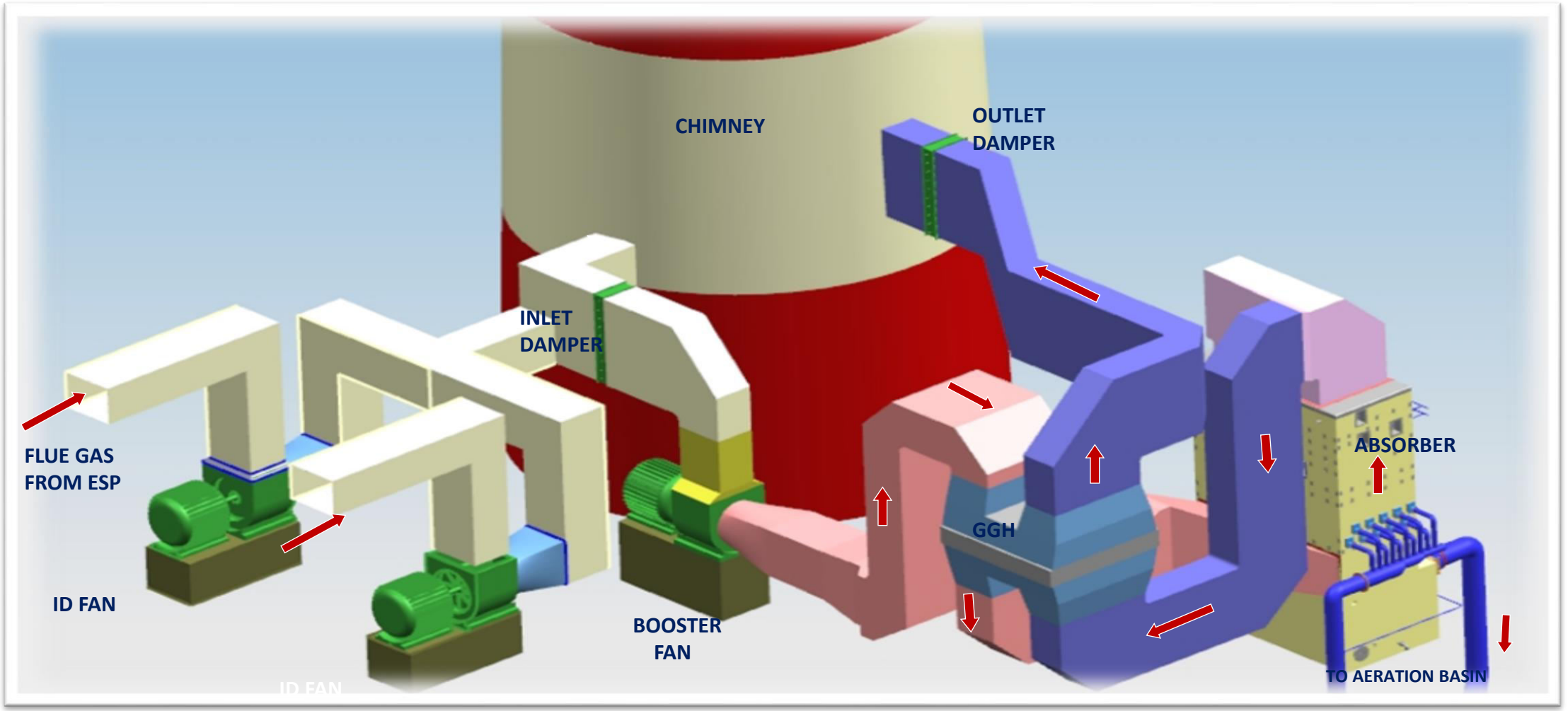
Cost Implication

FGD	Limestone Gypsum	Sea Water
By product	Gypsum	Used sea water
Use of by product	Saleable product	Disposed in to sea
Capital cost	High	Low
O&M cost	Medium	Low

