LINESIG®

CLEAN AIR | CLEANER TOMORROW

INDUSTRIAL AIR POLLUTION CONTROL SOLUTIONS

CLEANER PROCESSES A BRIGHTER TOMORROW

VENTURI SCRUBBER

LNS-SC-VEN

High-Energy Gas Cleaning & Particulate Control System



- **Efficient Dust & Mist Removal**
- **Reliable Industrial Operation**
- **Environmentally Responsible Solution**

Cleaner Air. Healthier Industry. Greener Tomorrow.

PEOPLE | PLANET | PROGRESS

WWW.LINESIG.COM

ADVANCED GAS CLEANING SOLUTIONS FOR A SUSTAINABLE WORLD

INDUSTRIAL VENTURI SCRUBBER SYSTEM

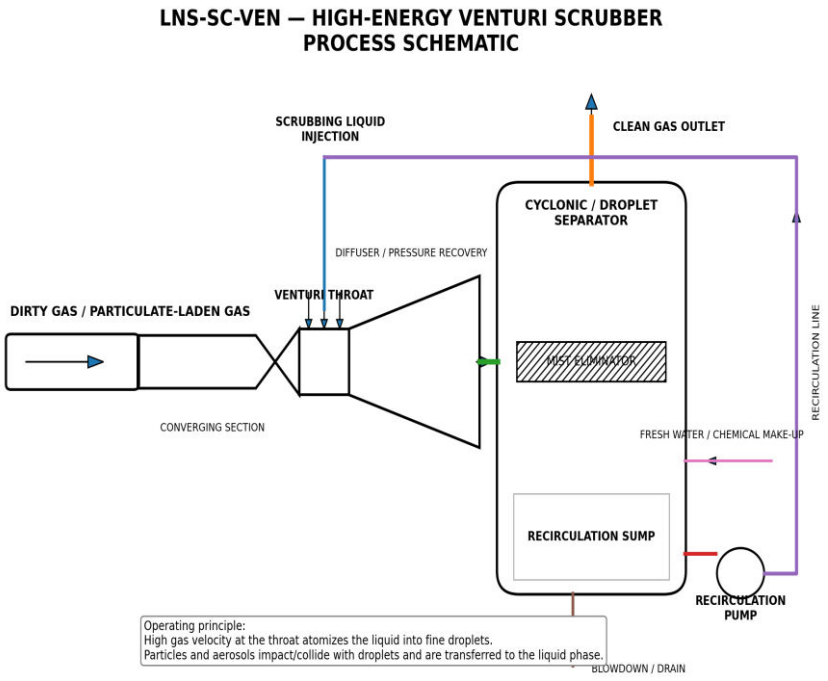
1. PROCESS OVERVIEW

The LINESIG LNS-SC-VEN Industrial Venturi Scrubber is a high-energy gas-cleaning system engineered for efficient removal of fine particulate matter, dust, acid mist, aerosols, smoke, entrained droplets and selected soluble/reactive gases from industrial exhaust streams. Contaminated gas is accelerated through a converging Venturi throat while scrubbing liquid is injected at or immediately upstream of the throat. The very high relative velocity between gas and liquid atomizes the scrubbing liquid into fine droplets, creating intense turbulence and particle-droplet collision.

The particle-laden droplets then pass through a diffuser, where velocity is reduced and part of the pressure is recovered, before entering a cyclonic or droplet-separation vessel. Captured solids and dissolved contaminants are transferred to the liquid phase, while treated gas passes through a mist eliminator and exits to the stack. The scrubbing liquor is collected in the sump, recirculated by pump, chemically conditioned where required, and controlled by make-up and blowdown.

