SwissBiogas.com

Additives for Desulfurisation in Anaerobic Digestion

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

SwissBiogas.com presents:

EG 1118 desulfurisation and gas booster additive

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

Desulfurisation, why?

- Protects the CHP unit
- Protects the engines
- Raises the efficiency of the whole plant
- Lowers the operating costs
- Increases the operational safety

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

Current desulfurisation methods:

- No reactor intervention
- Air injection
- FeClx (ferrous / ferric chloride) addition
- Iron oxide-hydroxide addition
- FeOx addition

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

Air injection, why not:

- Atmospheric nitrogen is unnecessarily added to the biogas (Ammonia)
- Excessive introduction of oxygen leads to formation of corrosive Sulfurous Acid
- % O_2 higher than 0.9% before CHP has a negative effect on efficiency of CHP
- Sulfur deposits formed in the fermenter gas compartment break off from time to time and drop into the substrate
- Risk of explosion
- Increased corrosion: $S + O_2 + H_2O \rightarrow H_2SO_4$
- The air flow should be controlled and adapted regularly:
  a) Less gas production but same air injection results in too much O_2 and dilution
  b) Higher gas production with same air injection results in too less O_2 with weak desulfurization effect

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

FeClx, why not:

- Forms HCl which penetrates the bacterial membrane
- Classified as dangerous substance
- Considered a corrosive substance
- Releases chlorides during desulfurisation → More corrosive than H_2S

CORROSIVE

IRRITANT

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

Iron oxide-hydroxide, why not:

- **Iron oxide-hydroxide binds metals.**
  These materials are known to bind a wide range of other compounds from water, including trace metals, arsenic, selenium, silicate, and organics. Metals such as manganese, cobalt, nickel, and zinc are known to bind to iron oxide hydroxide in simulated seawater solutions. It has also been claimed that the binding of copper and zinc by natural iron oxide hydroxide sediments exerts a powerful control on the concentration of copper and zinc in polluted rivers and estuaries. Although not studied in seawater, it has also been observed that phosphate binding by iron oxide hydroxide actually increases its binding of copper, cadmium, and nickel in freshwater.

- Reference : http://www.reefkeeping.com/issues/2004-11/rhf/

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

FeOx, why yes:

- Lowers H_2S very effectively
- Increases methane production
- Prevents corrosion of plant and CHP

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

What happens (inside the reactor):

$$2Fe^{3+} + H_2S \rightarrow 2Fe^{2+} + S + 2H^+ \quad (1)$$

$$2Fe^{2+} + (1/2)\ O_2 + H_2O \rightarrow 2Fe^{3+} + 2OH^- \quad (2)$$

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

Comparison of desulfurisation methods, EGx by SwissBiogas.com against others:

	EGx	*Iron Oxide*	*Iron Oxide-Hydroxide*	*Iron Chloride*	*Air Injection*
Investment into					
Storage and Handling	low	low	low	high	none
Dosing Equipment	none / low	none / low	medium	medium	medium
Risk of / to					
Exposure / Personnel	low	low	low	high	none
Explosion	low	low	low	low	high
Corrosion	low	low	low	high, HCl	high, H_2SO_4
Incompatibility	low	low	low	high	high
Gas Impurities	low	low	low	low	high
Reaction Products	none	none		HCl	H_2SO_4
Characteristics					
Reactive Content	> 60%	30% - 60%	10% - 15%	10% - 14%	none
Digestion Speed / Volume	high	low	low	high	low
Deposit Effect	high	high	medium	none	none
Methanogen Growth	increased	normal	normal	negative	negative
Gas Yield over Normal	higher	normal	normal	negative	negative
Trace Element Addition	not necessary	required	required	required	required
Shelf Life	> 12 months	> 12 months	< 12 months	< 12 months	none
Price per chem. Reaction	medium	high	medium	high	none

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

Where we test:

FAIRY LAND 时代桃源

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

The components of **EG 1118** as base *before* individual adjustments to customers' requirements

Note: The industry-leading high content of reactive FeOx

EG 1118	*[%]*
FeO	> 35
Fe_2O_3	> 35
MnO	< 1.0
C	< 0.5
Cr_2O_3	< 0.5
CaO	< 0.5
K_2O	< 0.5
Al_2O_3	< 0.5
SiO_2	< 0.5
ZnO	< 0.5
Na_2O	< 0.2
CuO	< 0.2
S	< 0.1
TiO_2	< 0.1
MgO	< 0.1
NiO	< 0.1
P_2O_5	< 0.1
MoO_3	< 0.05
V_2O_5	< 0.01
BaO	< 0.01
CoO	< 0.01
PbO	< 0.01
CdO	< 0.01
SnO_2	< 0.01
WO_3	< 0.01
Cl	< 0.01
SeO_2	< 0.01

