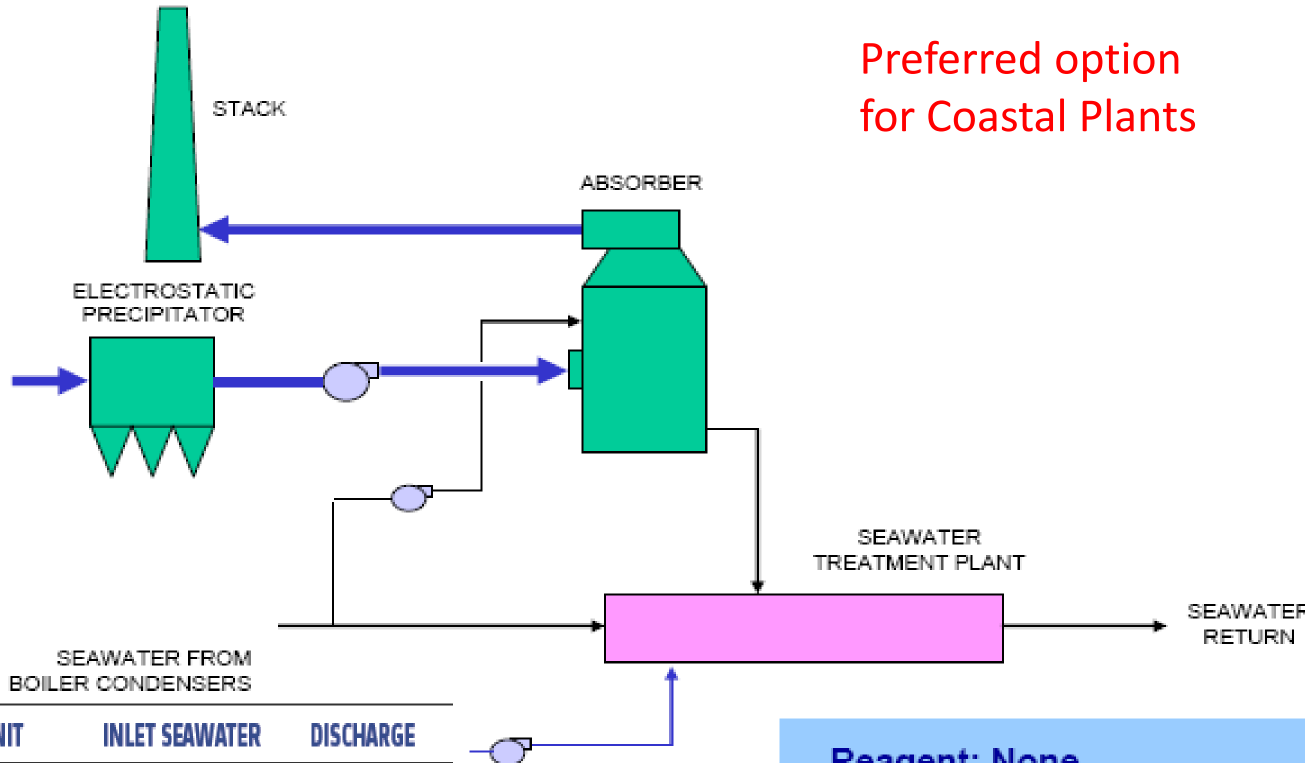
$CaSO_3 + \frac{1}{2}O_2 \longrightarrow CaSO_4(s)$