2. INDUSTRIAL APPLICATIONS

- **Metallurgy & Foundries:** furnace fumes, metal oxide dust, casting smoke, acid mist and hot particulate-laden gases.
- **Mineral Processing & Cement:** crusher/dryer exhaust, fine mineral dust, kiln-related particulate and high-dust process vents.
- **Chemical & Fertilizer Plants:** acid mist, reaction aerosols, ammonium/salt particulate and combined gas/particulate duties.
- **Incineration & Waste-to-Energy:** fly ash pre-cleaning, fine particulate, smoke, soluble acid-gas polishing and quench-integrated systems.
- **Battery / Surface Treatment:** acid aerosol, electrolyte mist, metal-finishing fumes and corrosive droplets.
- **Food / Drying / Rendering:** sticky particulate, grease/oil mist, organic aerosols and combined odour/particle exhaust.
- **Pulp & Paper / Process Boilers:** particulate and mist conditioning upstream of additional gas-treatment stages.

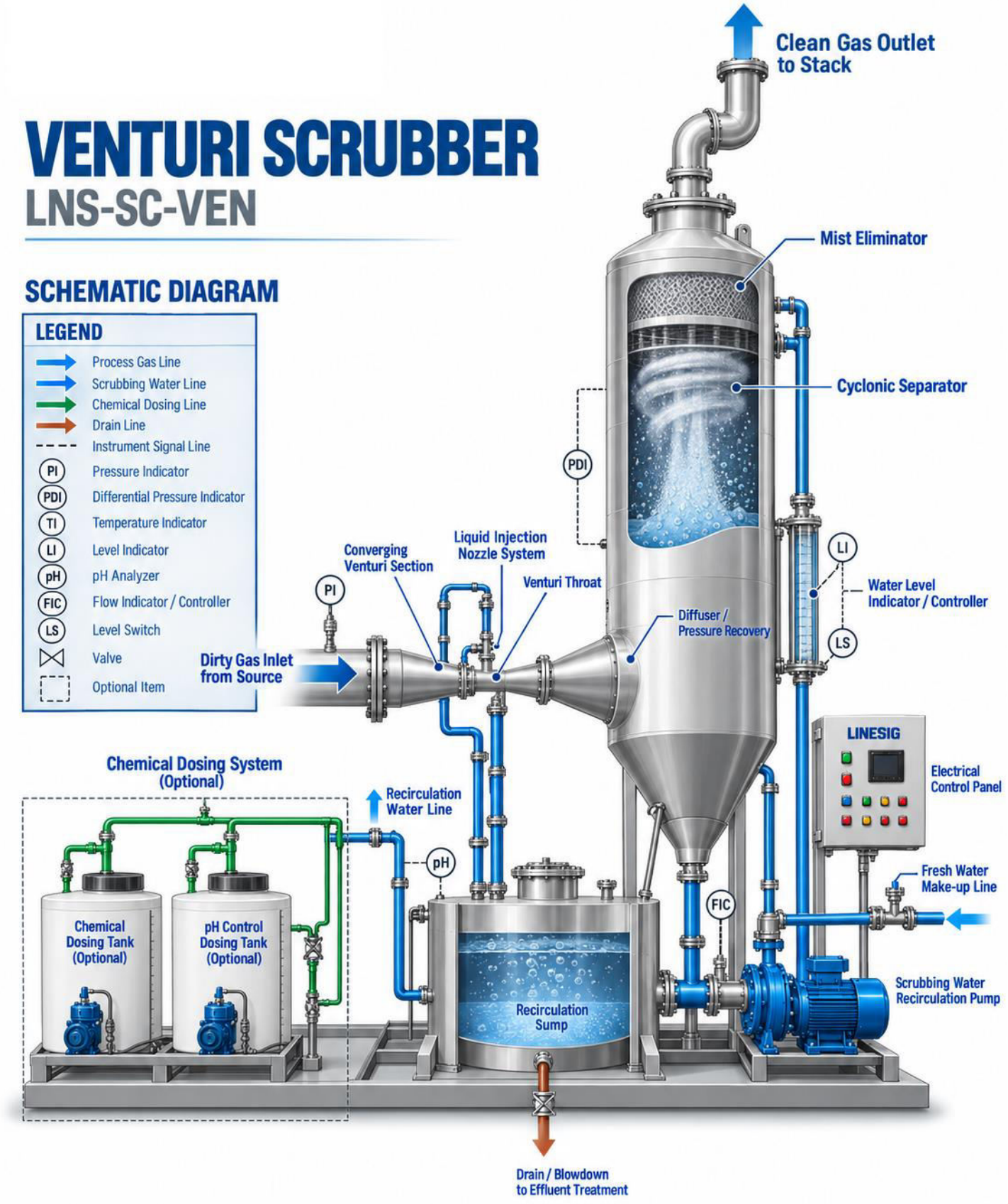


Typical process sequence:

Dirty gas → converging section → Venturi throat with liquid injection → diffuser / pressure recovery → cyclonic or knockout separator → mist eliminator → clean-gas outlet. The sump liquid is recirculated to the throat; fresh water, reagent addition, solids purge and blowdown are incorporated as required by the application.

VENTURI SCRUBBER
LNS-SC-VEN

SCHEMATIC DIAGRAM



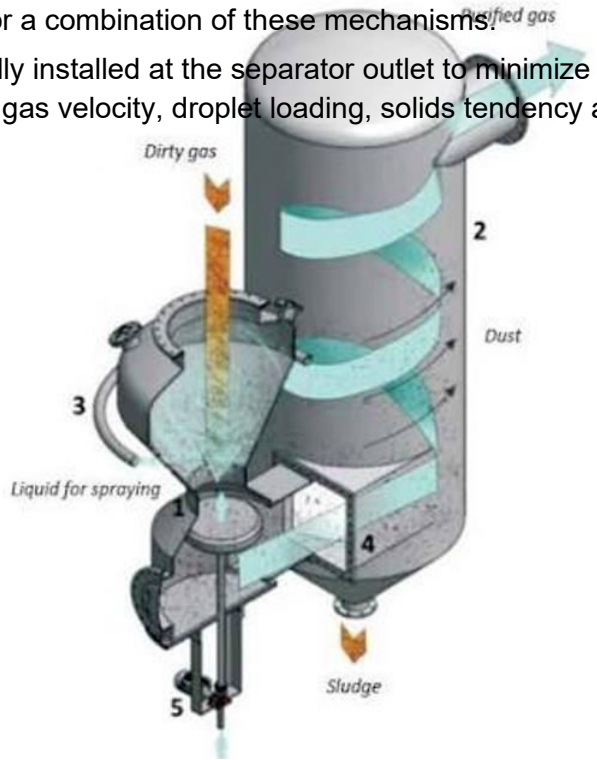
3. TECHNICAL & PERFORMANCE SPECIFICATIONS:

Parameter	Typical Design Range / Criterion	Engineering Comments
Gas Flow Rate	Project specific; scalable from small package units to large industrial duties	Final throat diameter and pressure drop are selected from actual gas flow and pollutant load.
Venturi Throat Gas Velocity	Typically 45 – 120 m/s	Higher velocity increases fine-particle capture but also energy consumption.
Venturi Pressure Drop	Typically 1.5 – 7.5 kPa	Principal performance-control parameter; final value depends on target particle size and efficiency.
Liquid-to-Gas Ratio	Typically 0.5 – 2.5 L/m³	Adjusted for dust loading, gas cooling, chemistry and desired droplet density.
Particulate Removal	High efficiency; often >95% for suitable particle distributions	Sub-micron performance depends strongly on pressure drop and particle properties.
Mist / Aerosol Capture	High efficiency for fine droplets and acid mist	Final guarantee requires inlet distribution and droplet-size data.
Gas Cooling / Quench	Available where hot gas enters the system	Can be integrated ahead of or within the Venturi section.

4. DROPLET / PARTICULATE SEPARATION

Following the Venturi section, the gas-liquid mixture enters a separator designed to remove the particle-laden droplets generated at the throat. The separator may use cyclonic swirl, tangential entry, vane separation, knockout volume or a combination of these mechanisms.

A final mist eliminator is typically installed at the separator outlet to minimize droplet carryover. The demister type is selected from gas velocity, droplet loading, solids tendency and maintenance requirements.



