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ENGINEERING CLEANER TOMORROW

CLEAN GAS TO STACK

PEOPLE
TECHNOLOGY
CLEAN ENVIRONMENT

FLUE GAS DESULFURIZATION SCRUBBER

LNS-SC-FGD

Industrial SO_2 Emission Control System

For a Cleaner Planet

- High SO_2 Removal
- Reliable Operation
- Cleaner Industry



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Healthier Environment.
Greener Tomorrow.

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SOLUTIONS FOR A SUSTAINABLE WORLD

EMISSION CONTROL FOR A BRIGHTER TOMORROW

FLUE GAS DESULFURIZATION SCRUBBER SYSTEM

1. PROCESS OVERVIEW

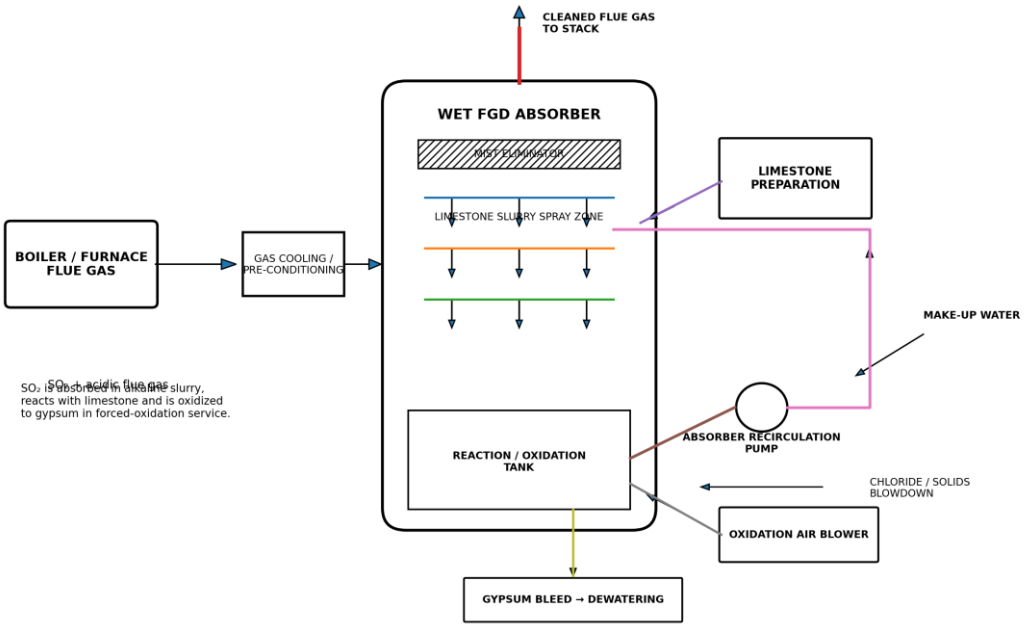
The LINESIG LNS-SC-FGD Flue Gas Desulfurization system is engineered for removal of sulfur dioxide (SO_2) and other acid-gas constituents from combustion and process flue-gas streams. The standard reference configuration is a wet limestone-gypsum FGD process with forced oxidation, selected for large gas volumes and continuous industrial service.

Flue gas enters the absorber and contacts with recirculating alkaline slurry through multiple spray levels. SO_2 is transferred from the gas phase into the liquid phase and neutralized by limestone-derived alkalinity. In the reaction tank, sulfite is oxidized with air to form calcium sulfate dihydrate (gypsum). Treated gas passes through a mist eliminator before discharge to the stack, while slurry is continuously recirculated and a controlled bleed is routed to dewatering.

2. INDUSTRIAL APPLICATIONS

- **Power generation:** coal-, oil- and solid-fuel-fired boilers.
- **Refineries and petrochemical complexes:** utility boilers, heaters and selected sulfur-bearing combustion sources.
- **Cement, lime and mineral processing:** kiln and calciner flue gas where SO_2 control is required.
- **Metallurgical plants:** sinter, roasting and smelting-related sulfur-bearing gas streams.
- **Waste-to-energy and industrial incineration:** acid-gas treatment in integrated flue-gas cleaning trains.
- **Marine / terminal utility applications:** large combustion plants requiring dedicated sulfur-emission control.
- Industrial furnaces and process heaters subject to regulated sulfur-emission limits.