$CaSO_4 + 2H_2O \longrightarrow CaSO_4 \cdot 2H_2O(s)$

DeSOx Technologies

Sea Water FGD

Preferred option
for Coastal Plants

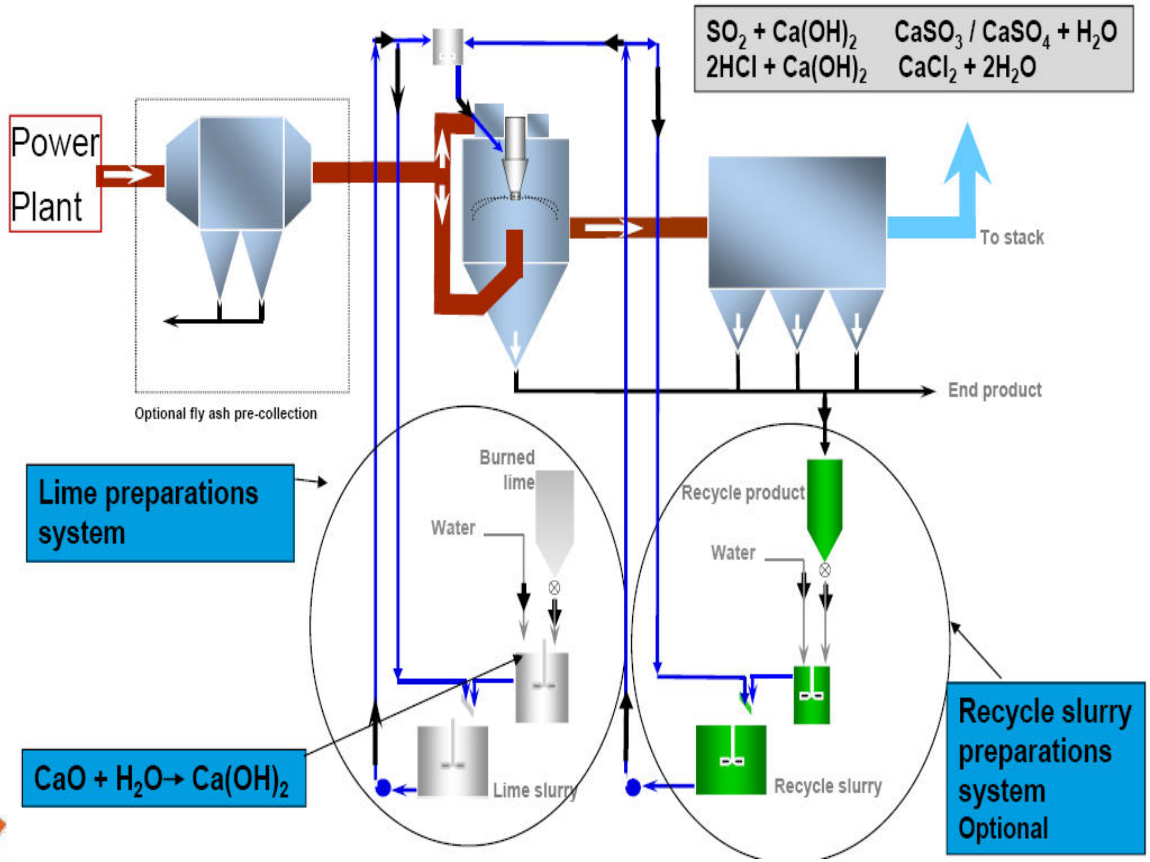


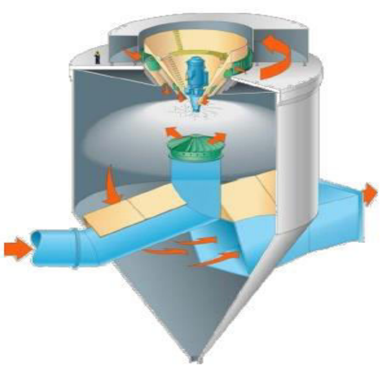
	UNIT	INLET SEAWATER	DISCHARGE
WATER QUALITY REQUIREMENTS			
pH		7 – 8	6 ~ 7
Sulfate	mg/l	2,700	2,785
Temperature	°C	T	T+1.5~2
Salinity	‰	33.5	33.5
Suspended solids	mg/l	SS	< (SS+1.0)
OXYGEN BALANCE CONTROLLED			
COD	MgO_2/l	0	< 2.5 – 5.0
DO	%	50 – 100	70 – 90

Reagent: None
Byproduct: None
Efficiency: >95%, Low/Med. S

DeSOx Technologies

Spray Dryer Absorber (SDA)





