H_2S SCRUBBERS FOR BIOGAS

CRA
Engineering a Safer World

BULK REMOVAL AND POLISHING, SUPPLIED AS ONE PACKAGE

Hydrogen sulphide in biogas corrodes engines, compressors, pipework and heat exchangers, and it damages upgrading membranes and catalysts. CRA removes it in two stages.

Bulk removal takes the H_2S down to below 100 ppm, and polishing takes it from there to below 5 ppm. CRA builds both stages in its own works and supplies them as one package, sized to the sulphur load of the gas.

Below 100 ppm
Outlet H_2S after bulk removal

Below 5 ppm
Outlet H_2S after polishing

Up to 90%
Less caustic than a once-through scrubber

Zero
Air added to the gas by the Regenerative Scrubber

THE RANGE, BY DUTY

Bulk Removal — Outlet below 100 ppm



Regenerative Scrubber
Chemical scrubber with biological regeneration

It suits CBG and high sulphur loads, and it adds no air to the gas.



Biological Scrubber
Bio-trickling scrubber

It suits gas engines and boilers, and it uses no caustic.

Polishing — Outlet below 5 ppm



Iron Oxide Scrubber
Dry fixed bed of iron oxide media

It follows bulk removal, or works on its own at small loads.



Carbon Scrubber
Fixed bed of activated carbon

It gives the final polish ahead of engines, membranes and catalysts.

HOW THE TWO STAGES RUN AS ONE TRAIN

The blower, both stages, the sampling points and the controls come from CRA as one package.

Step 1
Raw biogas
The gas arrives from the digester at its inlet H_2S.

Step 2
Bulk removal
A Regenerative or Biological Scrubber takes the H_2S to below 100 ppm.

Step 3
Polishing
An Iron Oxide or Carbon Scrubber takes it to below 5 ppm.

Step 4
Gas use
Clean gas goes on to the engine, the boiler or CBG upgrading.

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BULK REMOVAL

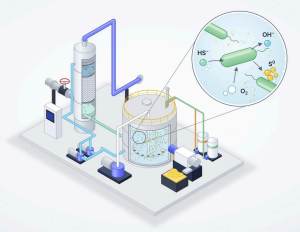
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THE FIRST STAGE TAKES THE H_2S DOWN TO BELOW 100 PPM

Regenerative Scrubber

Chemical scrubber with biological regeneration

Model code RS



H_2S is absorbed in a packed column by a mildly alkaline solution. The solution then passes to an aerated bioreactor, where sulphur-oxidising bacteria convert the sulphide to elemental sulphur and restore the alkalinity.

The air is fed only to the bioreactor, so none of it reaches the gas. Regeneration cuts caustic consumption by up to 90% against once-through scrubbing, and the sulphur leaves as a solid.

Inlet H_2S	**High loads, typically above 5,000 ppm**
Outlet H_2S	**Below 100 ppm**
Consumable	**Caustic make-up, up to 90% less than once-through**
By-product	**Elemental sulphur**
Air added to gas	**None**
Suits	**CBG and high sulphur loads**

Biological Scrubber

Bio-trickling scrubber for engines and boilers

Model code BS



Raw biogas passes through a packed column irrigated with water and nutrients, where sulphur-oxidising bacteria oxidise the H_2S. A small dose of air supplies the oxygen, and the sulphur leaves as a dilute sulphate effluent.

The scrubber uses no caustic, which gives engines and boilers the lowest running cost. It suits sites with a wastewater facility to take the effluent. CRA builds it under a technology collaboration with S&H Umweltengineering of Germany.

Inlet H_2S	**Up to about 10,000 ppm**
Outlet H_2S	**Below 100 ppm**
Consumable	**Nutrients and water**
By-product	**Dilute sulphate effluent**
Air added to gas	**A small dose, which engines and boilers tolerate**
Suits	**Gas engines and boilers**

WHAT THE SULPHUR LOAD COSTS IN CAUSTIC

A once-through caustic scrubber uses caustic in proportion to the sulphur it removes. The Regenerative Scrubber regenerates that caustic in its bioreactor and cuts the make-up by up to 90%.

34 kg
Sulphur carried each day by 1,000 Nm^3/h of gas at 1,000 ppm H_2S.

1.25 kg
Caustic soda a once-through scrubber needs, at the least, for each kg of sulphur.

1,030 kg
Sulphur carried each day by 1,000 Nm^3/h of gas at 3% H_2S.