Separator Element	Typical Arrangement
Primary Separation	Cyclonic / tangential gas-liquid disengagement
Secondary Separation	Chevron vane or mesh-pad mist eliminator
Sump	Integrated liquid collection and solids-settling volume
Solids Handling	Blowdown, purge, sludge drain or hydrocyclone option
Access	Manway, cleanout door and demister access as required

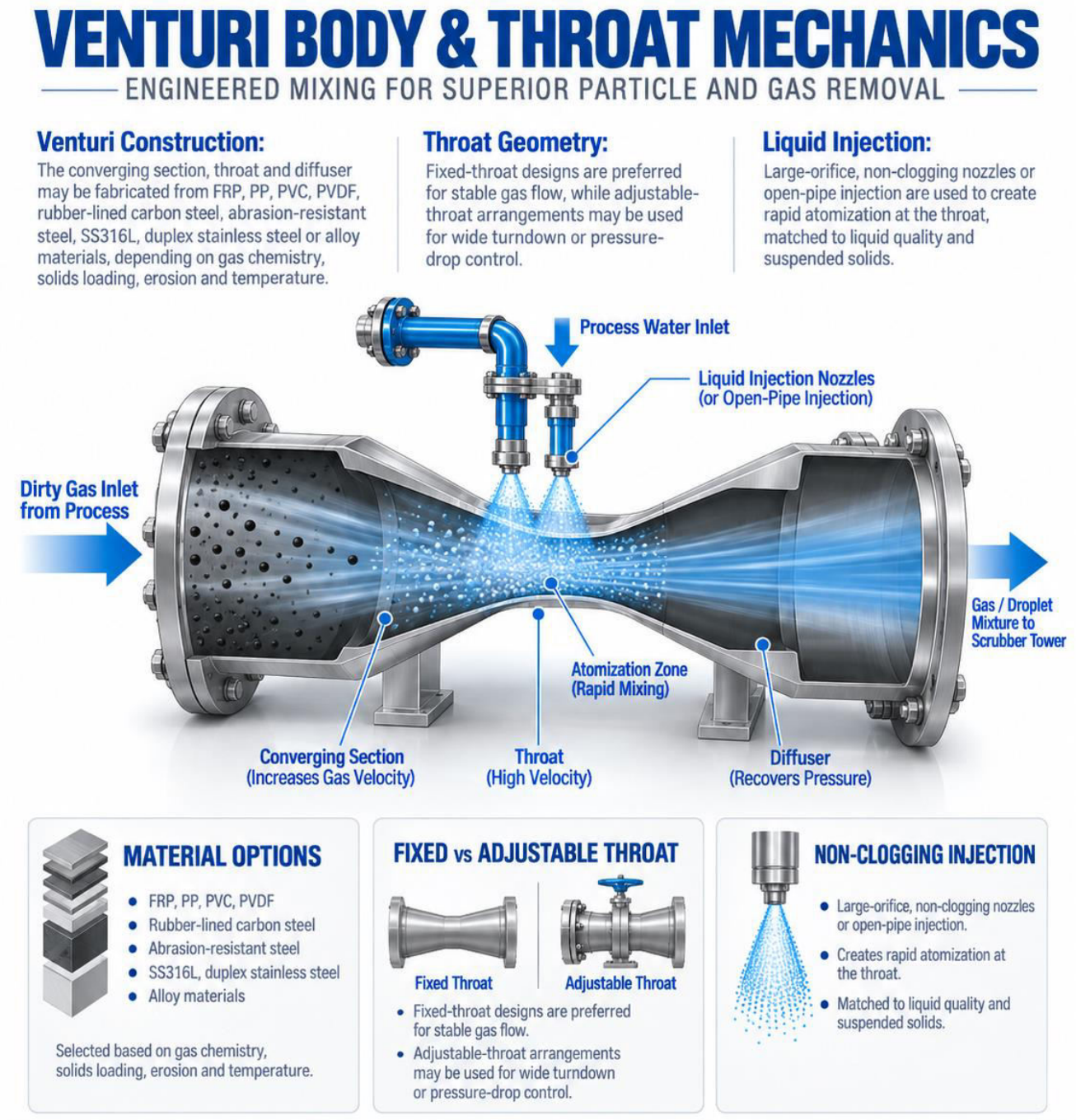
5. VENTURI BODY & THROAT MECHANICS

Venturi Construction: The converging section, throat and diffuser may be fabricated from FRP, PP, PVC, PVDF, rubber-lined carbon steel, abrasion-resistant steel, SS316L, duplex stainless steel or alloy materials according to gas chemistry, solids loading, erosion potential and operating temperature.