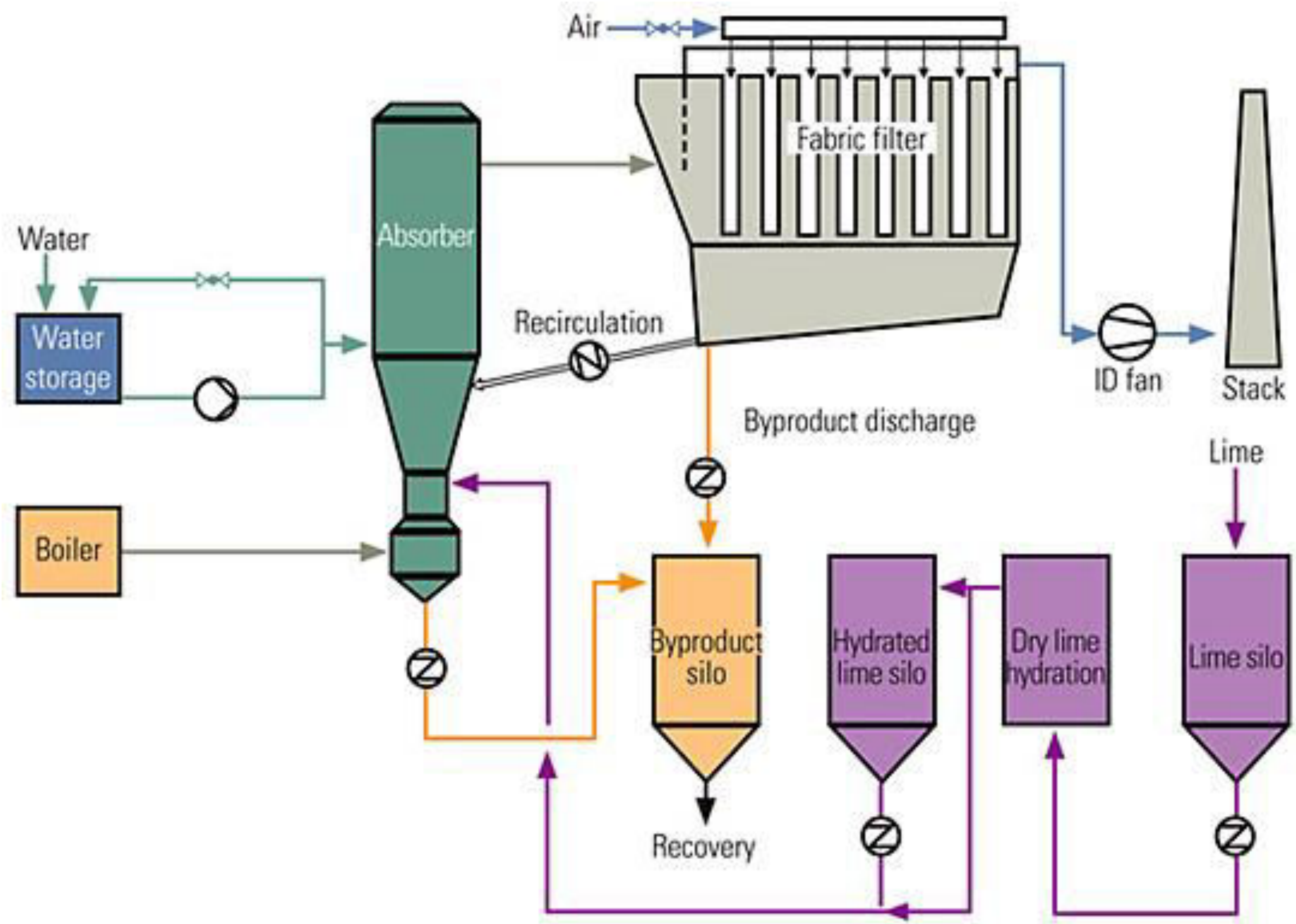
$SO2 + CaO + 1/2\ H2O \Rightarrow CaSO3 \bullet 1/2\ H2O$

