

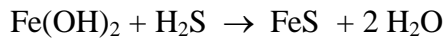
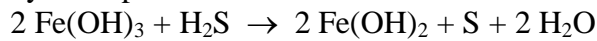
Alternative comparison

Desulphurization of biogas while using FerroSorp® DG respectively using the THIOPAQ-method

1 General information of FerroSorp® DG

For this method the hydrosulphide is precipitated directly in the fermenter.

FerroSorp® DG is a powdery, ironhydroxid based reactionmedium, which is used as the following reactionmechanism shows for the precipitation of hydrosulphide in anaerobic reactors:

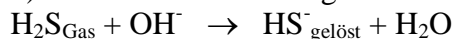


The dosingmass of the product depends on the to precipitate sulphideload in the bioreactor. The hydrosulphidecontent in the gas can vary between 100 ppm and 25.000 ppm. Hydrosulphidecontents of < 100 ppm are reached in the clear gas. The product is neither dangerous in use nor harmful for the water.

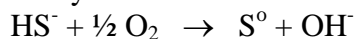
2 General information of the THIOPAQ-Process

For this method the hydrosulphide is precipitated outside the fermenter.

THIOPAQ-Process is a two-step method for the elimination of hydrosulphide of gases. The first step contains the transfer of hydrosulphide in a washingcolone from the gaseous stage to the liquid stage while having light basic ph-Values (8 - 9) based on the following chemical equation:



After this step the washingwater is conveyed to a bioreactor, in which elementary sulphide is developed by dosing oxygen and through microbiological catalysis based on the following chemical equation:



As this reaction sets alkalinity free it is possible to win back the agent in the washingliquid (Hydroxyl-Ions). On this way hydrosulphide is eliminated of the biogas by minimal use of chemicals.

3 Juxtaposition of the advantages and disadvantages of both methods

| method | advantages | disadvantages |
|--|--|---|
| FerroSorp® DG zur Biogasentschwefelung | <ul style="list-style-type: none">- Reliable and safe method- Hydrosulphidecontents of < 100 ppm can be easily reached in the clear gas- Safe method, not depending on the emerging hydrosulphideconcentration in fermenter- Not harmful for water or dangerous substance- The desulphurization happens internally, hence the blockade process of the methanaccumulation, | <ul style="list-style-type: none">- Continuously action of consumption (FerroSorp DG) pro |

| | | |
|--|--|--|
| | <p>which is caused by the toxic hydrosulphide is getting effectively eliminated</p> <ul style="list-style-type: none">- Micro elements are available for microorganisms- The fermentation medium contains sulphide and both is disposed agriculturally, where the sulphide operates as a fertiliser component- If there is a hydrosulphideconcentration in fermenter of > 2.000 ppm the FerroSorp-costs are mostly caught by the higher production of biogas.- No respectively minimal investment in the dosing technology of the product- Corrosion, which can be caused by hydrosulphide, in all parts which are touched by gas is stopped. | |
|--|--|--|

| method | advantages | disadvantages |
|-------------------|---|--|
| THIOPAQ-Verfahren | <ul style="list-style-type: none"> - Base is regenerated internally, which leads to a clear reduce of costs compared to the pure alkaline gas wash - Machine technology is available in different sizes (200 - 2.500 Nm³/h) - precipitation of H₂S up to 99 % possible | <ul style="list-style-type: none"> - high investment costs - machinetechonology - high maintenance energyeffort - waste products (sulphide sewage) need to be disposed - application of dangerous substances (sodium hydroxide) needs safety measures for storage and use - the accumulation of hydrosulphide is allowed but a possibly blockade of biological methanaccumulation is allowed, too. - Micro elements precipitated in the fermenter through sulphideconcentration, which leads to the limited access of microorganisms, this is another reason for the blockade of methanaccumulationprocess - If there is a high hydrosulphideproduction in the fermenter, the machineprecipitation is not safely possible. - The desulphurizationeffort is not available in time after the comissioning, because the biological process of sulphide regeneration needs a long limited startingprocess. - The sulphur is took out of the system and can no longer be used as a fertiliser. - The sulphur can rarely be used and needs disposal (costs!). |

3 Comprehension

It is to estimate that it is useful at least for higher contents of hydrosulphide > 2.000 ppm based on the blockade of the methanaccumulation of the gas, to apply a reaction medium like FerroSorp[®] DG.

Especially for smallbiogasmachines the investment requirements for the THIOPAQ-method can grow to a size, which show that FerroSorp[®] DG is the more economic alternative.