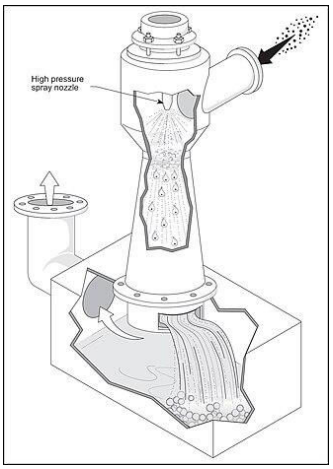
Throat Geometry: Fixed-throat designs are preferred for stable gas flow. Adjustable-throat arrangements can be supplied where wide turndown or pressure-drop control is required.

Liquid Injection: Large-orifice non-clogging nozzles or open-pipe injection are arranged to provide rapid atomization at the throat. Nozzle selection is matched to liquid quality and suspended solids.

Component	Typical Design Features
Converging Section	Smooth acceleration profile minimizing deposits and maldistribution
Throat	High-velocity wear zone; replaceable/lined construction recommended in erosive service
Diffuser	Gradual expansion for partial static-pressure recovery and reduced downstream velocity
Liquid Injection	Non-clogging spray nozzles or open injection headers
Access	Inspection/removal spool or access cover at throat area where practical



6. SOLIDS / SLURRY MANAGEMENT



- Recirculation-liquid solids concentration must be controlled to prevent nozzle blockage and excessive erosion.
- Continuous or intermittent blowdown may be used to remove accumulated solids.
- Basket strainers, hydrocyclones or external clarification can be added for high-solids applications.
- Slurry-compatible pumps and abrasion-resistant piping are recommended where captured dust forms an abrasive suspension.
- Settling zones and bottom drains should be arranged to avoid stagnant solids accumulation.

7. PROCESS GAS BLOWER SUBSYSTEM

Venturi scrubbers are high-energy devices. The process gas blower is therefore selected not only for duct and stack resistance, but also for the intentionally imposed Venturi pressure drop required to achieve the target capture efficiency.

Equipment Subsystem	Detailed Engineering Parameters
Process Gas Blower Type	Heavy-duty industrial centrifugal blower; direct or belt driven
Flow	Project-specific design gas volume with suitable operating margin
Static Pressure	Includes Venturi ΔP, separator, demister, duct, damper and stack losses
Construction	FRP / coated steel / SS / alloy to suit gas and temperature
Motor Control	VFD recommended where process flow or throat pressure-drop control is required
Performance Control	Gas flow and Venturi differential pressure are key monitored variables

Note: For energy optimization, the selected pressure drop should be the minimum that still achieves the required particulate/mist removal efficiency. Oversizing pressure drop increases blower power without corresponding process benefit.

8. RECIRCULATION PUMP SUBSYSTEM

The recirculation system supplies the Venturi liquid injection points and maintains the liquid inventory needed for particle capture, cooling and chemical absorption. Pump construction shall be selected for corrosion, solids concentration and abrasion.