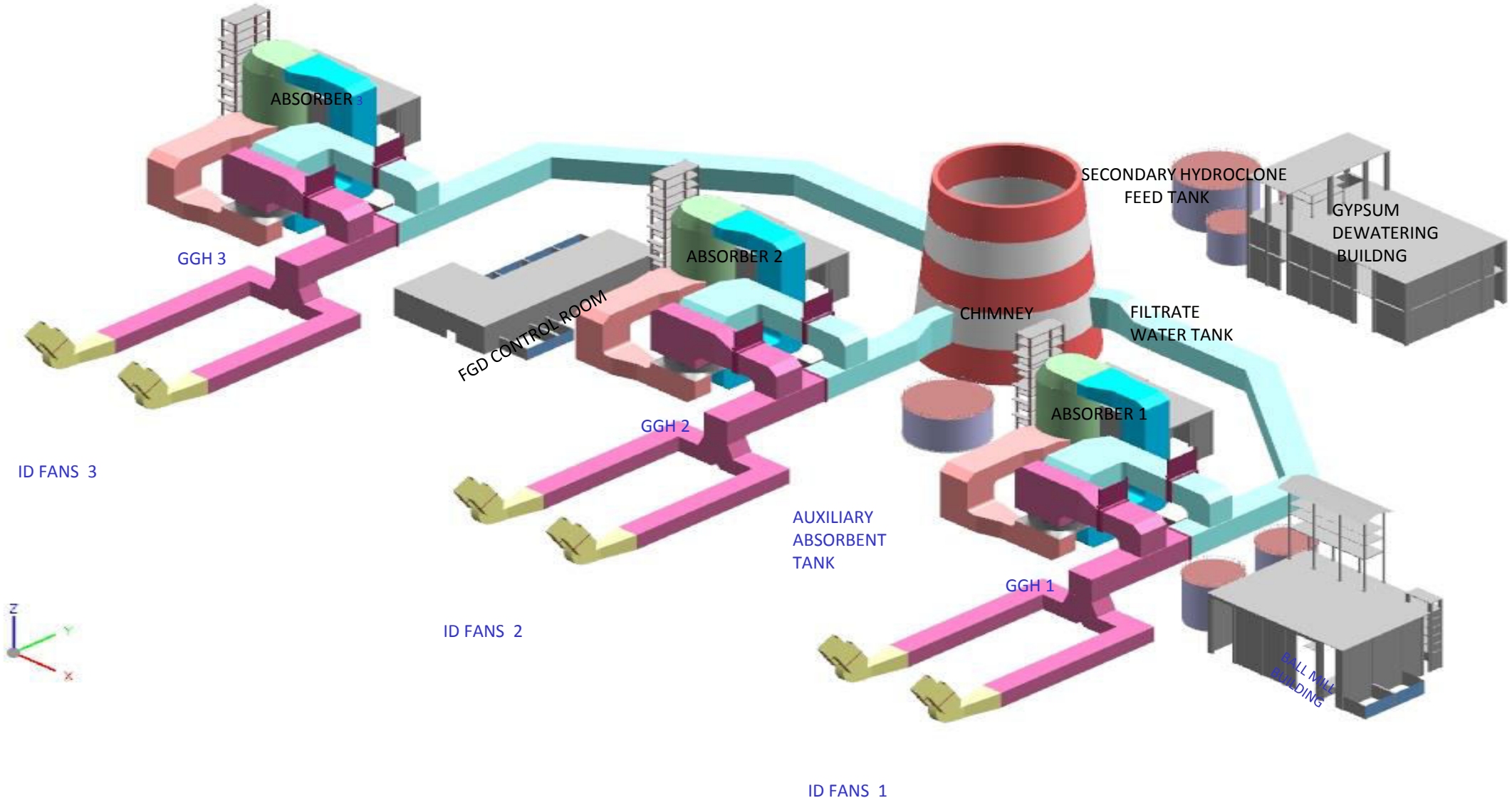
BHEL readiness to meet the current requirement

- BHEL is having a dedicated engineering group for FGD
- BHEL has successfully commissioned sea water based FGD at Trombay unit#8 250 MW of MHI Technology
- BHEL has supplied Wet Limestone based FGD to NTPC Bongaigaon 3X250MW of Ducon Technology.