LNS-SC-FGD — WET FLUE GAS DESULFURIZATION PROCESS SCHEMATIC



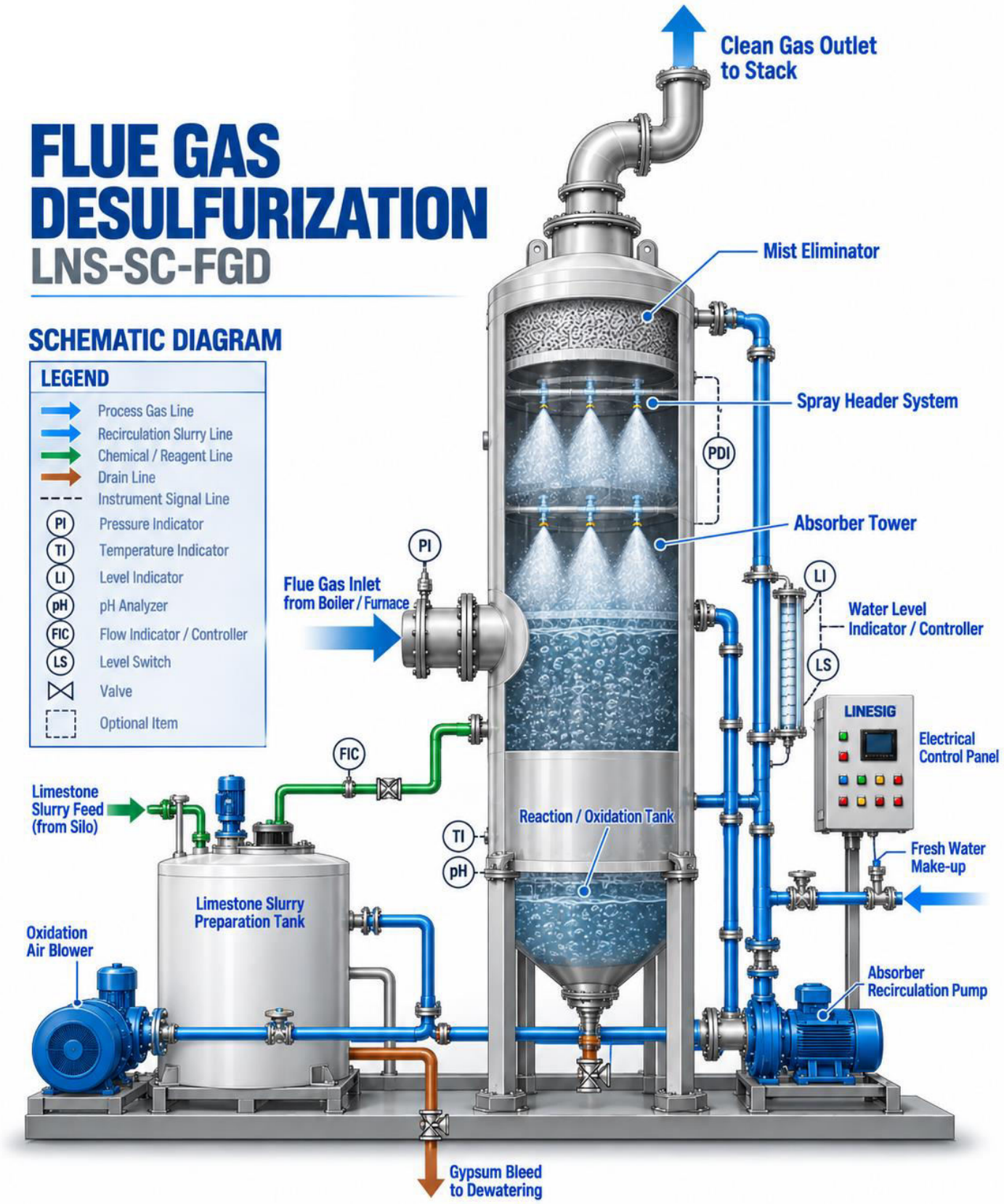
Reference process sequence:

Flue gas → optional gas cooling / pre-conditioning → wet absorber spray zone → mist eliminator → cleaned gas to stack. Limestone slurry is prepared and fed to the absorber reaction tank. Recirculation pumps return slurry to the spray headers. Oxidation air converts sulfite to gypsum; a controlled slurry bleed is routed to dewatering and water recovery.

FLUE GAS DESULFURIZATION

LNS-SC-FGD

SCHEMATIC DIAGRAM



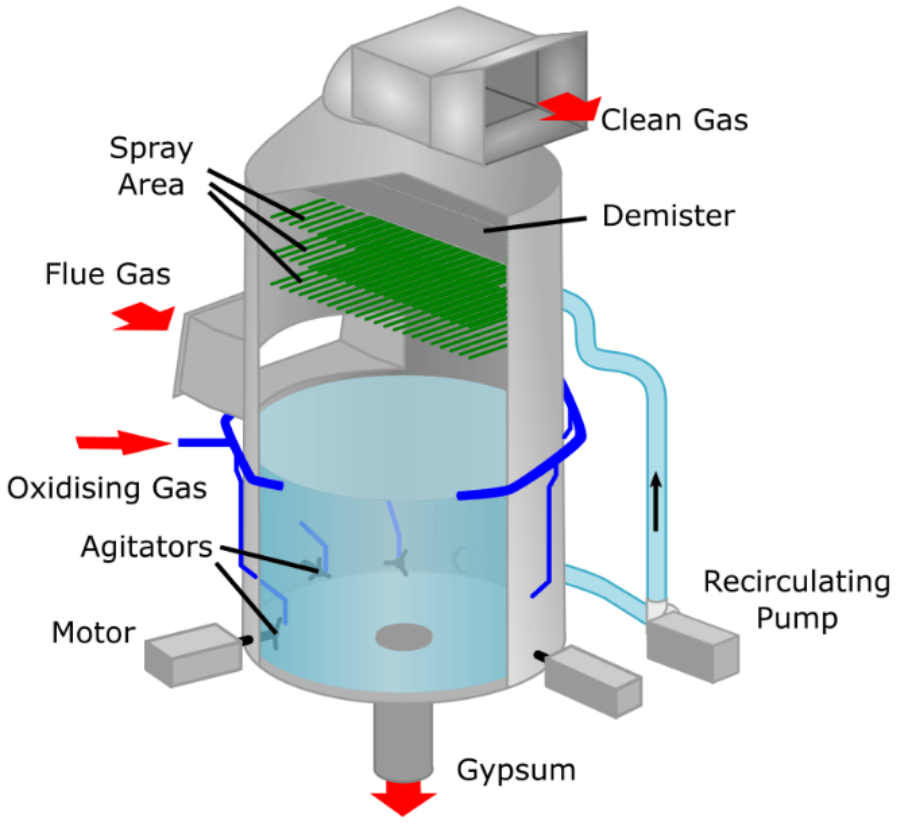
3. TECHNICAL & PERFORMANCE SPECIFICATIONS