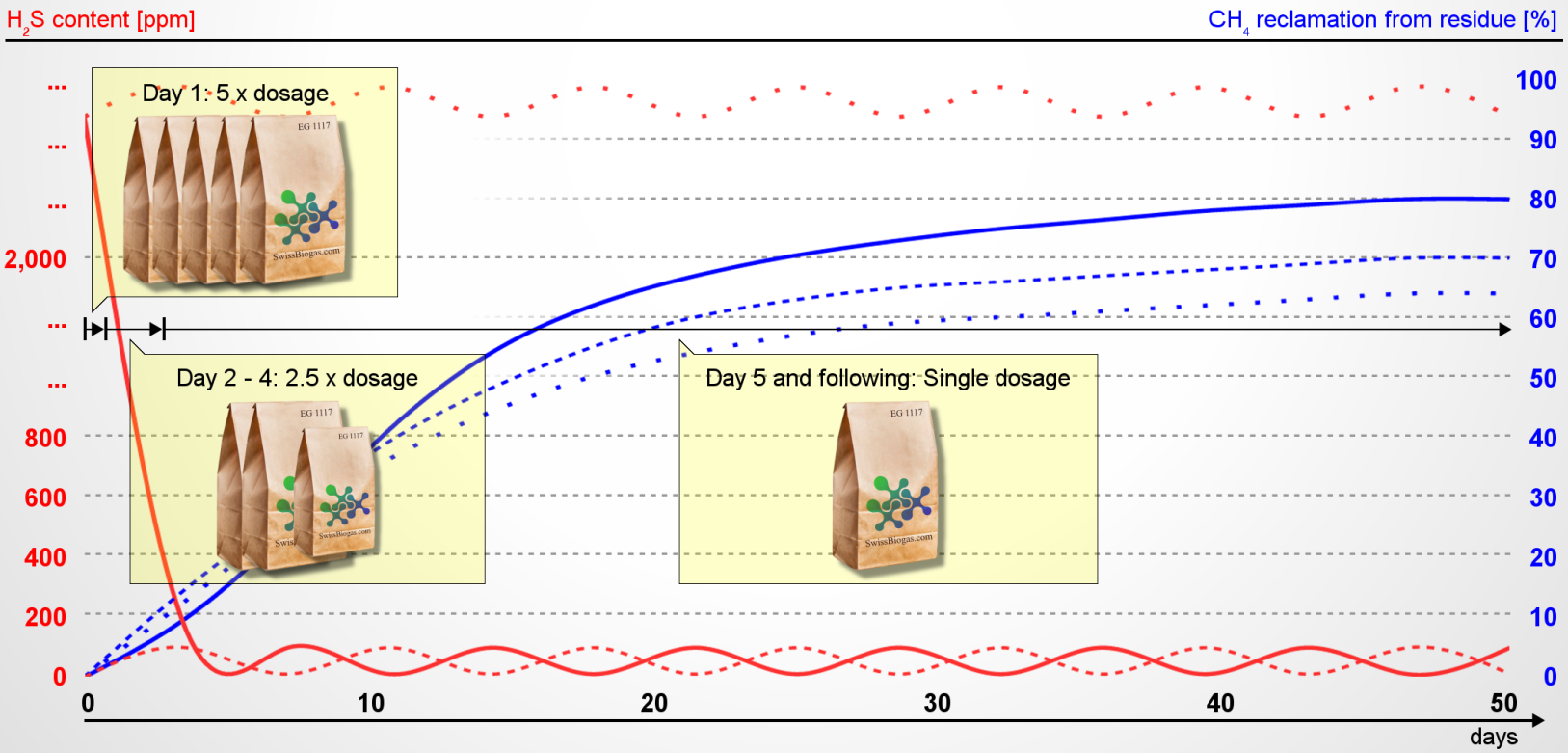
Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

Sample application of EGx by SwissBiogas.com in practice

Reduction of H_2S concentration during desulfurisation with EGx by SwissBiogas.com

Development graphs

- ——— (continuous) **with EGx by SwissBiogas.com**
- · · · · · · · · · (dotted) **with $FeCl_3$**
- - - - - - - - - - - (dashed) **without additives**



Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

How the dosage is calculated:

ENTSCHWEFELUNG
Bedarfsermittlung

Eisengehalt des Additivs		Rohbiogas, Volmenstrom	Schwefelwasserstoff im Rohbiogas		
mg/kg TS	mg/kg	m³/h	ppm	vol.-%	L
600000	540000	500	200	0.0200%	100

TS Gehalt des Additivs		Schwefelwasserstoff im Rohbiogas	Schwefel im Rohbiogas	Eisenbedarf	
		mol	mol	mol	g
90%	kann angepasst werden	4.464	4.202	8.404	468.959

Wirksamkeit/Effizienz	auch abh. von der Wasserlöslichkeit	Bedarf an Additiv		
%		kg/h	kg/d	20 kg Sack, Anzahl pro Tag
50%	kann angepasst werden	0.87	20.84	1.0

Konstanten für die Berechnung

Schwefel Atommasse	mol-Volumina
g/mol	L/mol
32.06	22.4

H2S Atommasse
g/mol
34.06

Fe Atommasse
g/mol
55.8

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

How we pack and ship:

Delivered in powder form, in

- 20 kg bags, or as per
- individual requirements

Please contact your agent for availability.

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

2017 test results by specific waste category: *Kitchen Waste*

- Additive: EG 1117
- Duration: 51 days

Increase of methane production overall:

- Average: 13.5%
- High: 19.3%

Increase rate of methane production per unit VS:

- Average: 16.3%
- High: 23.2%

Speeding up of fermentation rate; Peak of daily methane production:

- Average w/o additive: Day 13, 183.1 ml/day
- Average w/ additive: Day 10, 200.5 ml/day
- High: Day 10, 206.7 ml/day

Remark: All results above achieved **within 43 days**!
Orig. report (2018, Q1) available upon request

Autark Investments and Projects AG
Dept. SwissBiogas.com
Baarerstrasse 75, CH-6300 Zug
Switzerland
www.swissbiogas.com

For references please contact:

Fairyland Environmental Technology
3rd floor, Deshi Building
No. 9 East Road
Shangdi, Haidian district, Beijing
China
Tel.: 010-62975118
Email: fairyland@fairyland.com.cn