$CaSO3 + ½O2 + 2H2O \Rightarrow CaSO4 \bullet 2H2O$

SDA is the second most popular FGD technology after Wet Limestone FGD

DeSOx Technologies

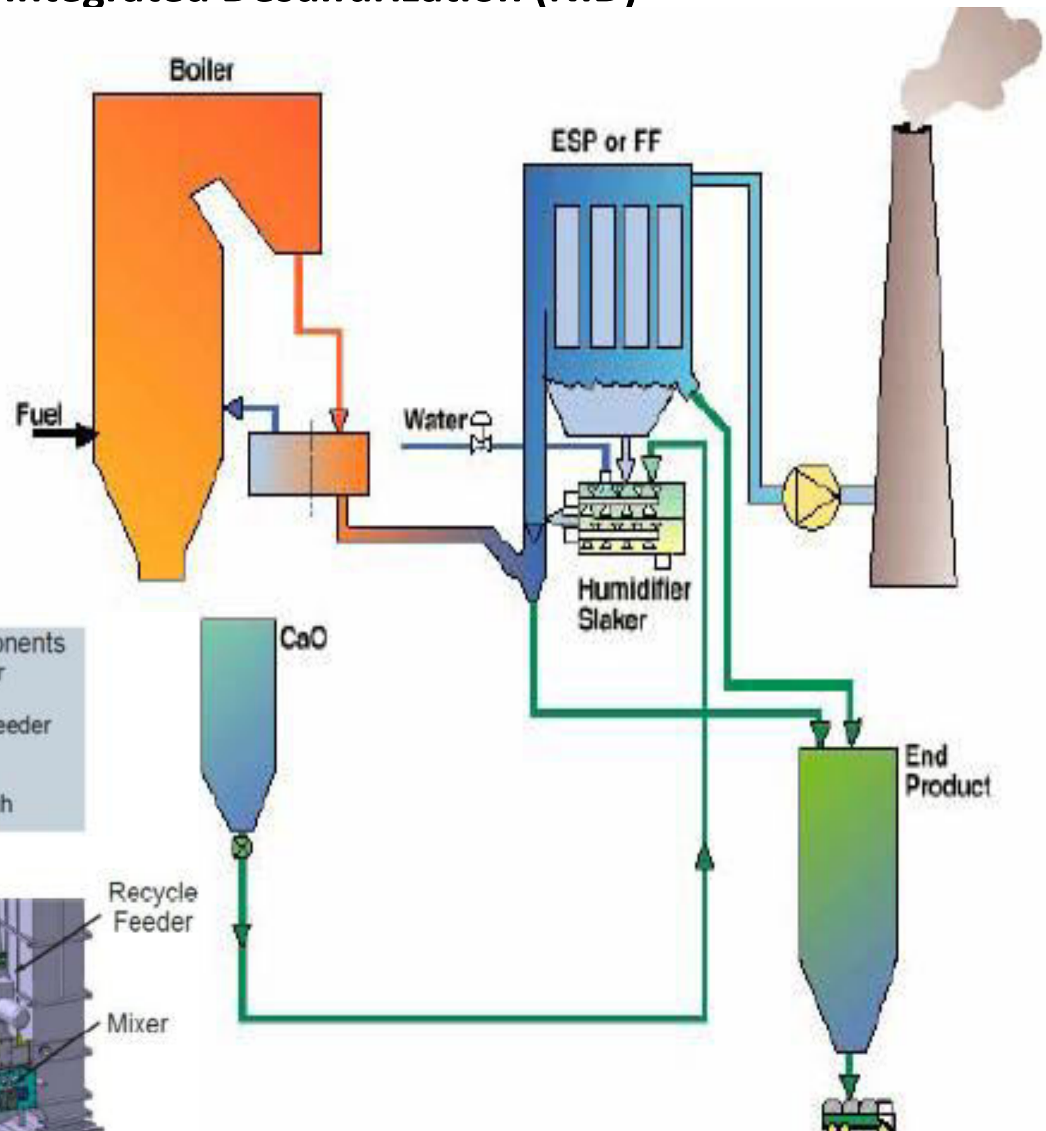
Circulating Dry Scrubber

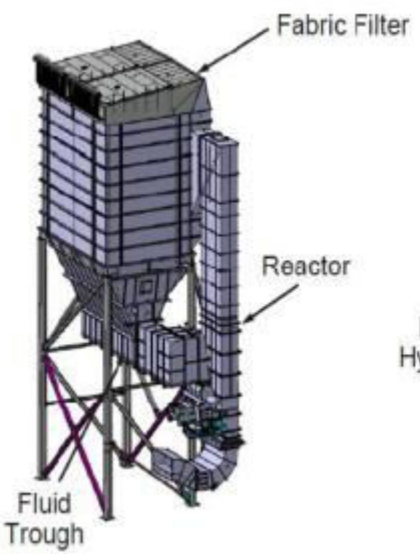


DeSOx Technologies

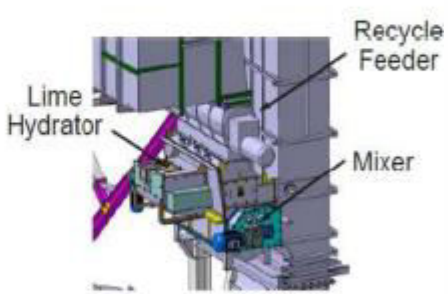
Novel Integrated Desulfurization (NID)

- Very high recirculation
- No slurry handling
- Direct usage of CaO
- "Dry" product
- High utilization of reagent