Parameter	Typical Design Range / Criterion	Engineering Comment
FGD Process	Wet limestone-gypsum, forced oxidation	Other reagent chemistry may be engineered for specific duties.
SO_2 Removal Efficiency	Typically, 90–99+%	Actual guarantee depends on inlet SO_2, reagent, L/G, pH, absorber design and permit target.
Absorbent	Ground limestone / lime or project-specific alkaline reagent	Purity, reactivity and particle size are critical design inputs.
Absorber Type	Open spray tower / spray absorber	Low plugging tendency for large utility duties.
Liquid-to-Gas Ratio	Project specific	Optimized against sulfur load, removal target, reagent quality and power consumption.
Absorber Pressure Drop	Low to moderate; project specific	Includes inlet, spray zone, mist eliminator and outlet losses.
Slurry pH	Typically mildly acidic to near-neutral operating range	Final control band is process-specific and selected for absorption/reagent utilization.
By-product	Gypsum in forced-oxidation limestone service	Quality depends on limestone, oxidation, chloride and solids control.

4. ABSORBER TOWER CONSTRUCTION:

The absorber shell and internals are selected for continuous wet, acidic, chloride-containing and abrasive slurry service. Depending on gas chemistry and project size, construction may use rubber-lined carbon steel, flake-glass-lined steel, high-alloy metallic materials, FRP, duplex stainless steel or hybrid material systems.

Component	Typical Engineering Features
Absorber Shell	Large vertical vessel with corrosion-resistant lining or alloy construction
Spray Headers	Multiple independently isolatable spray levels for turndown and maintenance
Spray Nozzles	Large-orifice abrasion-resistant nozzles suitable for limestone slurry
Mist Eliminator	Multi-stage chevron/vane separator with wash system
Reaction Tank	Integrated absorber sump with mixing, oxidation air and reagent control
Access	Manways, platforms, spray-level access and mist-eliminator maintenance provisions

