

NORAM
SULFURIC ACID
Products and Services

TURBOSCRUBBER® FOR GAS CLEANING & TAIL GAS SCRUBBING



The **TurboScrubber®** is a high efficiency gas-liquid contacting device used for scrubbing, absorption, desorption, and particulate removal applications. It is proven to be compatible with most scrubbing solutions used in conventional packed towers.

The TurboScrubber® uses hollow plastic elements of ellipsoidal shape to generate a three phase fluidized bed. This fluidized bed increases turbulence in the gaseous phase and the liquid phase, which significantly increases overall mass and heat transfer coefficients, as well as inter-phase surface renewal rates, compared to other available technologies. In addition, the fluidized bed can remove particulates down to sub-half-micron diameters ($< 0.5 \mu\text{m}$).

TurboScrubber Advantages

- High efficiency absorption (High mass transfer)
- High cooling efficiency (High heat transfer)
- Removal of sub-micron particulate matter and aerosols
- Compact equipment / Small footprint
- Can handle slurries without fouling and free from blockages
- Low gas-side pressure drop
- Wide turndown ratio
- Design flexibility for retrofits and debottlenecking
- Construction with corrosion resistant materials such as FRP, FRP-lined steel, or alloys
- Countercurrent flow design (important for heat transfer)

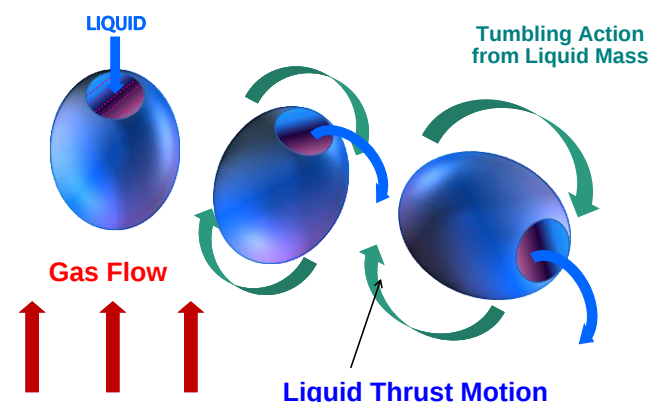
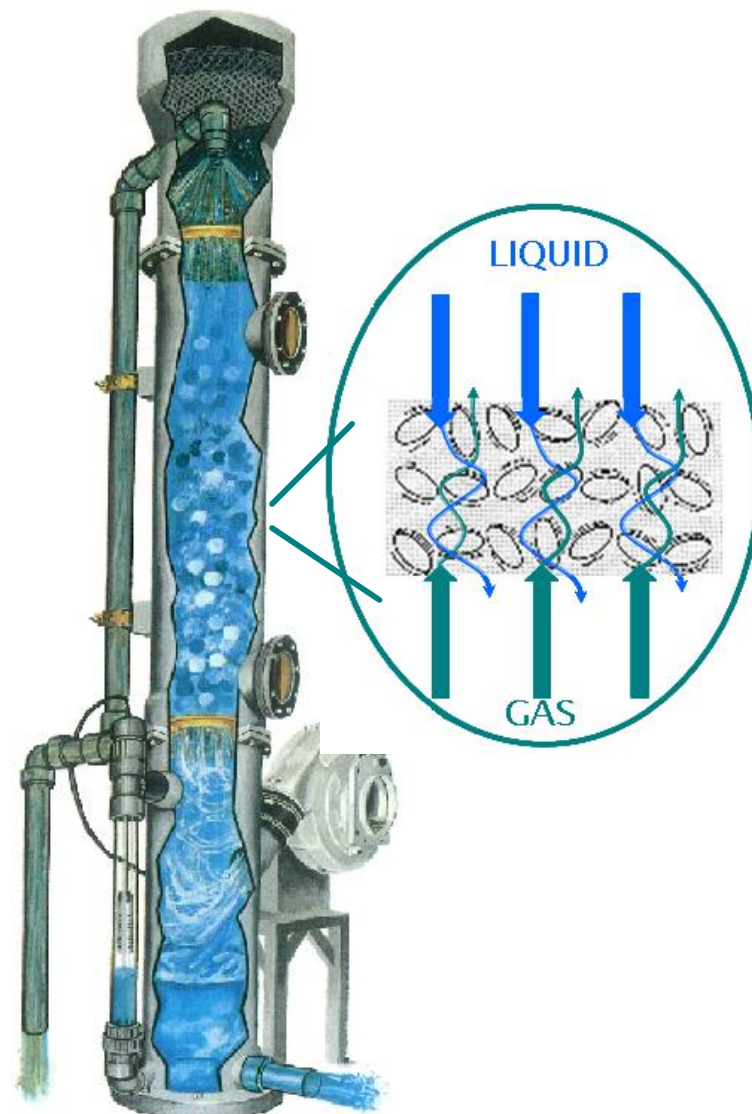
TurboScrubber Packing

TurboScrubber packing is an aerodynamic packing available either as the patented Turboid®, or the Turbopak®. The concave indentation on the Turbopak® provides additional thrust to the tumbling motion. The packing can be supplied either in PP or PVDF material.



Turboid®

Turbopak®



Gas Cleaning

NORAM's TurboScrubber® system can replace two pieces of equipment (scrubber + cooling tower) in the gas cleaning section of a sulfuric acid regeneration or metallurgical acid plant, and provide net savings in pressure drop.

