



THE 20<sup>TH</sup> INTERNATIONAL OPERATIONS & MAINTENANCE  
CONFERENCE IN THE ARAB COUNTRIES

# Biogas Purification & Desulfurization

Environment Serves Plant in Al Khobar

General Structural Data  
Desulfurization Design Concept  
Processing  
A. Initial Operation  
B. Ideal Operation  
Conclusion

    #OmaintecConf

National Water Company

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20 YEARS



# Attending Sheet



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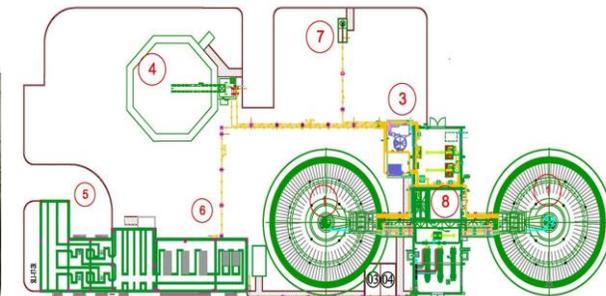
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### General Structural Data

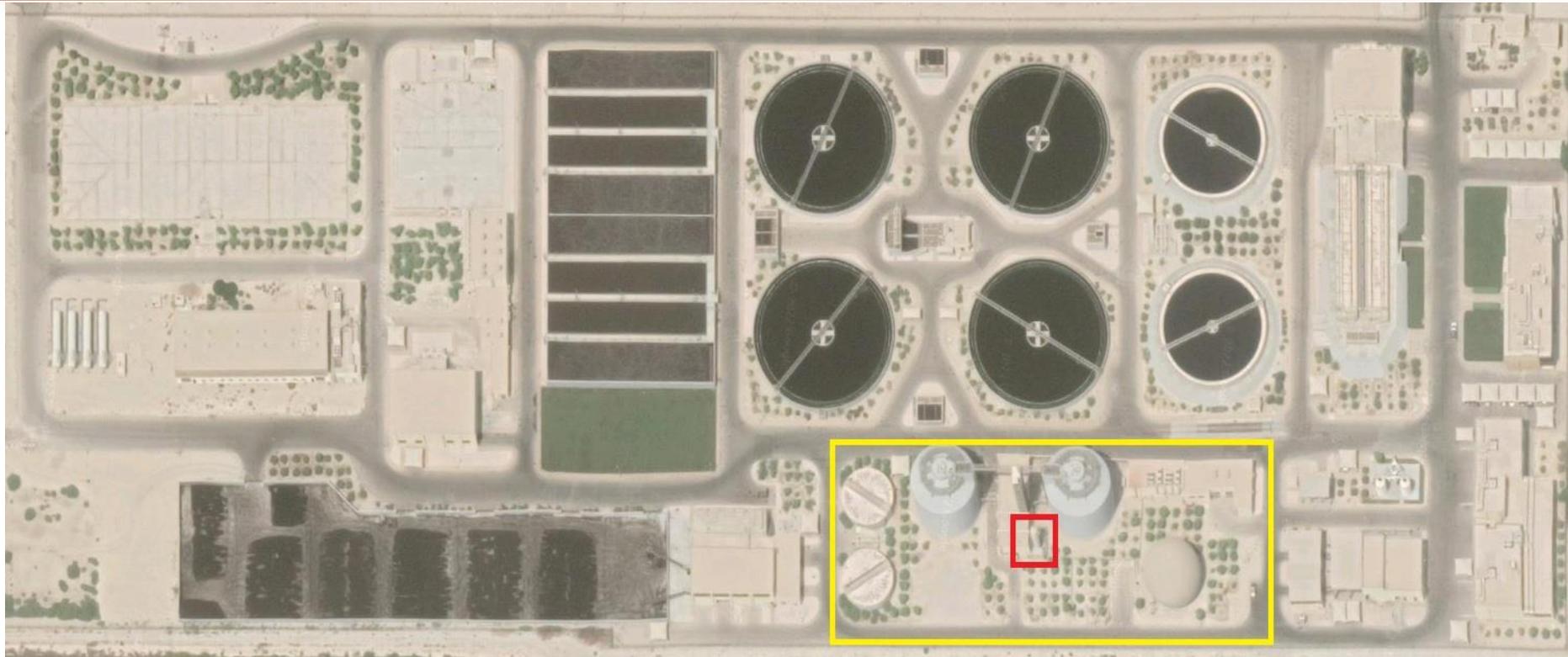
Owner	National Water Company
Total Project Cost	272,000,000 SAR
Desulfurization Unit Cost	888,457 SAR
Operation Date	21/03/2021
Capacity	70,000 m3/day
Location	Saudi Arabia, Eastern Sector, AL Khobar