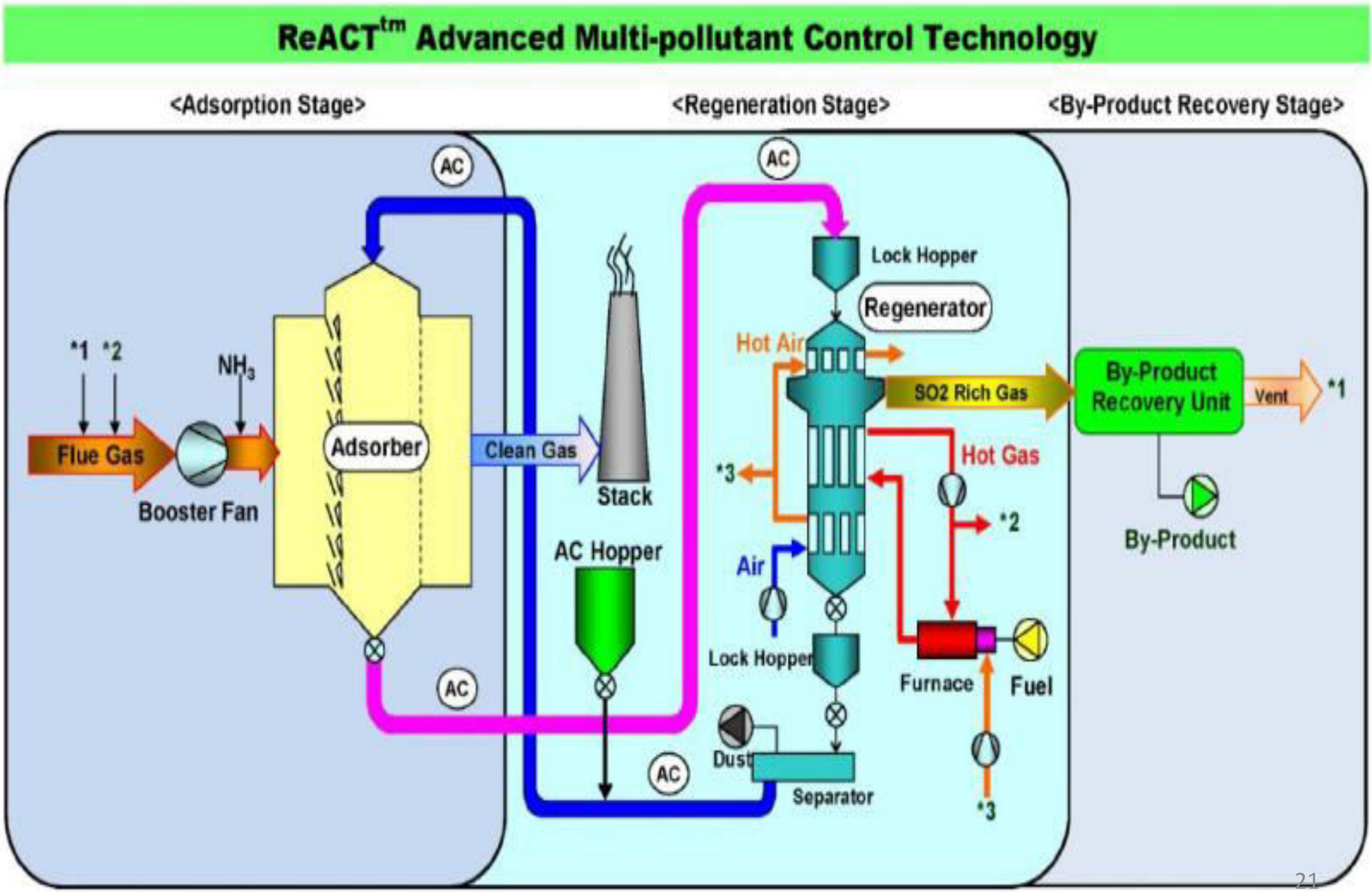


Key Components
- Fabric filter
- Reactor
- Recycle Feeder
- Mixer
- Hydrator
- Fluid trough



DeSOx Technologies

Regenerative Activated Coke Technology (ReACT)



Limestone Factsheet

- Production of limestone in India was 278.7 million tonnes during 2013-14
- There were 23 public and 694 private sector mines during 2013-14
- The share in production of public sector mines was 4.2% in 2013-14.
- Cement companies account for 50% of limestone production and mostly have their own captive mines.
- Majority of limestone is of 80%-85% purity which will produce gypsum for cement or fertiliser consumption. Current Gypsum rates vary between 700-1200 per Ton.
- High quality limestone mostly available in Rajasthan
- *Limestone mines are distributed almost all over India.*

DeSOx Technologies

Challenges

- Wet DeSOx technologies are relatively more matured yet new to majority of Indian operators