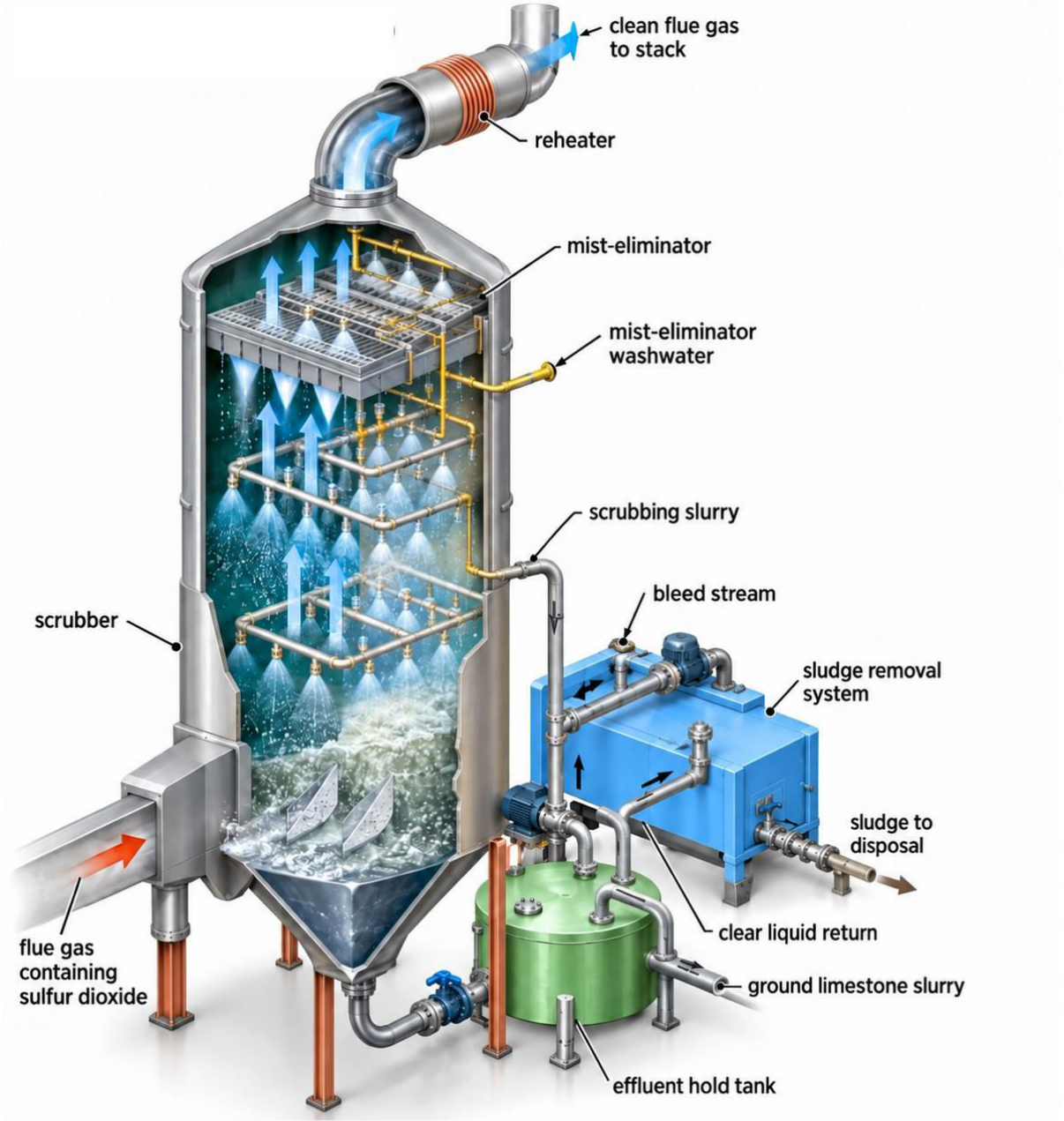


ABSORPTION CHEMISTRY & REACTION SYSTEM

5. LIMESTONE-GYPSUM REACTION

In wet limestone FGD, SO_2 dissolves into the recirculating slurry and forms sulfite/bisulfite species. Limestone neutralizes the absorbed sulfur species, while forced oxidation promotes conversion to sulfate. The principal solid by-product is calcium sulfate dihydrate (gypsum).

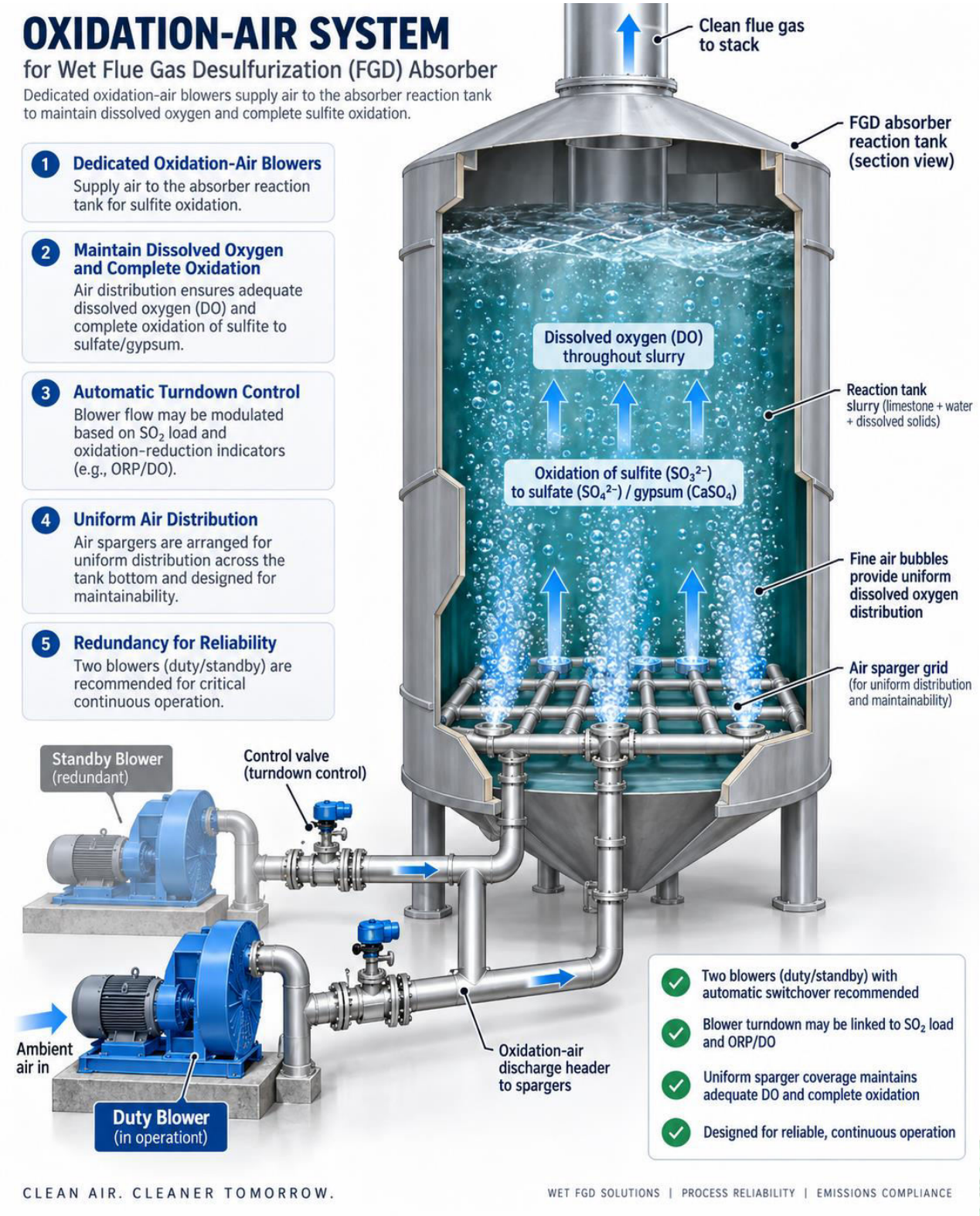
Detailed chemistry is influenced by limestone purity and reactivity, dissolved oxygen, pH, chloride concentration, temperature, liquid-to-gas ratio and slurry solids. Final reagent consumption and gypsum production shall therefore be calculated from the actual fuel sulfur balance and inlet flue-gas composition.