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## General Structural Data





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# Desulfurization Design Concept

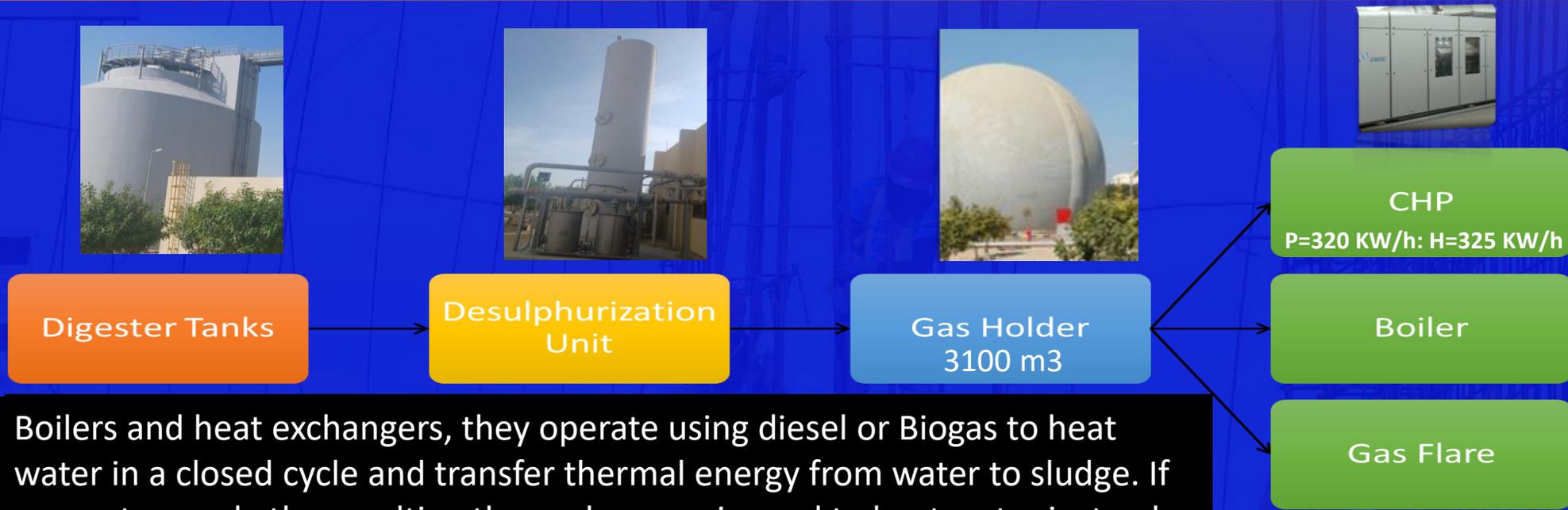
### Design Criteria

- Biological Filter (Polypropylene plastics ) (-10 up to 64 mbar pressure).
- Remove the hydrogen sulfide in the biogas to values below 200 ppm.
- Reduced carbon dioxide.
- Reduced water content of biogas.
- Volume of the unit  $\approx 18.5 \text{ m}^3$ .
- Designed by PASSAVANT and Arteria. (Constricted by Aziz company).





# Processing



Boilers and heat exchangers, they operate using diesel or Biogas to heat water in a closed cycle and transfer thermal energy from water to sludge. If generator work, the resulting thermal energy is used to heat water instead of boilers.

