

### Overheating Damage at Activated Carbon Filter

At one of the DMT's plants recently a safety incident occurred. An Activated Carbon Filter overheated due to an incorrect mode of operation, causing damage to the installation. This led to a significant financial loss including business interruption impacts.

To raise awareness for correct operation of Activated Carbon Filters, DMT publishes this S.H.E. bulletin to prevent this from happening again. Below you can find the outline of the cause, the technical background and recommendations.

#### What happened

Biogas upgrading facilities require proper pre-treatment of the Biogas in order to remove contaminants such as Hydrogen Sulphide ( $H_2S$ ). At the affected site, the installation has been successfully operated for many months.

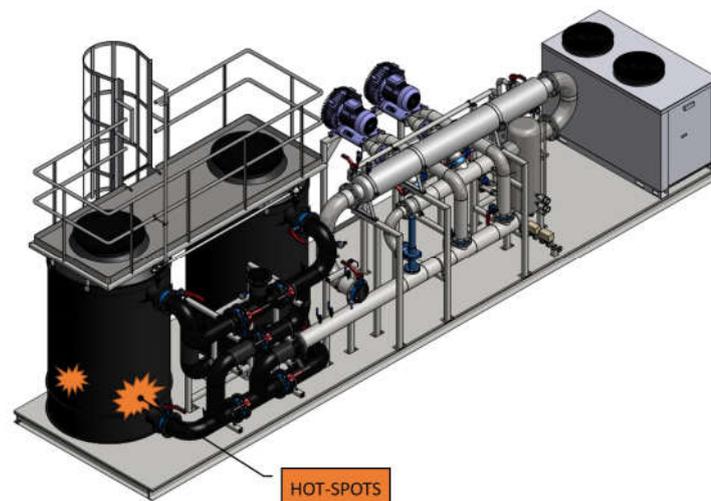
In August 2016, the system was operated for a period of time with no oxygen present in the biogas stream. The oxygen injection unit of the digester was not in use. This resulted in the biogas stream containing high amounts of  $H_2S$  and no oxygen present.

The absence of oxygen combined with the high  $H_2S$  concentration in the biogas, quickly saturated the activated carbon. Usually this would not be a problem when the biogas stream was transferred by a timer to the redundant fresh Active Carbon Filter and the saturated carbon filter was replaced.

However it appeared that both filters were saturated which resulted in several automatic shut downs due to the critical  $H_2S$  level alarm after the filters.

The operators incorrectly made several attempts to regenerate the saturated carbon by feeding air directly into the inlet of the filter, by connecting an external air compressor pump.

The compressed air was injected into the filters, while the biogas stream was not present. The overload of oxygen and the absence of any cooling effect of the biogas stream resulted in overheating by an exothermal chemical reaction (hot-spots) with a meltdown of the filter as a result.

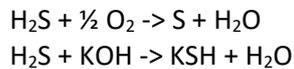


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### Technical explanation

Under normal operation conditions with the correct biogas specification, the hydrogen sulphide in the biogas reacts with oxygen and the potassium hydroxide in the activated carbon:



A small amount of oxygen reacts with the formed sulphur and water to sulphuric acid, which is an exothermal reaction which will be cooled down by the biogas stream.



If oxygen concentrations exceed the specified limits, the exothermal reaction becomes uncontrollable which gives rise to a potentially dangerous situation.

#### Operation with low or no oxygen in the biogas

Operation with too low or no oxygen will cause a delayed chemical reaction between H<sub>2</sub>S and the oxygen. H<sub>2</sub>S will accumulate within the activated carbon which can form dangerous clusters. If a cluster of H<sub>2</sub>S accumulation – after the faulty operation - is exposed with the normal amount of oxygen a clustered exothermal reaction can create hot-spots which can lead to an overheating or meltdown of the filter.

### Built-in DMT safety measurements

For determining the H<sub>2</sub>S saturation level of the activated carbon, the DMT installations measure the H<sub>2</sub>S level in the biogas after the filters. If this level exceeds more than 10 ppm the installation, a critical alarm is generated and the system shuts down. If this repeatedly happens in a short time, the activated carbon in the active filter is saturated and should be replaced. To prevent process interruptions the system is provided with two filters which can be run parallel. One filter is active in the gas stream. By changing the gas stream to the fresh active carbon filter, the saturated carbon filter can be replacement without process interruption.



The DMT Carborex MS<sup>®</sup> systems needs no critical adjustments.

### Recommendations

#### Controlling the required amount of oxygen into the biogas stream

It is recommended to have an automatic controlled air / oxygen injection unit to ensure the proper amount of oxygen for the desulphurization / regeneration process is present in the activated carbon filters. The released oxygen level / concentration in the biogas-stream towards the filters is between 0,1 and 0,5%. The optimum concentration oxygen depends on the pollution of H<sub>2</sub>S in the biogas. For further advice, please contact DMT.

#### Change over the active carbon filters

It is also recommended not to run the active carbon filters simultaneously. Under normal circumstances, this will not cause any problems but for continuous production reasons it is prudent to alternate the filters and replace the contents of the saturated filter.

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### Warnings

#### **Start-up of the plant after long-stop with oxygen supplementation**

Activated carbon can create hot-spots or massive heat-up if the plant is started up after a long period with use of oxygen injection in larger amounts than specified. If there is a biogas stream present it will have a cooling effect, but it can also create a dangerous situations.

#### **Regeneration of saturated activated carbon**

H<sub>2</sub>S saturated activated carbon filters can cause a dangerous overheating if the operator tries to regenerate the carbon with oxygen. Saturated activated carbon can only be regenerated by a skilled employee or a specialized supplier.

**In any circumstances: Never regenerate the carbon on-site. For safe operation, saturated carbon should be replaced on time.**

If you have any further questions, please contact DMT.

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