Flue gas desulfurization (FGD) limestone wet scrubber

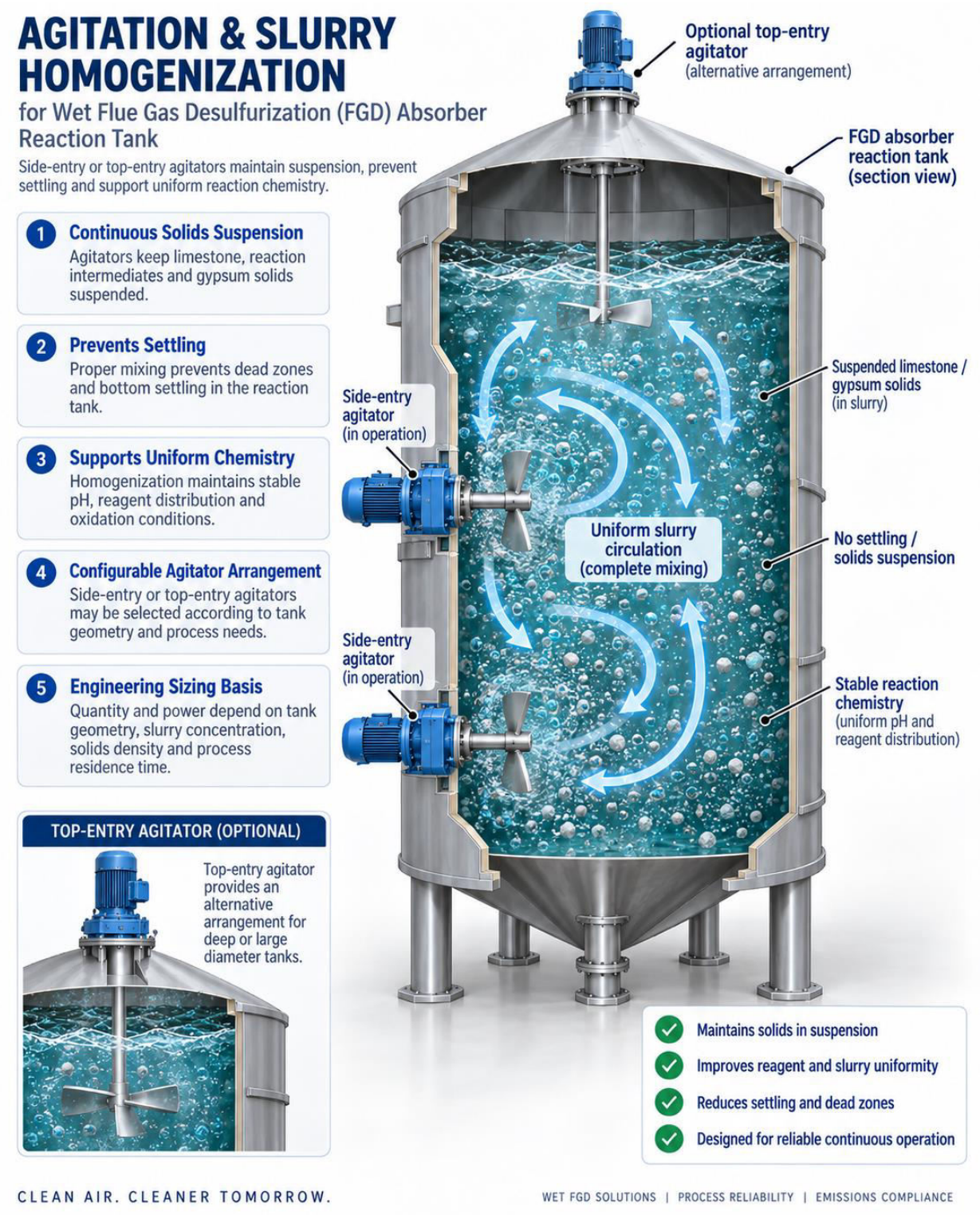
6. OXIDATION AIR SYSTEM

- Dedicated oxidation-air blowers supply air to the absorber reaction tank.
- Air distribution is designed to maintain adequate dissolved oxygen and complete sulfite oxidation.
- Blower turndown may be linked to SO_2 load and oxidation-reduction process indicators.
- Air spargers are arranged for uniform distribution and maintainability.
- Redundancy is recommended for critical continuous operation.