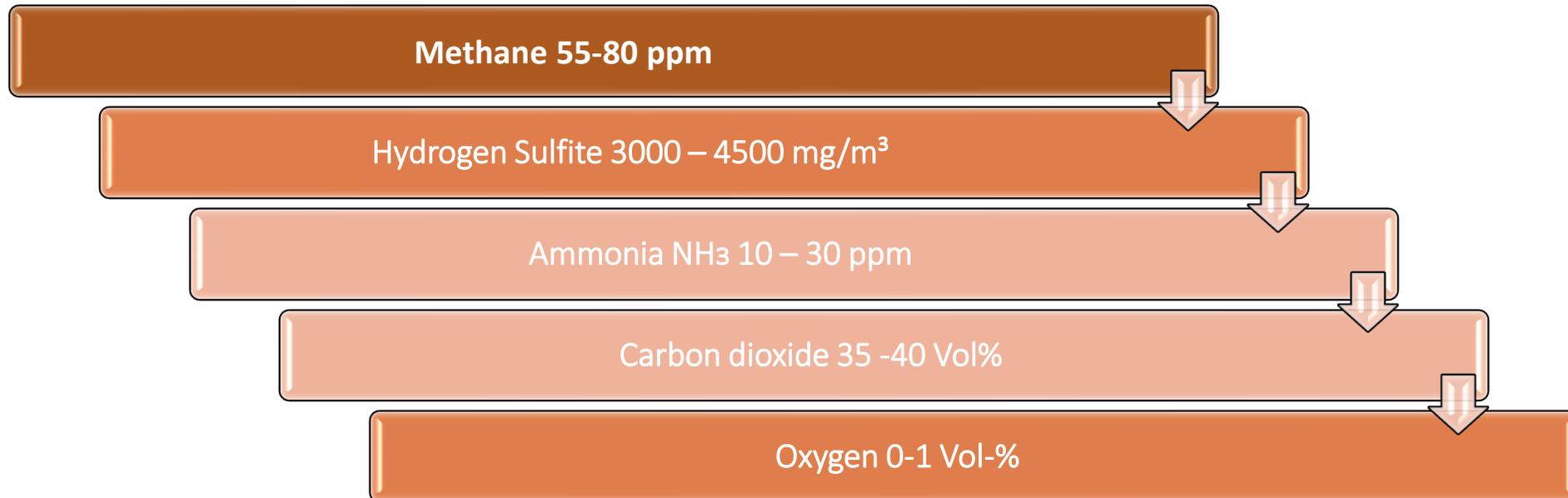
## Processing

### Desulfurization volume flow characteristic

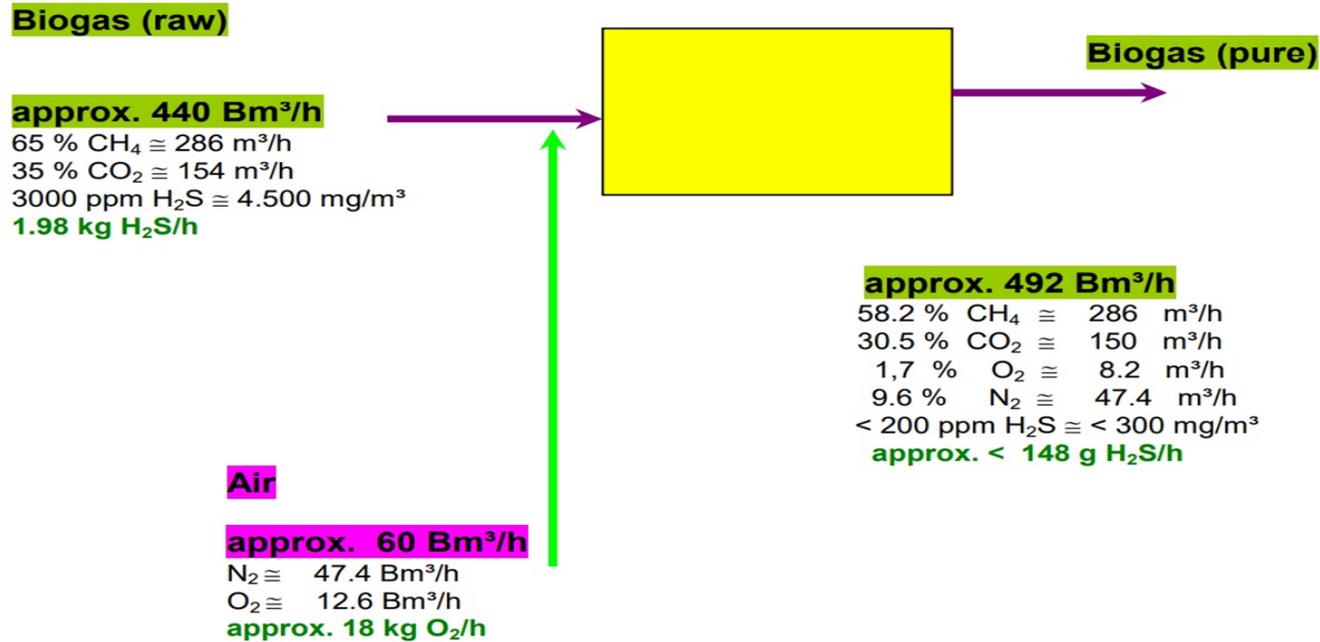


## Processing

### Biogas to be purified contents



# Processing



Mass balance for gas components

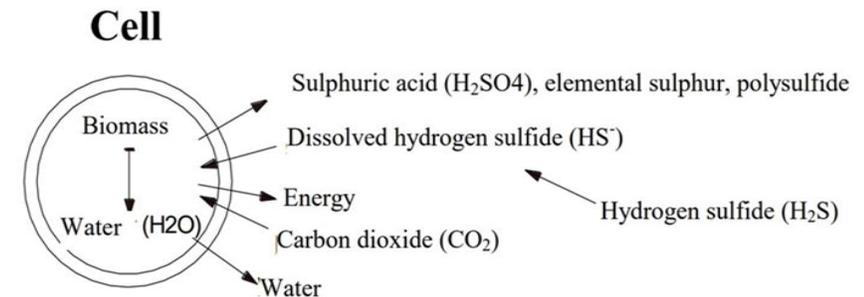
## Processing

### Concept of Oxidation levels of the hydrogen sulfide conversion

#### 1. Direct oxidation of hydrogen sulfide to sulfate.



#### 2. Oxidation of the sulfate with elemental sulfur as intermediate



Biochemical operating principle of the degradation of hydrogen sulfide with micro-organisms



