

FREE TECHNICAL GUIDE

Chemical scrubbing for process vents: liquors, stages and permits

Which liquor removes which gas, when a vent needs more than one stage, what a caustic scrubber will not do, and the data your permit will ask for.

For
Process and plant
engineers

And
EHS and
permitting leads

Covers
Chemical, pharma
and water





Match the liquor to the gas

A chemical scrubber works by reaction: the liquor is chosen to react with the gas you need to remove. Choose the wrong liquor and the gas passes straight through. Combine the wrong streams and you can make a new hazard.

Who it is for

Process and plant engineers specifying scrubbers for reactor, tank and process vents, and the EHS leads who own the permit.

How to use it

Read it before you write a scrubber specification or compare quotes. The checklist on the back page lists the data a supplier needs.

CONTENTS

01	Which liquor removes which gas	3
02	When a vent needs more than one stage	4
03	What a caustic scrubber will not do	5
04	The data your permit will ask for	6
05	What to send a supplier	7

FIVE THINGS TO GET RIGHT

- 1 List every gas**, not just the main one.
- 2 Take alkaline gases out first**, then acid gases.
- 3 Treat NO and insoluble VOCs** as separate problems.
- 4 Keep incompatible streams** out of the same sump.
- 5 Ask for outlet figures** per gas, in writing.

01

One gas, one chemistry

Most process gases fall into a few families. Each family has a liquor that reacts with it.

GAS	LIQUOR	WHAT FORMS	WATCH FOR
HCl, HF	Caustic (NaOH)	Sodium chloride or fluoride in solution	No glass or silica on HF duties
Chlorine	Caustic	Sodium hypochlorite	Keep alkaline; never mix with acid streams
Ammonia, amines	Dilute sulphuric acid	Ammonium or amine salts	Its own stage, upstream of caustic
SO ₂ , H ₂ S	Caustic, with oxidant for H ₂ S odour	Sulphite or sulphide, oxidised to sulphate	Keep sulphide liquor alkaline
NO _x	Oxidising stage, then caustic	Nitrite and nitrate	NO must be oxidised before it will absorb
Water-soluble solvents	Water	Dilute solvent in the bleed	Bleed disposal route

LIQUOR CONTROL

Each stage runs to a setpoint: pH for acid and caustic stages, ORP (oxidation-reduction potential) for oxidising stages. Dosing and bleed hold the chemistry steady as the load changes.

QUESTIONS TO ASK A SUPPLIER

Q1 Which liquor have you chosen for each gas, and why?

Q2 What setpoints will each stage run at?

Q3 What is the bleed rate and composition for each stage?

02

Stages in series, alkaline gases first

When a vent carries both alkaline and acid gases, one liquor cannot remove both. Put the stages in series.

IN	STAGE 1	STAGE 2	STAGE 3	OUT
Process vent Mixed gases	Acid Removes ammonia and amines	Caustic Removes acid gases and chlorine	Oxidising Only where NOx or odour needs it	To stack Within your limits

Why alkaline first

Ammonia would otherwise consume acid gas capacity, and acid gases would consume an acid stage. Separating them keeps each liquor working on its own job.

Why not one big stage

A single liquor at one pH cannot hold both acid and alkaline gases. You pay in reagent and still miss the limit.

Shared fan, shared stack

Stages are usually built as one package with a common fan and stack, so footprint grows less than you might expect.

Each stage, its own sump

Liquors never mix. Bleeds go to their own treatment or disposal routes.

IN PRACTICE

Check the order

Ask why the stages are in the order shown. Alkaline gases first is the usual answer for mixed acid and ammonia vents.

Batch processes

Loads swing with each batch. Dosing should follow the load rather than run at a fixed rate.

QUESTIONS TO ASK A SUPPLIER

Q1 Why does this vent need the number of stages proposed?

Q2 How does dosing respond when the batch load changes?

Q3 Where does each stage bleed to?

03

Know the limits before you buy

Chemical scrubbers are very good at soluble and reactive gases. They are not a cure for everything in a vent.

IT WILL NOT REMOVE	BECAUSE	USE INSTEAD OR AS WELL
Insoluble VOCs and solvents	They do not dissolve or react in the liquor	Thermal oxidiser or activated carbon
NO	It barely dissolves in caustic	An oxidising stage first, or SCR at high loads
Dust and particulate	A packed bed blinds and fouls	A venturi or a dust collector upstream
Sub-micron mist	Droplets pass through the packing	A fibre-bed or high-efficiency mist eliminator
Hot gas	Thermoplastics have a temperature ceiling	A quench ahead of the scrubber

HONEST QUOTES

A good proposal says what the scrubber will not do. If a quote promises to remove everything in a mixed vent with one caustic stage, ask how.

IN PRACTICE

Get a full contaminant list

Include solvents, particulates and temperature, not just the acid gases. What is left out is what breaks through.

Plan the combination

Where an oxidiser or carbon stage is needed, decide early where it sits relative to the scrubber.

QUESTIONS TO ASK A SUPPLIER

Q1 Which contaminants in our vent will this scrubber not remove?

Q2 What upstream or downstream stage do you recommend for them?

Q3 What happens if the inlet temperature rises above design?

04 Numbers, in writing, before you buy

Regulators judge a scrubber on what leaves the stack. Make sure the predicted figures line up with your limits.

Example: EU BAT conclusions for chemical-sector waste gas. Absorption in acid or alkaline scrubbers is named as a technique, with these associated emission levels for inorganic sources:

CHLORINE <0.5 to 2 mg/Nm ³	HCL 1 to 10 mg/Nm ³	AMMONIA 2 to 10 mg/Nm ³	NOX 10 to 150 mg/Nm ³
--	--	--	--

Source: Commission Implementing Decision (EU) 2022/2427. Your permit conditions take precedence.

Ask for this on the datasheet

- Design flow and temperature
- Inlet concentration for each gas
- Predicted outlet concentration for each gas
- Reagent use and bleed rate per stage
- Pressure drop and fan duty
- Materials of every wetted part

Keep it working, and prove it

- pH and ORP held at setpoint
- Recirculation flow and sump levels
- Pressure drop across each stage
- Periodic stack emission testing
- Signed commissioning record on file
- In the UK, LEV examined at least every 14 months under COSHH

IN PRACTICE

Agree reference conditions

Limits are quoted at stated temperature, pressure, oxygen and moisture. Make sure the supplier's figures use the same basis as your permit.

Plan the test points

Sampling ports on the stack let you test emissions without modifying ductwork later.

QUESTIONS TO ASK A SUPPLIER

Q1 What outlet concentration do you predict for each gas, at design flow?

Q2 Which reference conditions are your figures quoted at?

Q3 What will we need to monitor to show compliance?

05

The checklist for a quote you can trust

Send what you have; an engineer can fill gaps on a call or a site visit. The more of this list you can answer, the tighter the sizing and the fewer surprises at commissioning.

☐ **Every gas in the vent**, with concentrations if known

☐ **Extract flow** in m³/h, and temperature

☐ **Emission limits** or permit conditions

☐ **Process type:** batch, continuous or tank vent

☐ **Every source** that might share the scrubber

☐ **Hazardous area** classification, if any

☐ **Utilities:** power, water and effluent route

☐ **Drawings:** P&ID or process description



TALK TO AN ENGINEER

Tell us what is coming off your process

Send the gases, the flow and the limit you have to meet. A process engineer will reply within 4 working hours and tell you which stages it takes, before anyone talks about price.

WEB

caldera-technologies.com/chemical-scrubbers

EMAIL

hello@caldera-technologies.com