7. AGITATION & SLURRY HOMOGENIZATION

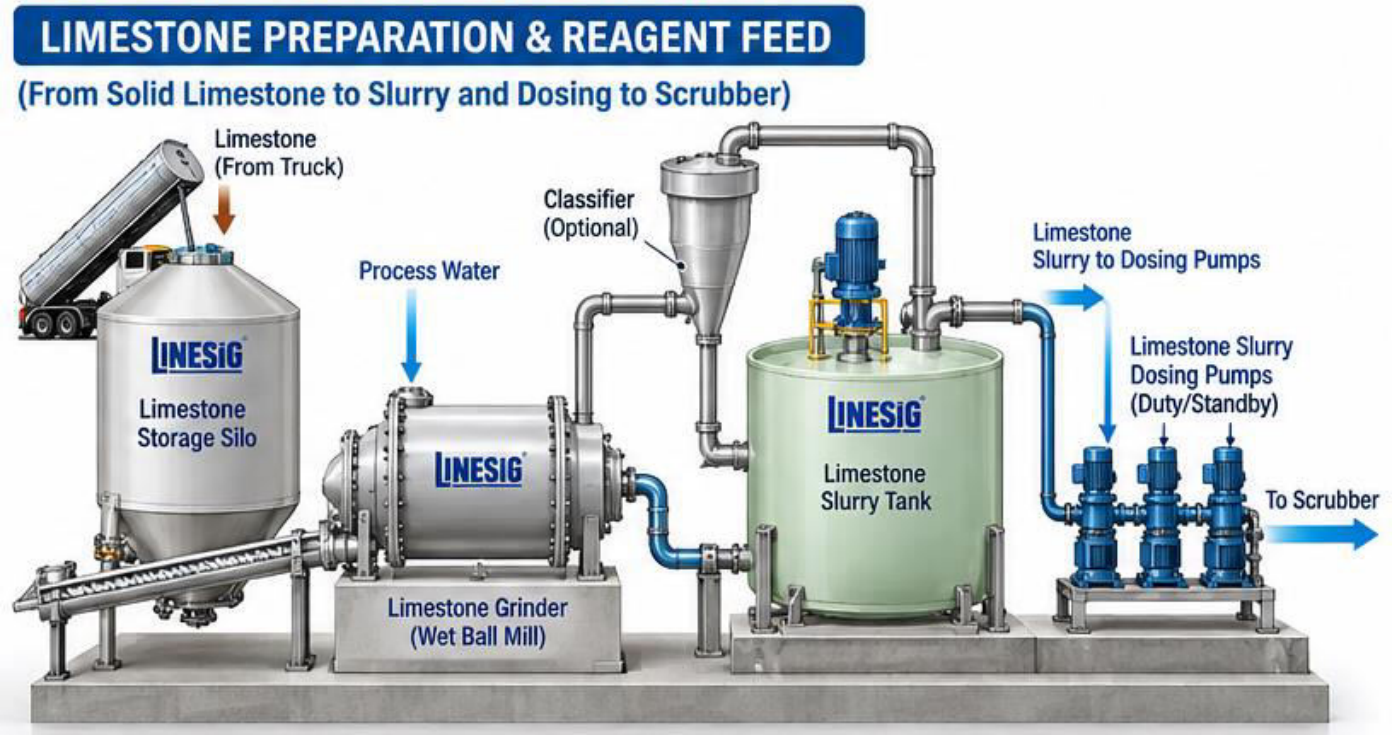
Side-entry or top-entry agitators maintain limestone, reaction intermediates and gypsum solids in suspension, prevent settling and support uniform chemistry. Agitator quantity and power are determined from tank geometry, slurry concentration, solids density and process residence time.