Layout of Trombay FGD



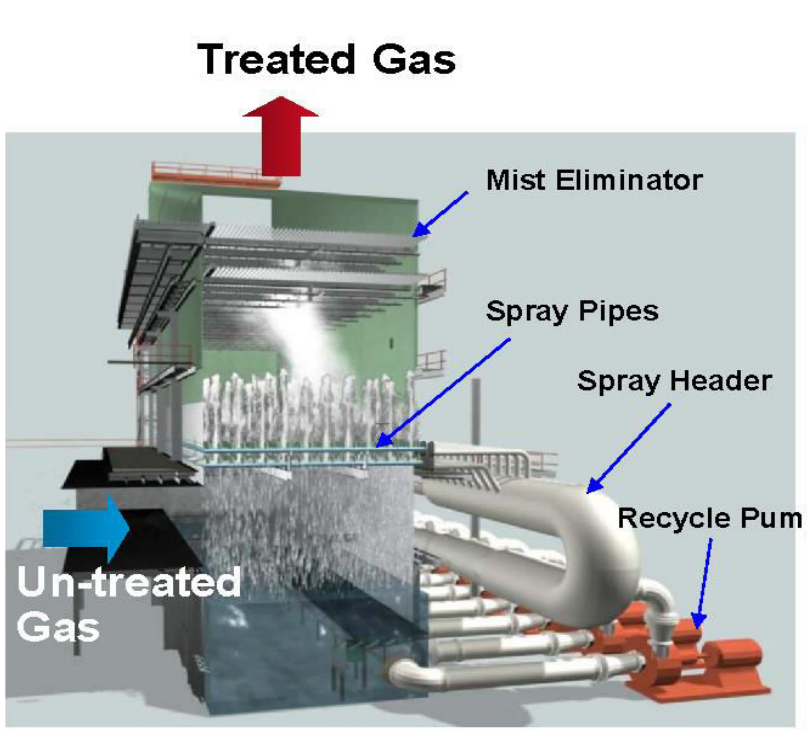
Layout of Bongaigaon FGD



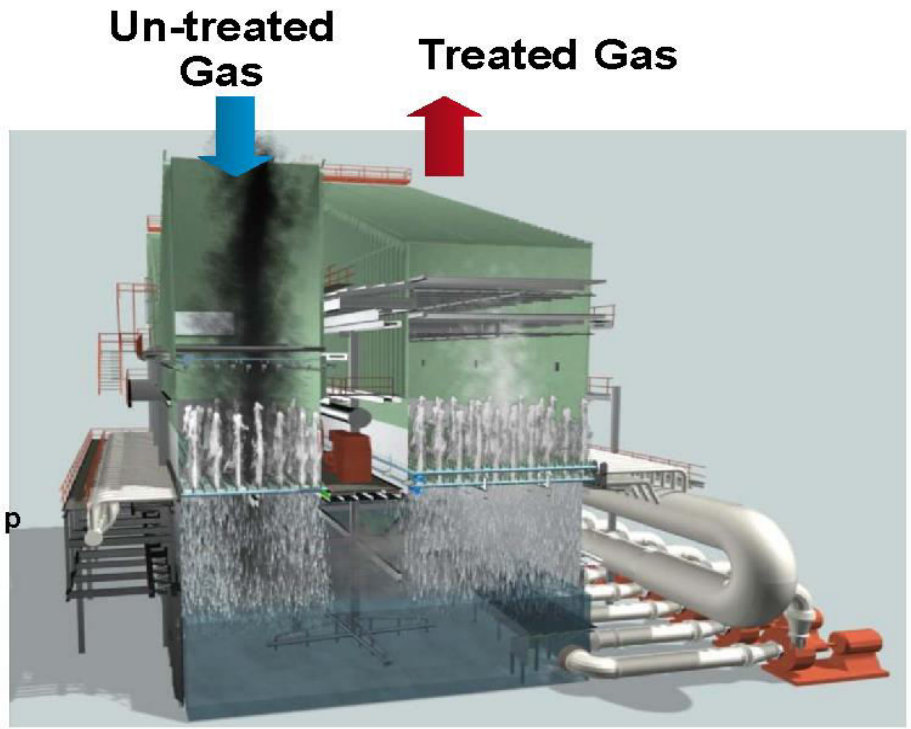
Technology Tie-up with MHPS

- BHEL has signed a TCA with M/s MHPS for Wet FGD technology in April 2013 and it is valid up to 2028.
- MHPS trained BHEL Engineers in Wet FGD technology (Limestone / Sea water).
- BHEL and MHPS jointly designed the Wet Limestone FGD system for NTPC Vindhyachal 1x500 MW Project and offered.
- BHEL designed Wet Limestone FGD by its own and NOA received for Maitree 2X660 MW project at Bangladesh