- Wet limestone based FGD, although a preferred option, has large consumptive water requirement associated with extremely polluted blow down which must be taken care through an expensive ZLD system
- Lime stone supply and gypsum off take chain needs to be evolved quickly
- FGD retrofit may not be possible in many of the older stations

Way Forward

- No major issues in adoption in new units

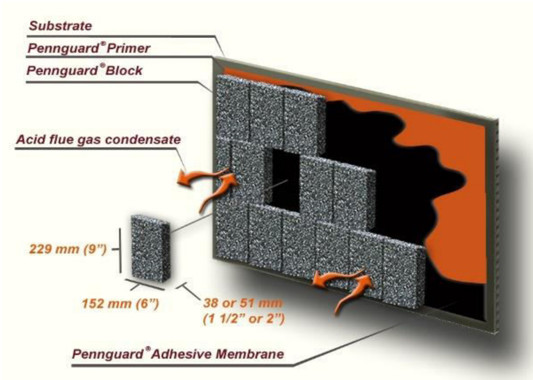
Chimney Material for Retrofit Cases

ITEM	BOROSILICATE GLASS BLOCKS	GLASS FLAKE REINFORCED VINYL ESTER COATING
THICKNESS	51 MM	1.5 MM
SERVICE TEMPERATURE	UPTO 199 DEG C CONTONUOUS	UPTO 140 DEG C CONTINUOUS
DESIGN LIFE	30 YEARS	8-10 YEARS
GUARANTEE LIFE	10 YEARS	3-4 YEARS
COST	VERY HIGH	LOW
SUPPLIERS	HADEK, NETHERLANDS ECOCERA, KOREA	AKZONOBEL, JOTUN, DENSO, CORROCOAT, HEMPEL, STEULLER
APPLICATOR	LOCAL APPLICATOR TRAINED BY SUPPLIER	AUTHORIZED APPLICATORS
EXECUTION TIME	2-3 MONTHS	2-3 MONTHS