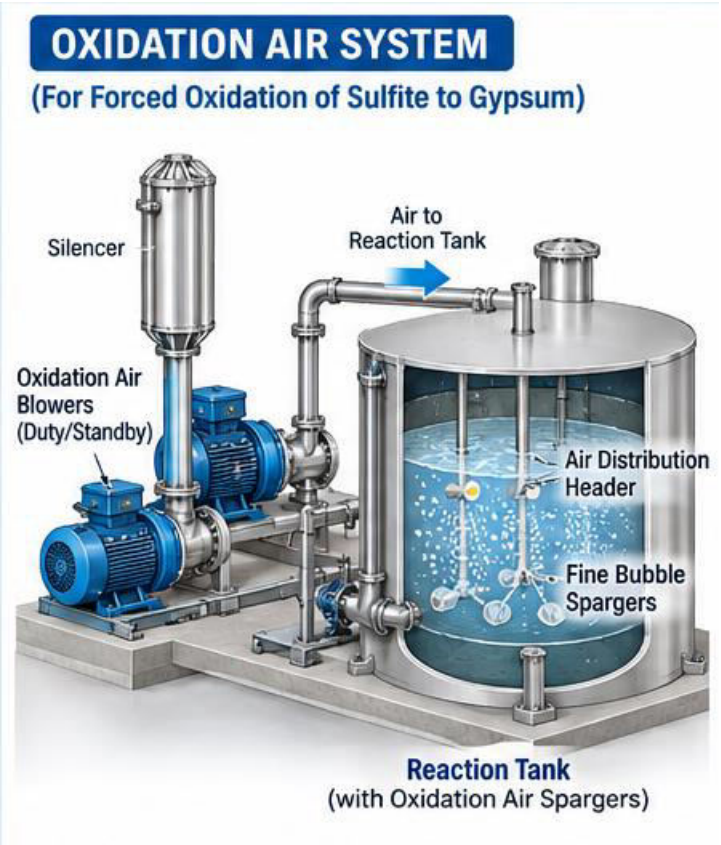


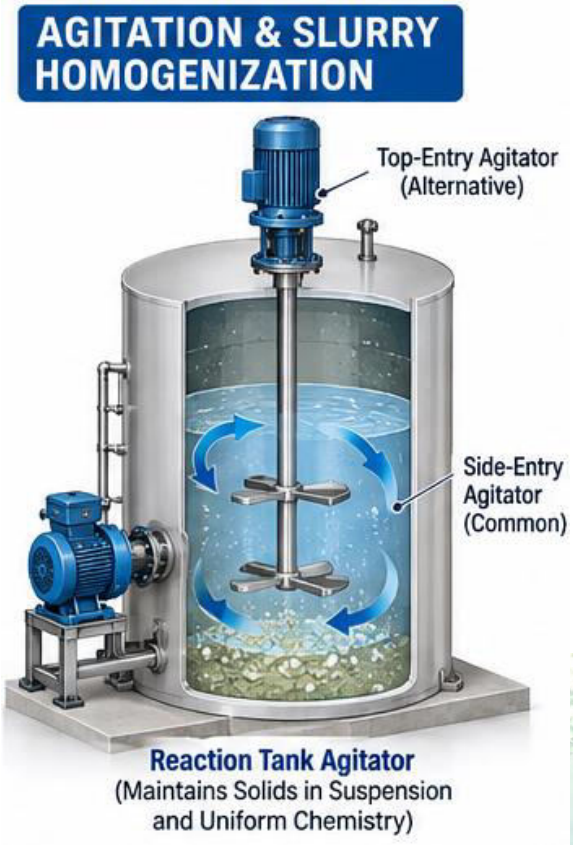
LIMESTONE PREPARATION & REAGENT FEED

8. LIMESTONE PREPARATION SYSTEM

Subsystem	Typical Scope
Limestone Receiving	Bulk storage silo / hopper and dust control
Metering	Loss-in-weight or volumetric feed system
Slurry Preparation	Wet ball mill, attritor, slaker or purchased fine-limestone slurry preparation
Slurry Tank	Agitated reagent storage / day tank
Reagent Transfer	Duty/standby slurry pumps
Quality Control	Density, solids concentration, particle-size and reagent purity monitoring as required







9. REAGENT CONTROL

Reagent feed is generally controlled using absorber pH, inlet sulfur load, recirculation chemistry and target SO_2 removal. Feed control should avoid both under-dosing, which risks emission exceedance, and excessive dosing, which increases reagent consumption and may affect gypsum quality.

RECIRCULATION, MIST ELIMINATION & GAS PATH

10. ABSORBER RECIRCULATION PUMPS

Large slurry recirculation pumps deliver absorber liquor from the reaction tank to the spray headers. These pumps are among the major energy consumers in wet FGD service and are selected for high-flow, abrasive slurry operation.

Parameter	Typical Design Basis
Pump Type	Heavy-duty horizontal or vertical slurry pump
Duty Philosophy	Multiple parallel pumps; each generally associated with one or more spray levels
Materials	High-chrome alloy, rubber-lined, duplex or application-specific abrasion/corrosion-resistant materials
Seal Arrangement	Mechanical seal / gland arrangement selected for slurry service
Control	Pump staging and spray-level isolation for load turndown



11. MIST ELIMINATION

The mist eliminator removes entrained slurry droplets before the cleaned gas leaves the absorber. Multi-stage chevron elements are commonly used. Dedicated wash headers periodically remove deposited solids and maintain low pressure drop.

12. GAS PATH & BOOSTER / ID FAN INTERFACE

The total FGD pressure drop must be incorporated into the boiler induced-draft fan or dedicated booster-fan design. Gas-path materials, duct expansion joints, wet-stack interface, gas reheat philosophy and corrosion protection are project-specific and require integration with the upstream boiler and downstream stack.