DCFS Type Absorber



Single Tower DCFS

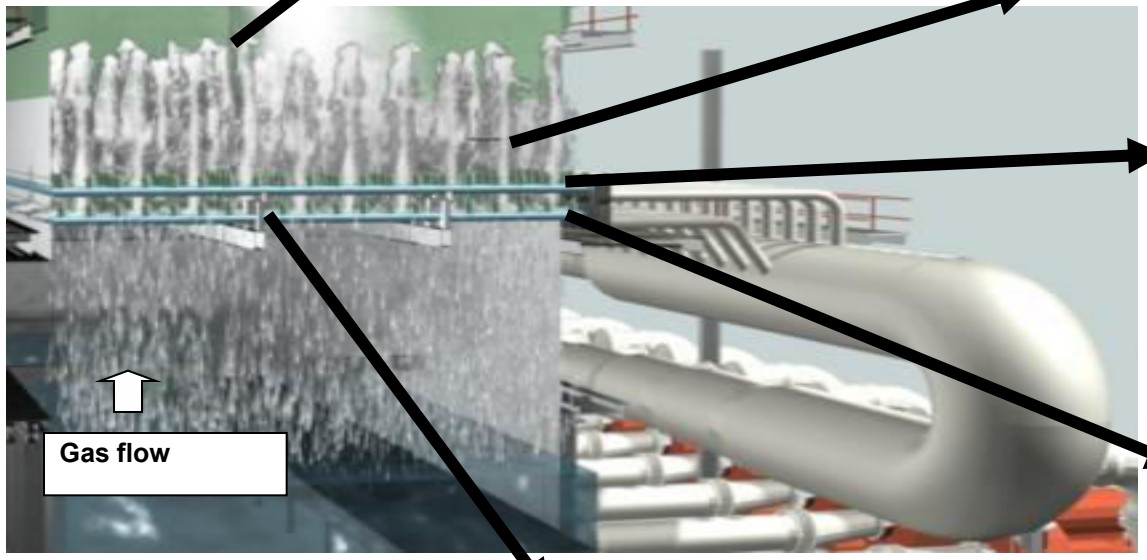


Twin Tower DCFS

Features of DCFS

Highly Densed Liquid Droplets (Enfoldment of Gas by the High Densed Liquid Droplets)

Double-Contact Liquid Columns (Rising Up / Falling Down)