469 tonnes
Caustic a once-through scrubber would need for that load in a year, at the least.

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POLISHING

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THE SECOND STAGE TAKES THE H_2S DOWN TO BELOW 5 PPM

Polishing follows bulk removal and takes the H_2S from below 100 ppm to below 5 ppm. CRA pairs the Iron Oxide Scrubber with CBG trains, and the Carbon Scrubber with engines and boilers that need a lower outlet.

Iron Oxide Scrubber

Dry fixed bed of iron oxide media



Gas passes down through a fixed bed of iron oxide media, where the H_2S reacts to form iron sulphide that stays in the bed. A moisture conditioning point ahead of the media keeps the reaction active.

The vessel runs without power or chemical dosing, and the spent media leaves dry. CRA fabricates the vessels in its own works to ASME Section VIII Division 1.

Duty	**After bulk removal, or on its own at small loads**
Outlet H_2S	**Below 5 ppm**
Consumable	**Iron oxide media**
Waste	**Dry spent media**
Power and dosing	**None**

Carbon Scrubber

Fixed bed of activated carbon



Gas passes through a fixed bed of impregnated activated carbon, where the remaining H_2S is adsorbed and oxidised on the carbon surface. The same bed removes siloxanes and volatile organic compounds.

CRA supplies the vessels singly or as a lead and lag pair, so the lead bed can be changed with the line still running. The media is selected against the gas analysis and its moisture.

Duty	**Final polish ahead of engines, membranes and catalysts**
Outlet H_2S	**Below 5 ppm**
Also removes	**Siloxanes and VOCs**
Consumable	**Impregnated activated carbon**
Change-out	**Lead and lag vessels, with the line still running**

ANOTHER OPTION

Caustic Scrubber. A once-through caustic unit suits sites with intermittent gas and caustic already on hand.

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SELECTION AND REFERENCES

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SIZED FROM THE GAS FLOW, THE INLET H_2S AND THE GAS USE

CHOOSING A SCRUBBER

Where the gas goes	Inlet H_2S and site	Bulk removal	Polishing
CBG, membranes or grid	Any sulphur load above about 5 kg a day	Regenerative Scrubber	Iron Oxide Scrubber
Engine or boiler	Up to about 5,000 ppm, with a route for sulphate effluent	Biological Scrubber	Carbon Scrubber, where the engine needs a lower outlet
Engine or boiler	5,000 to 10,000 ppm	Biological or Regenerative Scrubber, decided with the engineer	Carbon Scrubber, where the engine needs a lower outlet
Engine or boiler	Above 10,000 ppm, or no route for sulphate effluent	Regenerative Scrubber	Carbon Scrubber, where the engine needs a lower outlet
Any use	Sulphur load below about 5 kg a day	No wet scrubber	Iron Oxide Scrubber on its own

The sulphur load in kg a day is gas flow (Nm^3/h) × inlet H_2S (ppm) × 0.0000343. Model codes are RS or BS followed by that load, so an RS-450 is designed for up to 450 kg of sulphur a day. A CRA process engineer confirms the train on a call.

REFERENCE PROJECTS

These six CRA scrubber projects all treat sewage digester gas. Inlet and outlet figures are design basis.

Project	Scrubbers	Gas flow	Inlet H_2S	Outlet H_2S
Dharavi STP, Mumbai	Regenerative and Carbon	1,275 Nm^3/h	10,000 ppm	Below 100 ppm
Malad WwTF, Mumbai	Regenerative and Carbon	1,450 Nm^3/h	5,000 to 10,000 ppm	100 ppm or less
K&C Valley STP, Bangalore	Caustic, three towers	1,050 Nm^3/h	10,000 ppm	50 ppm
Diggian STP, Chandigarh	Caustic	557 m^3/h	5,000 to 10,000 ppm	Below 200 ppm
Bhandup STP, Mumbai	Biological	590 Nm^3/h	7,000 ppm	200 ppm
Municipal WWTP, Mozambique	Biological	240 Nm^3/h	900 ppm	100 ppm

For an enquiry

Send CRA the gas flow, the inlet H_2S, the gas composition, the gas use and the utilities at site, or book a call with a process engineer at www.cra.energy.

About CRA

CRA was founded in 1993 and builds its gas systems in two works in the National Capital Region of India. Process, mechanical, electrical and automation engineering sit in one team.

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