GYPSUM DEWATERING & WATER MANAGEMENT

13. GYPSUM BLEED & DEWATERING

Stage	Typical Equipment / Function
Primary Bleed	Controlled withdrawal from absorber reaction tank
Hydrocyclone	Slurry classification / thickening where required
Secondary Dewatering	Vacuum belt filter, centrifuge or equivalent
Cake Handling	Conveyor, storage or disposal / by-product use
Filtrate Return	Recovered water returned to process where chemistry allows

14. WATER & CHLORIDE CONTROL

- Make-up water replaces evaporation, mist-eliminator wash and blowdown losses.
- Chloride concentration is controlled because excessive chloride can affect corrosion, limestone dissolution and gypsum quality.
- A controlled blowdown / wastewater stream removes accumulated chlorides and dissolved solids.
- Water balance must include fuel moisture, gas saturation, oxidation air, wash water and dewatering returns.
- Final wastewater treatment scope is site-specific and depends on discharge requirements.

CONTROL, INSTRUMENTATION & PROTECTION

15. INTEGRATED CONTROL PHILOSOPHY

The LNS-SC-FGD is designed for PLC/DCS integration with continuous monitoring of sulfur-removal performance, slurry chemistry, gas path, pump operation and water balance. Control architecture may be local-package based or fully integrated into the plant DCS.

Instrument / Control	Function
Inlet SO_2 Analyzer	Measures incoming sulfur load and supports feed-forward control
Outlet SO_2 Analyzer / CEMS Interface	Verifies emission performance
Absorber pH	Primary reagent-feed control variable
Slurry Density	Monitors solids concentration and reaction inventory
Absorber Level	Controls water balance and protects pumps
Gas Differential Pressure	Monitors absorber/mist-eliminator fouling
Recirculation Pump Pressure / Flow	Confirms spray-system duty
Oxidation Air Flow / Pressure	Confirms forced-oxidation performance
Mist Eliminator DP	Initiates wash / maintenance alarm
Chloride / Conductivity	Supports blowdown and corrosion control

16. TYPICAL INTERLOCKS

- Low absorber level → protect recirculation pumps.
- Loss of recirculation → restrict or trip affected boiler/flue-gas train as defined by plant philosophy.
- High absorber pressure drop → alarm and operating response.
- Loss of oxidation air → alarm and load/reagent response.
- High outlet SO_2 → alarm, reagent/recirculation corrective action and plant-level escalation.

17. AVAILABLE FGD CONFIGURATIONS (As per industrial typical application bases)

Configuration	Typical Application
Wet Limestone-Gypsum FGD	Large continuous boilers, power and heavy industry; high SO_2 removal
Wet Lime Scrubbing	Where higher reagent reactivity or compact chemistry is preferred
Seawater FGD	Coastal applications where seawater chemistry and discharge conditions permit
Semi-Dry / Spray Dryer Absorber	Medium sulfur load and lower wastewater generation
Dry Sorbent Injection	Lower-capital or polishing duties; commonly combined with particulate filtration

18. WHEN TO SELECT LNS-SC-FGD

Duty	Suitability
High SO_2 mass load	Primary application
Large boiler / furnace gas volume	Excellent
Continuous high-removal requirement	Excellent
Particulate-only control	Use dedicated particulate system / Venturi as appropriate
Small intermittent acid-gas duty	Wet packed-bed or dry scrubber may be more economical
Very low wastewater objective	Semi-dry / dry options may be preferred

19. DESIGN INPUTS REQUIRED

- Minimum / normal / maximum dry and wet flue-gas flow.
- Inlet and required outlet SO_2 concentration or mass rate.
- Full flue-gas composition: O_2, CO_2, H_2O, SO_2, SO_3, HCl, HF, NOx and other relevant species.
- Gas temperature, pressure, humidity and acid dew point.
- Fuel sulfur content and operating load profile.
- Fly-ash / particulate concentration and upstream particulate-control system.
- Limestone/lime analysis, purity, reactivity and available particle size.
- Water quality, wastewater limitations and chloride balance.
- Required gypsum quality / disposal route.
- Site design conditions, hazardous area classification and applicable emission limits.

20. STANDARD PACKAGE / SYSTEM SCOPE

Item	Typical Scope
A	Absorber tower with reaction tank
B	Spray headers and abrasion-resistant nozzles
C	Mist eliminator and wash system
D	Absorber recirculation pumps
E	Limestone/lime preparation and reagent feed package
F	Oxidation air blower package
G	Reaction-tank agitators
H	Gypsum bleed and dewatering interface / package
I	Make-up water and blowdown systems
J	Process analyzers and instrumentation
K	PLC/DCS interface and control panels
L	Platforms, access, maintenance connections and local piping
M	Optional booster fan / duct / wet-stack interface engineering





CONTROL SULFUR EMISSIONS. PROTECT AIR QUALITY. SUPPORT CLEANER INDUSTRY.

Engineered flue-gas desulfurization solutions for demanding continuous industrial service.



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