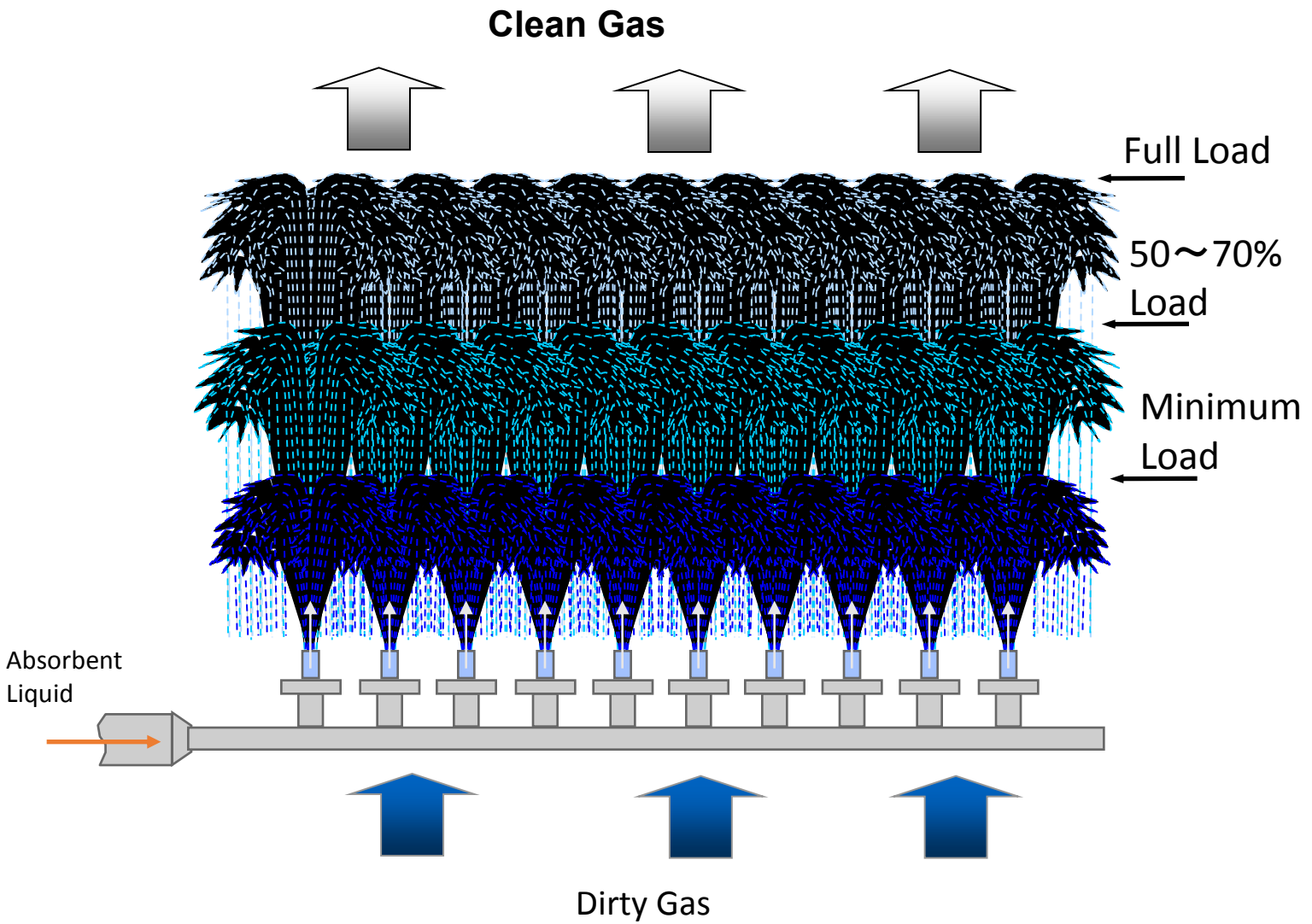


Low-pressure Nozzles

Single Stage Nozzles

Self Washing (Upper Nozzle)

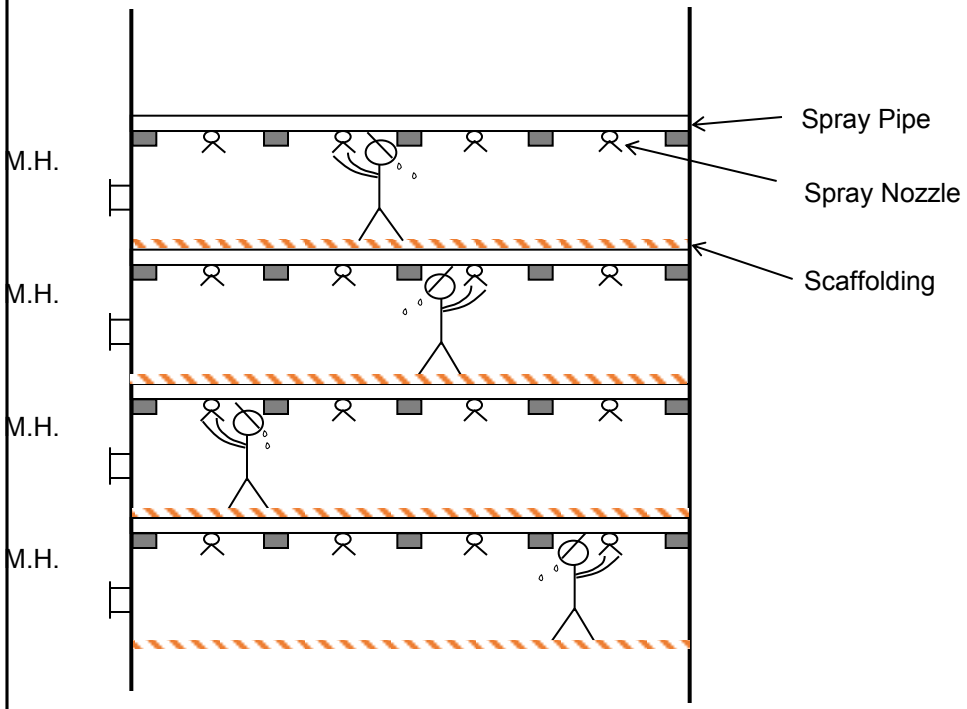
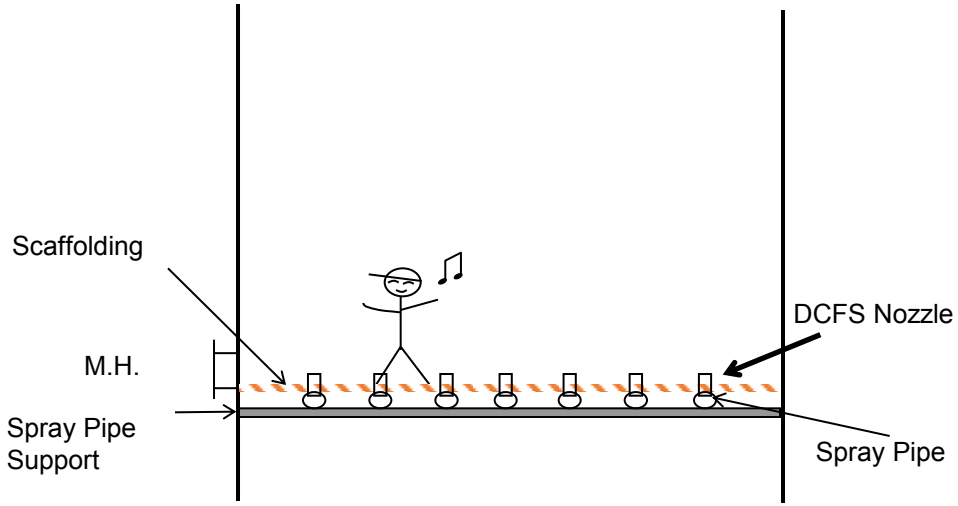
Spray System Load Adjustment



Energy Saving for Partial Load

Liquid column height is adjusted by changing the number of recirculation pumps according to boiler load, thus for energy saving.