Parameter	Typical Design Basis
Pump Type	Horizontal end-suction, recessed-impeller, slurry pump or vertical sump pump
Flow	Set by selected L/G ratio and gas flow
TDH	Venturi injection pressure + piping/friction + static head
MOC	PP / PVDF / FRP-lined / rubber-lined / SS316L / abrasion-resistant alloys
Seal	Single/double mechanical seal or sealless design according to chemistry
Redundancy	1 Duty + 1 Standby recommended for critical continuous operation

9. MAKE-UP / BLOWDOWN / WATER QUALITY

- Fresh-water make-up maintains working volume after evaporation and blowdown losses.
- Blowdown controls suspended solids, dissolved salts and captured contaminant concentration.
- Conductivity, turbidity or solids concentration may be used as automatic blowdown criteria.
- Water quality should be reviewed for scaling, precipitation and nozzle-fouling potential.
- Where chemistry is required, reagent dosing may be linked to pH, ORP or contaminant analyzer signals.

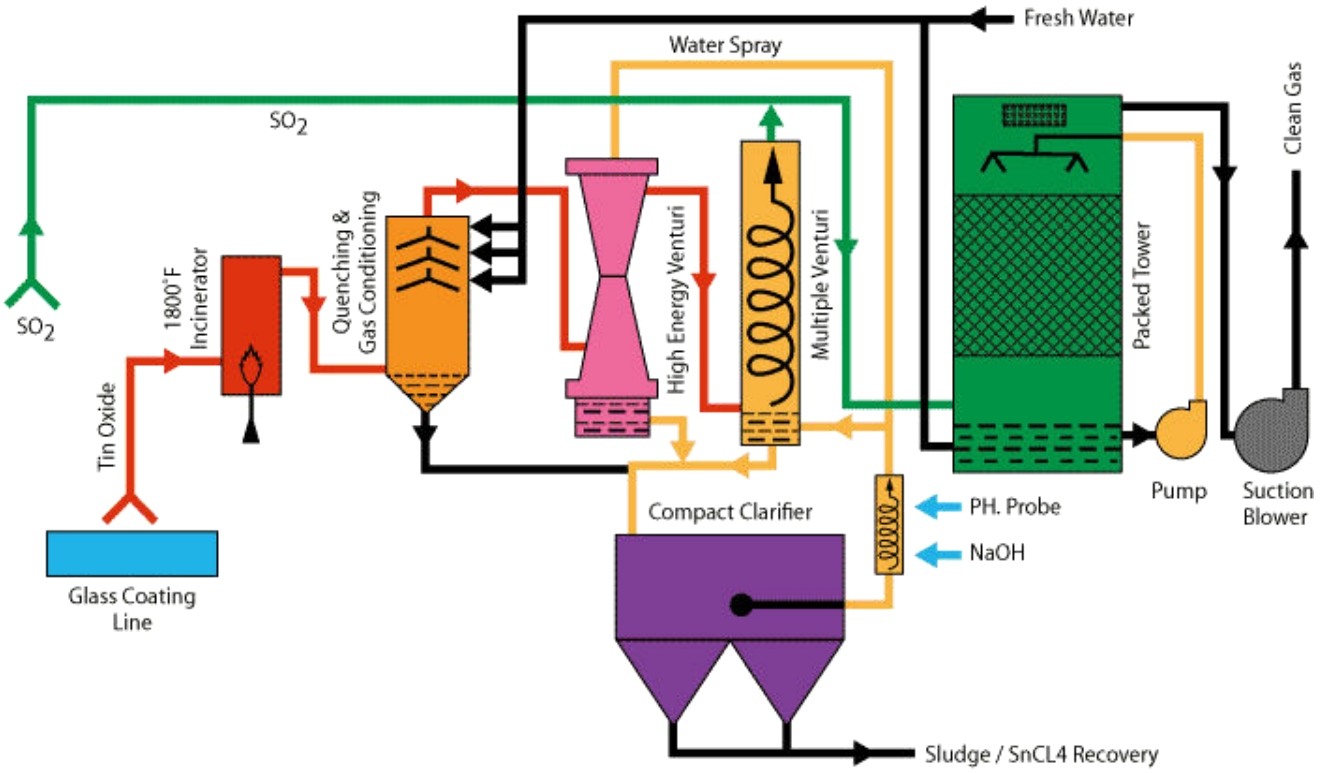
10. CHEMICAL INJECTION OPTIONS

Although the Venturi mechanism is primarily used for particulate and aerosol capture, the recirculation liquid can be chemically conditioned when simultaneous gas absorption is required. Final reagent selection depends on gas composition, temperature, residence time and downstream treatment.