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## Processing

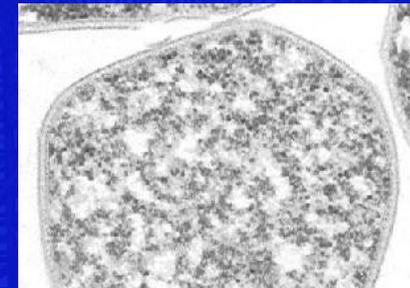
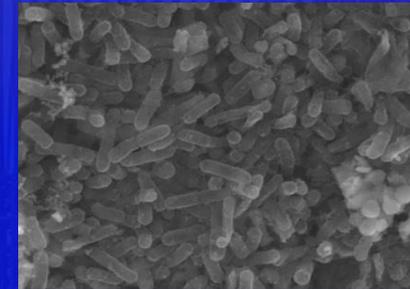
### Elimination Conditions of sulfur components by the sulfur-oxidizing micro-organisms:

- Availability of oxygen.
- Existence of an oxidizable source of sulfur (e.g. Hydrogen sulfide or organically bound sulfur).
- Availability of ammonia as a nitrogen source.
- Availability of carbon dioxide (CO<sub>2</sub>) for sulfur oxidizers. or hydrocarbons (mercaptans etc.) as carbon source.
- Availability of phosphor, nitrogen, trace elements.
- Minimum PH value: 1.