Comparison with conventional Spray Tower

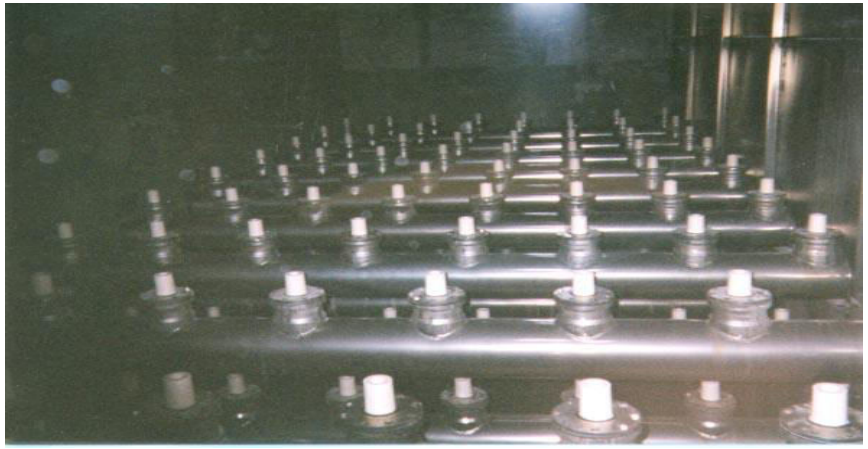
Item	Spray Tower	BHEL-MHPS DCFS
Maintainability		
Features	• **Scaffolding is required for each stage of spray pipe.** • **It is hard to install the scaffolding for each stage of spray pipe.** • **Maintenance work is hard because the workers are forced to keep looking up the spray pipes and nozzles**	• **Only one stage scaffolding is required.** • **It is easy to install the scaffolding on spray pipes.** • **Maintenance work is easy because the workers can inspect nozzles by looking down.**

Internal condition of DCFS after operation

No special maintenance is required, because scaling will not occur due to Mitsubishi's unique absorber design without internal elements, except for single-stage nozzles of the DCFS system.

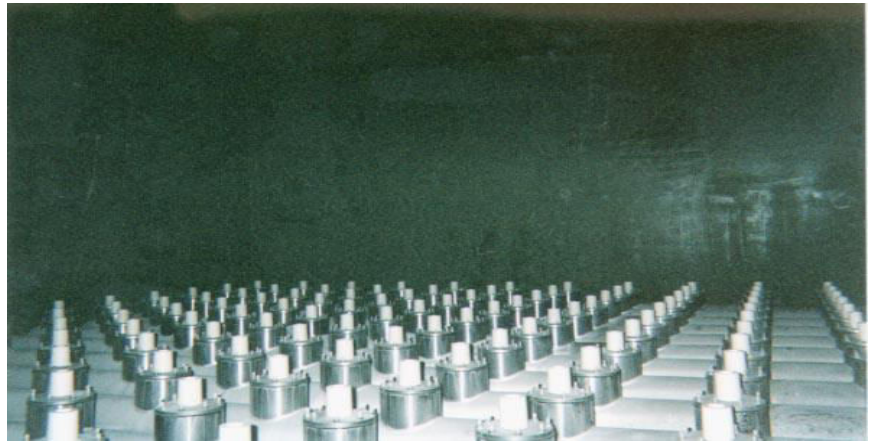
Kashima-minami (136MW)

Operation start : July '93
Photographed : May '99
(6^{th} Periodical Inspection)



Misumi (1,000MW)

Operation start : Dec. '97
Photographed : May '99
(1^{st} Periodical Inspection)



Mikuni (250MW)

Operation start : Mar. '97
Photographed : Mar. '99
(1^{st} Periodical Inspection)