Replacement of Existing Scrubber

NORAM's TurboScrubber system can replace an existing scrubber due to its particulate removal properties which can:

- Allow for debottlenecking of the plant by reducing pressure drop and/or increasing total plant gas flow, while achieving near-complete removal of SO_3 , H_2SO_4 , As, Se, F, Cl, Pb, Cd, Cu, Bi, dust, acid mist, tars, etc.
- Minimize fouling and plugging of equipment downstream such as cooling towers and WESPs, reducing downtime
- Minimize product acid quality problems

Replacement of Existing Cooling Tower

NORAM's TurboScrubber system can replace an existing cooling tower and offers the following operational benefits:

- Eliminate fouling in the cooling tower reducing downtime
- Minimize fouling and plugging of equipment downstream such as WESPs
- Improve heat transfer (i.e. more efficient gas cooling sending less water to drying tower)

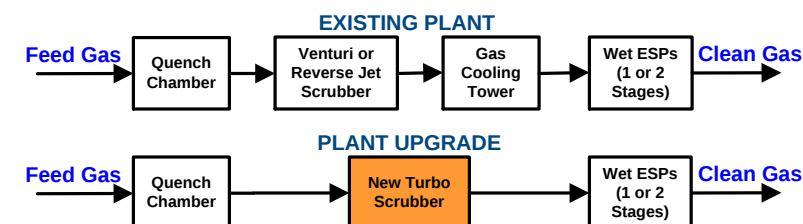
Replacement of Both Existing Scrubber and Cooling Tower

NORAM's TurboScrubber system can replace both scrubber and cooling tower. The following common combinations of gas cleaning equipment can be replaced by the TurboScrubber system:

- High pressure drop fixed-throat Venturi scrubber and cooling tower
- High pressure drop variable-throat Venturi scrubber and cooling tower
- Reverse-jet scrubber and cooling tower/froth column
- Radial flow scrubber and cooling tower

This replacement is possible because the TurboScrubber:

- Achieves particulate and aerosol removal with high efficiencies
- Is countercurrent, which is important for heat transfer, cooling and water removal
- Does not foul in dirty service
- Has a potentially lower pressure drop of about 20 "WC (compared to 25 to 50 "WC for other equipment combinations)



Tail Gas Scrubbing

NORAM's TurboScrubber system can be installed as a tail gas scrubber at the tail end of a sulfuric acid plant.

Environmental regulations regarding SO_2 emissions are continuously being tightened around the world. This holds true for both start-up and continuous operating modes. Further, during start-up, acid plants often experience an acid plume from the stack due to cold acid not being able to fully absorb SO_3 .

Start-up and Continuous Operations

Installing a TurboScrubber after the Final Absorption Tower of an acid plant significantly reduces stack emissions during both start-up and continuous operation. The operation of the TurboScrubber is flexible such that the liquid to gas ratio can be modified for either start-up or normal operations. This flexibility allows using one piece of equipment for two very different operations:

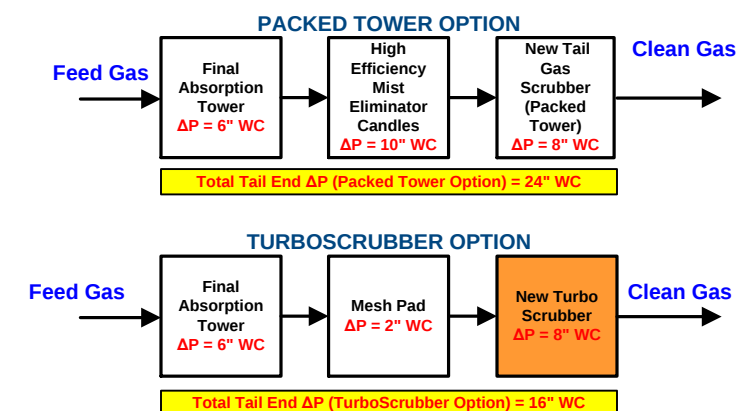
- SO_2 and acid plume removal during start-up,
- SO_2 removal during normal operation

Zero Net Pressure Drop

The TurboScrubber can remove SO_2 and fine acid mist coming from the upstream Final Absorption Tower. This feature allows replacement of the high efficiency mist eliminator (typically candles) in the Final Absorption Tower with a low pressure drop mesh pad. The TurboScrubber can therefore be installed without adding pressure drop to the plant.

Summary of the TurboScrubber's advantages as a tail gas scrubber:

- Capable of handling slurries (e.g. CaCO_3 , $\text{Ca}(\text{OH})_2$, $\text{Mg}(\text{OH})_2$); Also suitable for scrubbing solutions commonly used in packed towers (e.g. NaOH , Na_2CO_3 , NH_3 , H_2O_2 , sea water)
- Tunable SO_2 removal efficiency - even after installation, by variation of liquid flow rate and number of turboids
- Capable of acid mist removal due to the fluidized bed design (a significant feature not available in conventional packed towers)
- Capable of acid plume/blue haze removal during startup with cold acid



NORAM ENGINEERING AND CONSTRUCTORS LTD.

Suite #1800 – 200 Granville Street
Vancouver, British Columbia, Canada, V6C1S4
Tel: 604-681-2030 Fax: 604-683-9164
E-mail: acid@noram-eng.com Website: www.noram-eng.com

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