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AZZURO

AT A GLANCE:

Effectiveness

Removes over 99.5% H₂S and other toxic sulfur compounds

Capacity

Flow rates up to 20,000 cfm and H₂S concentrations up to 20,000 ppm

Technology

An adaptive and self-regulating process that uses no chemicals and operates at ambient temperature and pressure

Reliability

Consistent performance, few moving parts, extremely high reliability, and near zero maintenance

Versatility

A modular design, easily configurable for a wide range of applications

Economics

Simple to install, minimizes disruptions to operations, reduces steam consumption, and produces an economic by-product. CAPEX can be recovered in as little as 24 months

**UNRIVALED
and GUARANTEED
PERFORMANCE**



FROM THE *GLOBAL LEADER* IN BIOREACTOR TECHNOLOGY

Azzuro has The Solution to reducing sulfur emissions. The technology provides expanded capabilities for treatment of H₂S, SO₂, COS, CS₂ and mercaptans while offering high reliability and reduced maintenance, all at significantly lower installed cost.

Over 99.5% of H₂S and SO₂ can be eliminated by a rugged biological system that has few moving parts, consumes no chemicals, and operates at ambient temperature and pressure.

Sulfur Challenges

Increasingly stringent government regulations on sulfur emissions can be an expensive problem for the petroleum industry. The California Air Resources Board (CARB) has set a mandatory 2/3 reduction on sulfur emissions from flares and local Air Resources Boards are enforcing additional restrictions and aggressive time schedules for meeting this requirement. Further limitations are likely in 2017 and similar restrictions impact oil exploration and production fields as well as storage and transshipment facilities.

Eliminating sulfur contamination is also a critical factor in realizing the benefits of enhanced gas recovery systems. Recovering the value of waste gas for use as fuel or feedstock depends on the long-term reliability of sulfur treatment processes and the time required to recapture investments in new equipment. Total investment includes equipment expense, cost of facility modifications required for integration of new processes, and the expense incurred by disruptions to operations.