Contaminant / Duty	Typical Liquid Chemistry / Treatment
Acid gases (HCl / HF / SO2)	Alkaline liquor such as NaOH or lime-based chemistry
Ammonia / alkaline vapours	Dilute acid scrubbing where appropriate
H2S / reduced sulfur compounds	Alkaline + oxidizing chemistry if required
Acid mist / aerosol	Water or alkaline recirculation depending on acid strength
Sticky organic aerosol	Water, detergent-compatible or application-specific wash liquor

11. MULTI-STAGE CONFIGURATIONS

- Venturi + Cyclonic Separator for high dust and droplet loads.
- Venturi + Packed-Bed Wet Scrubber for combined particulate and soluble-gas treatment.
- Quench + Venturi + Separator for hot combustion/process gases.
- Venturi + Wet Electrostatic Precipitator or polishing stage for very fine residual aerosols where required.
- Venturi pre-cleaner upstream of FGD systems where particulate conditioning is beneficial.



12. INTEGRATED CONTROL & AUTOMATION

The LNS-SC-VEN may be supplied with PLC/HMI automation for safe control of gas flow, recirculation, blowdown and chemical conditioning. Venturi differential pressure and recirculation flow are key process variables because they directly influence collection performance.

Control Loop / Instrument	Function
Venturi Differential Pressure (PDT)	Confirms operating energy / capture condition and detects throat changes
Gas Flow Transmitter	Monitors design airflow and blower/VFD performance
Recirculation Flow Transmitter / Low-Flow Switch	Proves liquid injection and interlocks gas operation
Sump Level Transmitter	Controls make-up and protects recirculation pump
Pump Discharge Pressure	Monitors nozzle/injection condition
Conductivity / Turbidity	Optional automatic blowdown control
pH / ORP	Optional reagent dosing for gas absorption/oxidation duties
Blower VFD	Flow or pressure-drop control and energy optimization
High DP / Low Flow Trip	Protects process performance and equipment

13. WHEN TO SELECT A VENTURI SCRUBBER

Process Requirement	LNS-SC-VEN Suitability
Fine particulate / dust	Excellent
Acid mist / aerosol	Excellent
Oil or process mist	Excellent / application dependent
Sticky particulate	Very good
High inlet dust loading	Very good
Simultaneous gas + particulate	Very good when chemistry is incorporated
Large soluble-gas-only duty	Usually better served by LNS-SC-WET packed bed
Very low wastewater requirement	Dry scrubber may be preferred
SO2-dominant large flue-gas duty	LNS-SC-FGD normally preferred

14. DESIGN INPUTS REQUIRED

- Minimum / normal / maximum gas flow.
- Gas temperature, pressure, humidity and dew point.
- Particle-size distribution and mass loading.
- Particle density, abrasiveness, stickiness and solubility.
- Aerosol / mist concentration and droplet-size distribution where applicable.
- Gaseous contaminant composition if simultaneous absorption is required.
- Required outlet particulate/emission guarantee.
- Available water quality and wastewater/disposal constraints.
- Allowable pressure drop and available blower power.
- Corrosion, hazardous-area and site ambient requirements.

15. STANDARD PACKAGE COMPONENTS

Item	Description
A	Venturi converging section, throat and diffuser
B	Liquid-injection nozzles / header
C	Cyclonic / knockout separator
D	Mist eliminator
E	Integrated or external recirculation sump
F	Recirculation pump(s)
G	Fresh-water make-up connection
H	Blowdown / sludge drain system
I	Optional chemical dosing package
J	Gas blower / VFD where included in package
K	Differential-pressure, flow and level instrumentation
L	Electrical / PLC control panel
M	Access manholes / cleanout doors / maintenance connections





CLEANER INDUSTRY. HEALTHIER AIR. GREENER TOMORROW.

High-energy particulate and aerosol control for demanding industrial exhaust applications.