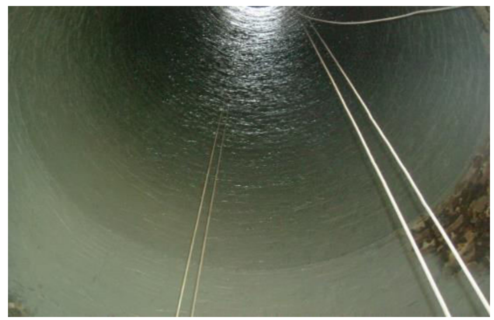
Chimney Material for New Builds

ITEM	FRP FLUE LINER	Titanium Clad Sheet
THICKNESS	25MM	1.2 MM Ti+ 10 MM MS
SERVICE TEMPERATURE	UPTO 150 DEG C CONTONUOUS	UPTO 900 DEG C CONTONUOUS
DESIGN LIFE	30 YEARS	20 YEARS
GUARANTEE LIFE	3 YEARS	-
COST	LOW	HIGH
SUPPLIERS	PLASTICON, DENMARK FIBROGRATS, INDORE	CHINESE SUPPLIERS
APPLICATOR	AUTHORIZED APPLICATORS	FABRICATION IS COMPLEX. DATA NOT AVAILABLE
EXECUTION TIME	6-8 MONTHS	6-* MONTHS

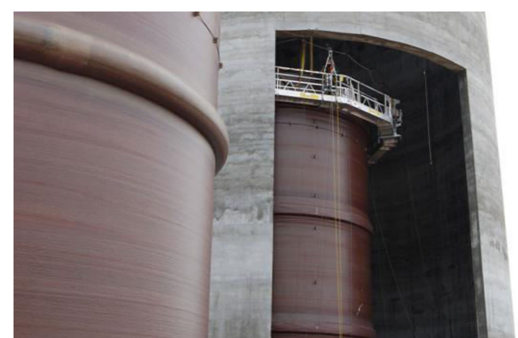
Borosilicate Glass



Flake Glass Coating



FRP Flue Liner



Mercury Emission Control

- Globally, there is no mature / commercially available technology for mercury emission control
- Fortunately, India coals have relatively lower mercury content (0.5 ppm)
- The other emission control measures like FGD and ESP by default capture a significant portion of mercury

Closed Cycle Cooling - Implications

Inland Project Retrofits

- Higher consumptive water requirement due to higher evaporation losses
- Reduced power generation efficiency due to higher cooling water temperature by around 2%.
- Serious layout constraints within acquired land limits

Coastal Projects

- Coastal projects are endowed with abundance of saline sea water and should be permitted to employ open cycle cooling for better efficiency (lower emissions)
- Sea water FGD is the least cost option for deSOx which will be completely ruled out if open cycle cooling is not permitted

Reduced Water Consumption
(2.5m^3/Hr/MW)

- Typically 2.1m^3/Hr/MW of water is lost in closed cycle cooling from the cooling towers
- Limestone based wet FGD consumes about 0.25 m^3/Hr/MW of water
- In addition, there are evaporation and seepage losses from bottom ash dyke
- Hardly any water left for other consumptive needs
  - DM water consumption
  - Potable water
  - Fugitive coal and ash dust suppression
  - Green belt and plant horticulture

Conclusion

- Promulgation of new environment norms by MoEF is a commendable move
- The emission norms are comparable with the best in the world
- However, in order to make implementation of the norms more practicable and better feasible, it is suggested that
  - Older units which have already lived half their life or more may be exempted from retrofits due to various technical constraints
  - Emission control technologies are still in developmental stage, especially for Indian coals, at least 5 – 7 years should be allowed for compliance
- NTPC is committed to implement all of the stipulations in the units ordered after issuance of the new norms (07.12.2015).

Thank You

Any questions?