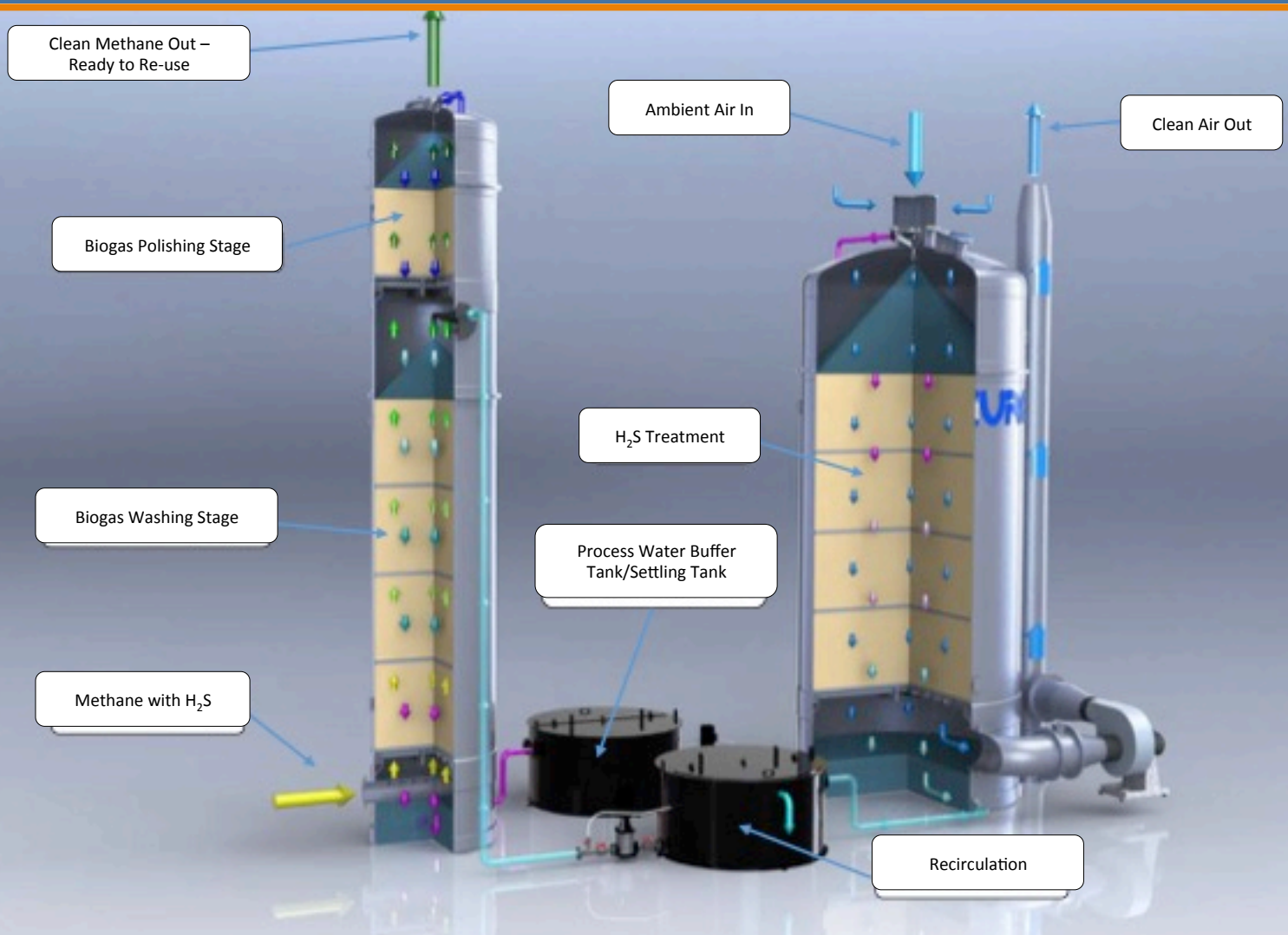
Azzuro's Solution

Our performance proven Sulfatech System offer a highly efficient and cost-effective alternative to historical methods of reducing sulfur emissions. In contrast to amine treatment, thermal oxidation, or caustic scrubbing, Azzuro's technology provides expanded capabilities for treatment of H₂S, SO₂, COS, CS₂ and mercaptans while offering higher reliability and reduced maintenance, all at significantly lower installed cost.

Over 99.5% of H₂S and SO₂ can be eliminated by a rugged biological system that has few moving parts, consumes no chemicals, and operates at ambient temperature and pressure.

The Sulfatech Systems also offer high volumetric efficiency. Large concentrations of sulfur are removed from hydrocarbon streams in a single-pass flow-through biological process. Many systems can be supplied as a small skid, located close to the flare header, tank farm, well head, or other emission source. Utility requirements are modest, long piping runs are not required, installation is rapid, and disruptions to operations are minimal.

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AZZURO'S Sulfatech - Process Description

The key of this technology is the "Anaerobic-Aerobic Biological Wheel". The system uses two different phases (i.e. anaerobic and aerobic) of biological activity to have H_2S from Biogas or Flare Gas absorbed in an Anaerobic Chamber and subsequently pumped into an Aerobic Biotrickling Filter that oxidizes the H_2S into H_2SO_4 .

The biogas flow always stays in the Anaerobic Zone, where it is washed by a "Biological Slurry". Where washing it with just water will take an enormous amount of water, and with caustic a good amount of caustic, the Biological Slurry will absorb/dissolve the H_2S easily. This is due to the biological conversion of the H_2S , immediately after the H_2S is dissolved into the Biological Slurry.

After scrubbing the biogas the Biological Slurry is pumped into an Aerobic Biotrickling Unit. The Biological Slurry contains the dissolved H_2S , and the converted products of the biological conversion, i.e.: HS^- , S , CS , COS and other reduced sulfur compounds. As a next step, the Biological Slurry is sprayed into the Aerobic Biotrickling Unit and mixed with ambient air. In this aerobic trickling phase the Biological Slurry is fully aerated and oxidizes all the sulfur compounds into sulfuric acid.

The operation is run in such a way that a 3 - 5% sulfuric acid drain comes out of the Biotrickling Unit. This acid drain is brought back into the Biogas Washing Chamber (still containing the Biological Slurry), ready to scrub the H_2S out of the methane again.

To maintain the right sulfuric acid concentration and salt level so that the bioslurry remains capable of dissolving all H_2S , a small percentage of the flow is refreshed with potable water. The return slurry is still set to have a H_2SO_4 concentration of 3-5%.

Due to the anaerobic and acid environment the biological reduction of CH_4 is minimal to nothing. The only loss of CH_4 is the result of a small amount dissolving into the water flow.

Performance Features

The unique design and operating characteristics of Azzuro's biological process makes it ideally suited for use in demanding applications. Our bacteria strains are highly adaptive living organisms that recover quickly from process variations and upsets.