Absorber Mounted Type

Independent Type

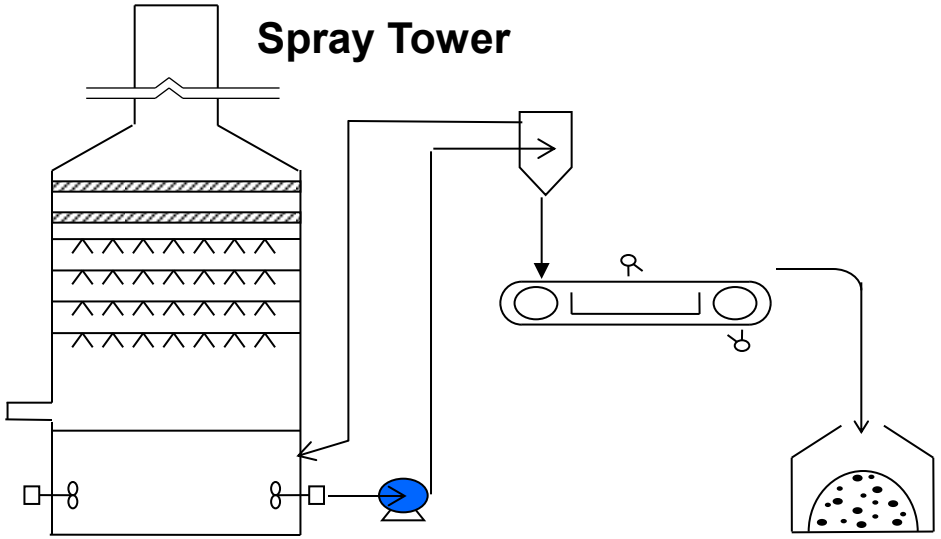
Absorber-mounted Type

Absorber-mounted Type fit even small space

Merit of DCFS - Smaller Tank Volume

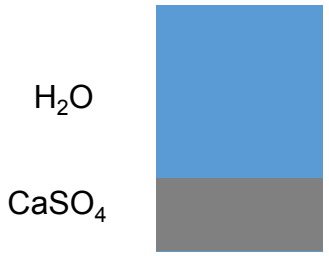
15 wt.% Slurry

Spray Tower



Absorbent Slurry
15wt.% SS

Product Gypsum

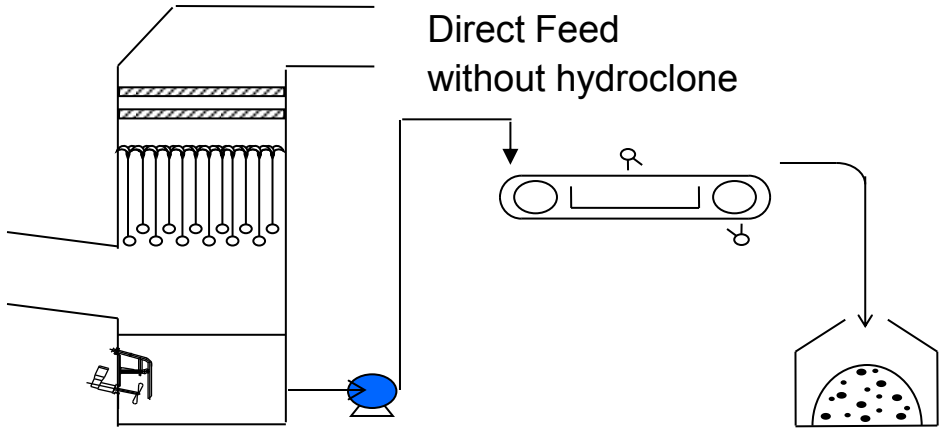


Same Solid Retention Time

30 wt.% Slurry

DCFS

Direct Feed
without hydroclone

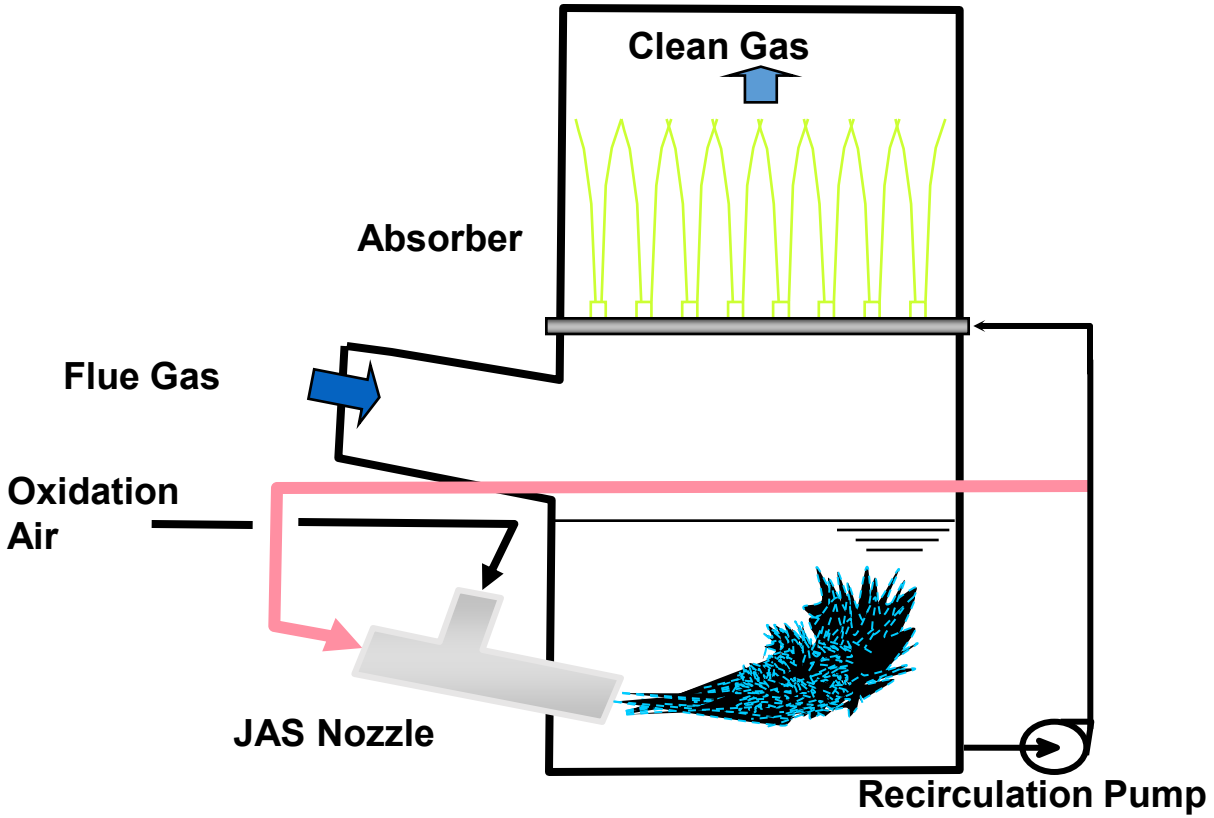


Absorbent Slurry
30wt.% SS

Product Gypsum

Smaller Tank Volume

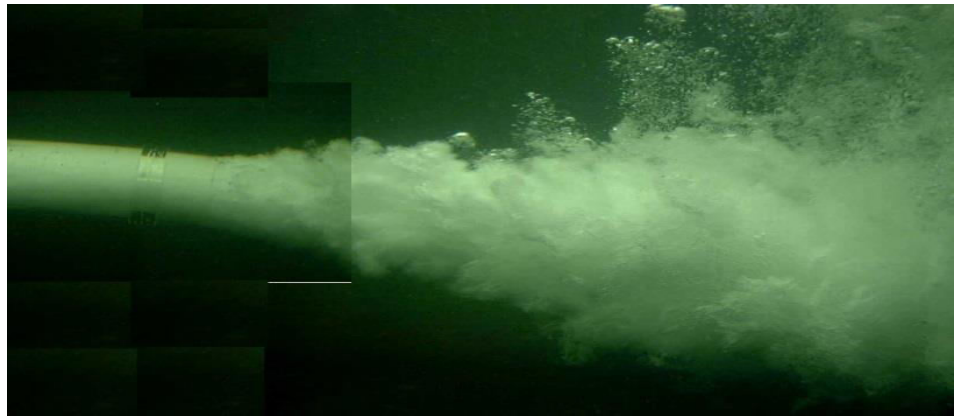
Jet air sparger (JAS)



Principle

- A part of the absorber slurry is fed to JAS.
- Low pressure area is generated in JAS where air is sucked either directly from ambient or through blower.

Features



Oxidation Method	Jet Air Sparger	Side-entry Oxidation Agitator	Fixed Air Sparger
Air utilization Percentage (Indicative)	60	30	20

- Energy Saving
  - High air-utilization percentage
  - Blower less
- Reduced maintenance and high reliability
  - No rotating equipment
  - No structured parts

Assured Regulations for Emissions, By-Products and Discharge

(1) Outlet SO_2 concentration / Desulfurization ratio

(2) Outlet dust concentration

(3) By-product Gypsum Quality
- -Purity : 95% for gypsum wall board, 90% for cement additives
- -Moisture content <10%

(4) Outlet Flue Gas Temperature

(5) Wastewater Quantity / Quality
- -Waste water quantity
- -Quality : pH, SS, COD, F^-, Cl^-, etc.…

(6) Utility Consumptions
- -Less Electric power, Limestone, Process water
- -No other additive required

Thank You