## Processing A. Initial Operation

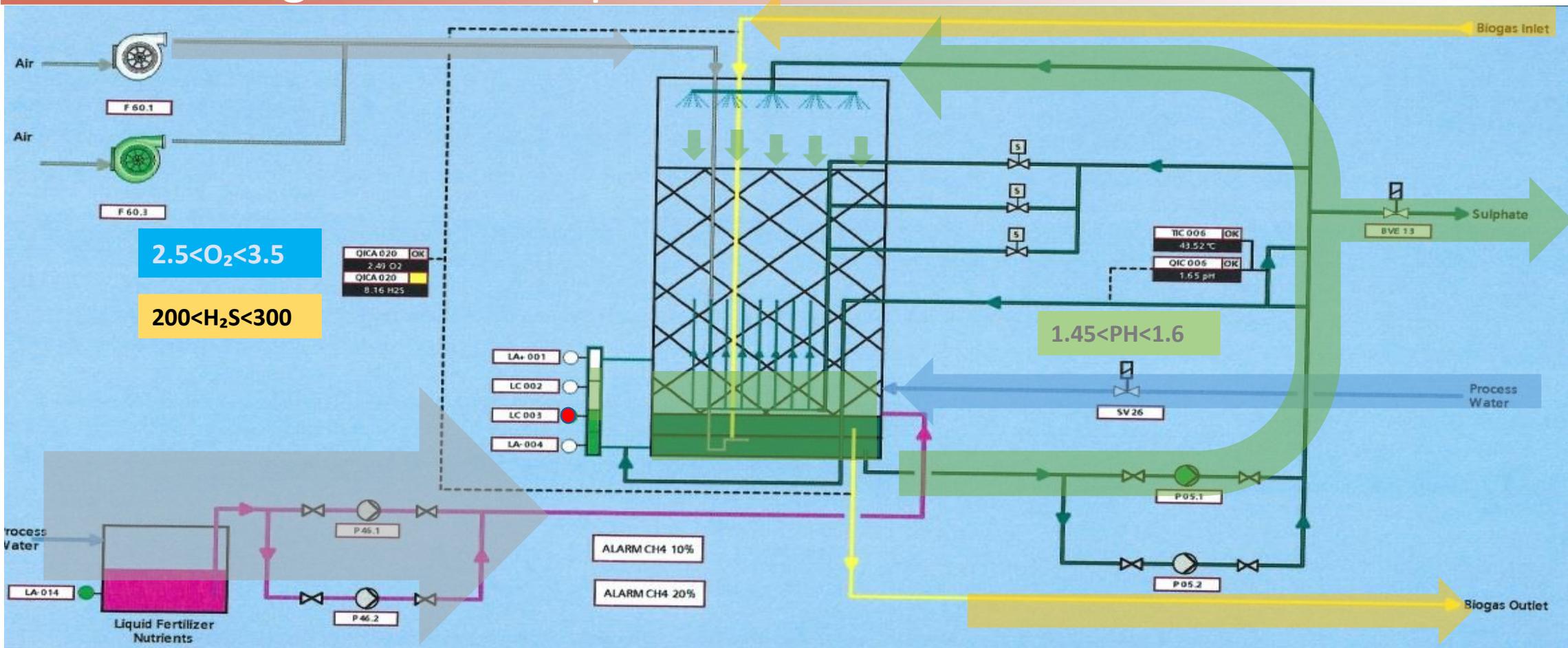
- 1.) Separately dissolve the nutrient salts in water. No distilled water necessary!
- 2.) Fill up the ready-made saline solution in the growth tank with the corresponding amount of water.
- 3.) Add the corresponding amount of sulfur.
- 4.) Inoculate with the MO-suspension at a ratio of 1:20 to the nutrient solution.
- 5.) Set the ventilation in a way that allows the liquid in the tank to mix well.
- 6.) Check the propagation visually and by measuring the pH value.
- 7.) Duration of the cultivation phase: 18-20 days.
- 8.) If it becomes apparent that the biological trickle-bed reactor cannot be ventilated for a longer period of time (> 1 week), about 250-300 l of microorganism suspension must to be removed from the tank.

Thiobacillus



Sulfolbus

Processing B. Ideal Operation





## Processing B. Ideal Operation

### Required Quantity of Fertilizer

1 dosing pump delivers app. 200 ml per minute → both 400 ml/min

1.) Calculation of the respective amount of H<sub>2</sub>S

Volume flow biogas at the inlet [m<sup>3</sup>/h] x H<sub>2</sub>S concentration [mg/m<sup>3</sup>] = H<sub>2</sub>S quantity [kg/h]

Density of H<sub>2</sub>S approx. 1.5 kg/m<sup>3</sup> → 1 ppm ≠ 1.5 mg/m<sup>3</sup>

**Example:**

100 m<sup>3</sup>/h x 500 ppm → 100x500x1.5/1,000,000 = 0.075 kg H<sub>2</sub>S/h



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### Processing B. Ideal Operation

#### Required Quantity of Fertilizer

2.) For 1 kg H<sub>2</sub>S/h approx. 1.7 kg/d of fertilizers are required.