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Applications include:

- ***Meeting regulatory compliance for sulfur emissions from flares and flare gas recovery systems.***
- ***Reducing corrosive damage in steam plants by treatment of boiler feed gas.***
- ***Reducing toxic exposure and minimizing sulfur concentrations from vapor recovery systems, including tank farms, marine terminals, load stations, and other storage or transshipment facilities.***
- ***Highly cost effective replacement for thermal oxidizers and caustic scrubbers used in post-SRU waste gas treatment.***
- ***Treatment of sour gas from API Separators.***
- ***Polishing of waste gas from other treatment systems.***
- ***Natural gas sweetening and water treatment at the well head.***
- ***Locations requiring long-term remote unattended operation.***
- ***Any applications where sulfur loads are anticipated to increase over time.***

Applications

The modular design of our Systems makes them easily configurable for a wide range of applications as does their small footprint, simplified installation, and minimal utility requirements.

Reducing toxic exposure and controlling sulfur emissions are common problems across many industries and Azzuro is constantly discovering new applications of its technology. Please contact us if you have a requirement not included in the list on the left.

Flexibility

Bioreactor outlet concentrations remain stable, even when inlet concentrations vary widely over short time periods.

Adaptability

Sulfur removal capacity can naturally increase in response to increasing sulfur loads.

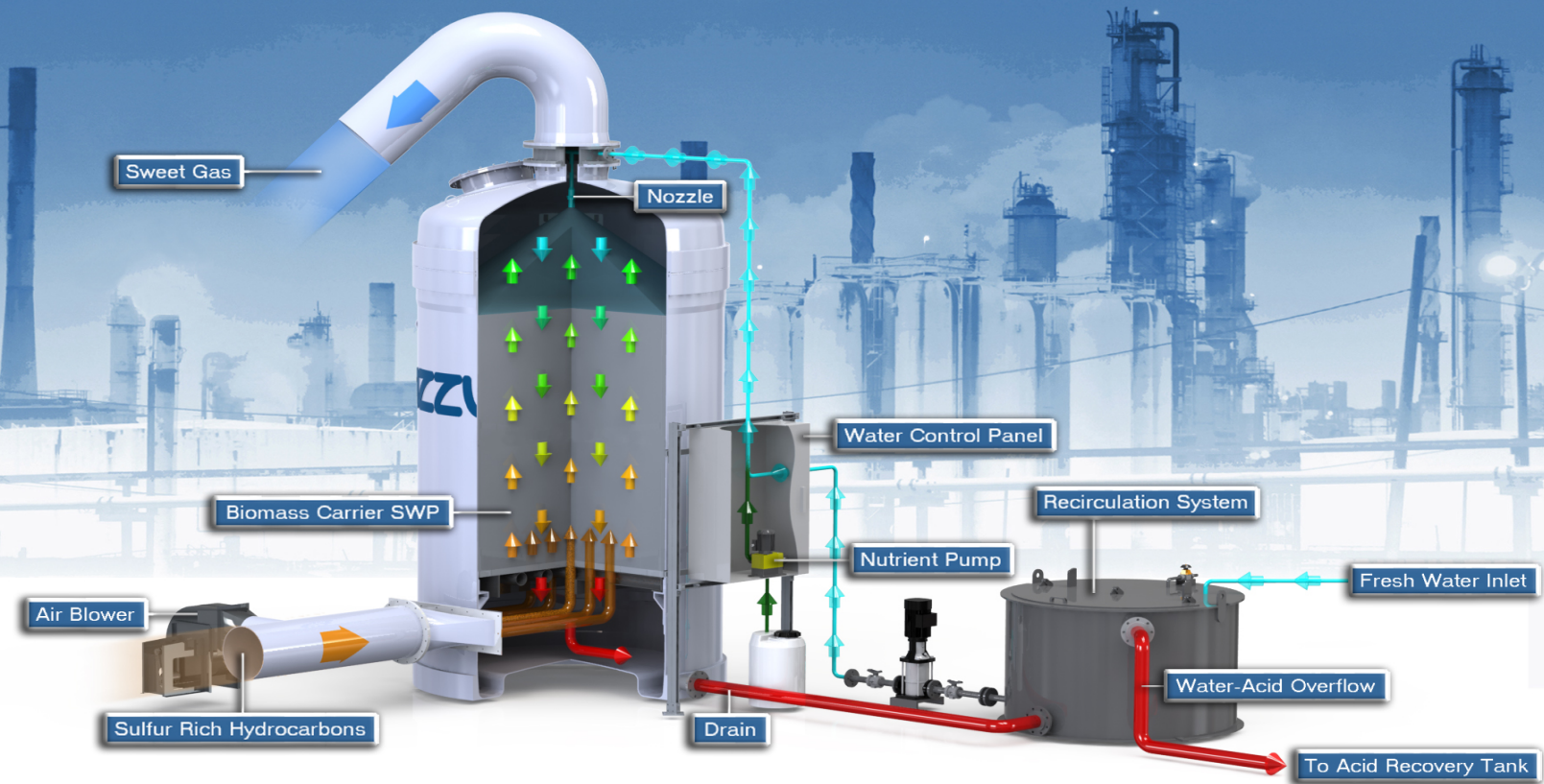
Durability

Our technology is tolerant to loss of hydrocarbon, water, or nutrient supply. Even in extreme cases of power failure, sulfur removal efficiency is recovered quickly without operator intervention.