#### Example:

0.075 kg H<sub>2</sub>S/h → about 0.075 kg/d or 0.075 l/d supply of concentrated fertilizer or 0.15 l/d diluted 1:1 with water are required

→ Density of fertilizer calculated with 1,000 kg/m<sup>3</sup>

→ Delivery rate per pump about 200 ml/min → 400 ml/min (2 pumps)

## Processing B. Ideal Operation

### Required Quantity of Fertilizer

Biogas volume flow	H <sub>2</sub> S input	H <sub>2</sub> S quantity	Quantity of fertilizer 1:1 diluted with H <sub>2</sub> O	Dosing interval	Dosing duration Time for working of both pumps (P46.1/2) every hour
[m <sup>3</sup> /h]	[ppm]	[g/h]	[ml/day]	[h]	[s]
150	2000	450	1530	1	about 10
300	2000	900	3060	1	about 20
440	2000	1320	4488	1	about 28
150	3000	675	2230	1	about 14
300	3000	1350	4590	1	about 29
440	3000	1980	6732	1	about 42



## Processing B. Ideal Operation

### Sigent DryLoc™ PH and ORP electrode

#### SAFETY INSTRUCTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications ( 0-95 C ) / 6.89 bar.
4. Wear safety goggles or face shield during installation/service.
5. Do not alter product construction.
6. When using chemicals or solvents care should be taken and appropriate eye, face, hand, body, and/or respiratory protection should be used.



## Processing B. Ideal Operation



SEITENKANALVERDICHTER  
EINSTUFIG UND DOPPELSTUFIG

SIDE CHANNEL BLOWERS  
SINGLE STAGE AND DOUBLE STAGE

Typ Type	Effizienzklasse Efficiency class	Frequenz Frequency	Grenzwerte der Drosselkurve Überdruck		Grenzwerte der Drosselkurve Unterdruck		Nennwerte des Motors			Schalldruckpegel Sound pressure level	Gewicht (ca.) Weight (approx.)
			Maximum performance when used as blower		Maximum performance when used as extractor		Motor ratings				
			$\dot{V}$ max. $\dot{V}$ max.	$\Delta p_t$ max. $\Delta p_t$ max.	$\dot{V}$ max. $\dot{V}$ max.	$\Delta p_t$ max. $\Delta p_t$ max.	Leistung Rated output	Spannung Voltage	Strom Current		
		Hz	m <sup>3</sup> /min	mbar	m <sup>3</sup> /min	mbar	kW	V	A	dB (A)	kg
1SD 410	IE2	50	2,42	130 / 160 <sup>1)</sup>	2,42	130 / 160 <sup>1)</sup>	0,75	230/400	2,95/1,7	63	16
	-	60	2,92	160	2,92	160	0,90	277/480	2,95/1,71	64	16
1SD 410	IE2	50	2,42	200 / 200 <sup>1)</sup>	2,42	170 / 170 <sup>1)</sup>	1,10	230/400	4,0/2,3	63	16
	-	60	2,92	220	2,92	210	1,30	277/480	4,5/2,6	64	16

<sup>1)</sup> Arbeitspunkt bei max. Auslastung / Operating point at max. load

## Processing B. Ideal Operation

### The magnetic switches

- Accommodated in a housing( PP ~ 65X50X35 mm), which can be fastened to a pipe by means of a tube clamp which is attached to the housing.
- The housing contains a connection terminal and a microswitch; a magnet is fixed to the lever of the latter.
- When the magnetic switch is installed and the magnet on the microswitch lever is activated by a magnet moving up and down in the tube, this changes the position of the microswitch lever and an electrical circuit is created.
- The magnetic switches have so-called bistable characteristics; i.e. they remain in the switching status caused by the influence of the passing magnet and only switch over when the magnet passes by in the opposite direction.





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### Conclusion

- Desulfurization reduces sulfur dioxide (SO<sub>2</sub>) released to atmosphere during combustion process, since Hydrogen Sulfide is a highly toxic and corrosively acting gas which is transformed to sulfur dioxide during its use.
- Bacteria use carbon dioxide as a carbon source, so carbon dioxide emission into the atmosphere reduced by approximately ; 5%.
- Water content of the raw biogas is also reduced to about 30-40 °C by the cooling down procedure during the passage through the column.
- Odor problems will be reduced, in which are common in biogas plants, since H<sub>2</sub>S has one of the lowest odor thresholds known, making the human nose very sensitive even to trace concentrations.



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