Spacious Wire Pac Media (SWP)

This unique support structure immobilizes large populations of bacteria while maintaining uniform gas flow over the entire microbial bed. All bacteria are therefore uniformly exposed to sulfur gases, preferentially absorb them, extract the energy required for bacterial growth via oxidation, and produce an economic sulfuric acid by-product stream. The SWP support minimizes the contact time required for this process to take place, maximizing volumetric efficiency and stabilizing performance over time.

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Bioreactor Technology

Our high-performance Bioreactors are modular towers containing sulfur-consuming bacteria. Our patented synthetic Spacious Wire Pac Media (SWP) provides a high surface area and stable porous framework for supporting large bacterial populations that can weigh tons.

As shown in the above figure, the sequence of the Bioreactor operation is as follows:

- The treatment stream enters at the bottom of the tower after mixing with air required for bacterial oxidation of sulfur compounds. In applications where hydrocarbon recovery is desired, the mixing ratio is restricted to approx. 1% of the hydrocarbon upper explosion limit, providing a 100x safety factor.
- The sulfur-rich stream passes upward through one or more immobilized bacterial beds.
- The bacteria extract energy from sulfur compounds, oxidizing them to sulfuric acid in the process, and sweet gas exits from the top of the reactor.
- A small flow rate of water is sprayed over the bed(s) via an external tank and recirculation pump. The water flow washes the sulfuric acid to the bottom of the tower where it is collected for economic use or neutralization with inexpensive lime.
- A smaller secondary pump supplies bacteria-sustaining nutrients to the water flow. The nutrient flow rate is low and the nutrient storage tank requires refilling only once every two months. This is the total routine maintenance required by the system!



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Petrobras - Presidente Getúlio Vargas Refinery (Repar)



Benefits of Teaming with Azzuro

Leading Edge Technology

Our microbial technology is the result of years of development performed in collaboration with Departments of Microbiology at major US and European Universities. Extensive microbial R&D begins with culture cultivation and characterization in the lab and extends to pilot scale reactors for process optimization. The result is an efficient and rugged biological system that naturally treats sulfur for years without degraded performance. With Azzuro, you are at the forefront of the industry.

Global Footprint

Azzuro is as global as it gets and that is what you should expect from a partner. We have installations in Australia, Brazil, Canada, Chile, Denmark, Finland, France, Jordan, Kuwait, United Arab Emirates, the UK, and the USA. We are where you are.

Quality

We understand that quality of workmanship leads directly to reliable performance and customer satisfaction. This is why Azzuro assembles products from a standardized family of modules rather than custom engineered components. Modularity guarantees that the same level of quality, workmanship, and performance is built into each product we manufacture.

Reliability

In nearly 400 installations spanning almost 20 years we have never had a service call for other than routine maintenance (and this is rare).

About Azzuro

Azzuro is the global leader in designing, engineering and maintaining high-efficiency biological reactors for a broad range of emission control requirements in petroleum, water, agriculture, food and beverage, chemical, and other industries. Our technical leadership is based on experience and a solid knowledge of our systems and processes. We are dedicated to our customer's success and driven to continually refine and improve a technology that is endorsed by some of the world's largest municipal, industrial, and engineering organizations.

Representative Customers:

3M (prev. Nylonge), USA	Sponge Production
Anheuser-Busch, USA	Brewery
Bayer, Germany	Rubber Production
Carlsberg, Poland	Brewery
Cargill, Belgium	Seed Extraction
DOW Chemicals, France	Pesticide Production
Gamatex, Belgium	Hydrocarbon Storage Tank
Heineken, Netherlands	Brewery
Ineos Lucite, Netherlands	Acrylates Production
Nedalco, Netherlands	Ethanol Production
Nerefco, Netherlands	
(BP-Chevron-Texaco),	Refinery Wastewater Off-Gas
Petrobras, Repar, Brazil	API-Separator
Petrobras, Rnest, Brazil	API-Separator
Petrobras, Reduc, Brazil	API-Separator
Shell, France	Refinery Wastewater Off-Gas
Sidmar, Belgium	Steel Mill
ViskoTeepak, Finland	Viscose Production

Some of the Engineering Firms we have worked with:

Arcadis, Black & Veatch, CDM Smith, CH2MHill, Degremont, Halcrow, HDR, MWH, SKM and Veolia