

FERROLOX[®] - G

GUIDELINES FOR REPLACING FERROLOX[®] - G IN FILTER TANKS FOR DESULFURIZATION

Guidelines for FERROLOX[®] - G

The flushing of the gas filter with nitrogen and the bordering system components is always required on the filter tank or bordering components, which can endanger the health of the employees, or if there is any possibility of igniting the gas/air mixture. All the safety guidelines have to be followed during the replacement of the desulfurization pellets.

Very importantly, necessary work involving ignition sources have to be carried out in the period in which the formation of an explosive atmosphere is impossible. All crossing points to gas-bearing parts of the system have to be properly sealed.

Work has to be performed within the **Ex-Zone** of the gas filter. Therefore appropriate measures to prevent the ignition of an explosive atmosphere must be taken.

If there is any risk of unintentional ignition sources during flushing the tank, this operation should not be performed, in particular during a thunderstorm

Equipment

Below listed equipment that are required for proper flushing and monitoring the explosion hazard. *Tools and equipment that are required for further work and after preventing an explosion hazard are not listed.

- Fire protection and Firefighting equipment
- Fire Blanket
- Cooling water, sufficiently long water hose and spray nozzle

- Warning device for explosion
- H₂S detector
- Nitrogen cylinder with pressure reducer
- Compressed air hose with proper connection
- Wrench
- Explosion proof hand lamp
- Flange covers



Work Preparation

To regulate and examine the system components to be flushed, the employee in charge of the wastewater treatment plant / biogas plant is to be consulted. Together the gas pipe system is examined and appropriate crossing points to non-vented system parts are determined.

Flanged joints where gaskets can be inserted are preferred as crossing points to non-vented system parts.

NOTE!

As within the plant area to be flushed there should be no manifolds with pipe branches that cannot be completely vented or securely closed off.

Especially critical are connections of supply lines for gas network, as gas can be pressed and unnoticed into the work area.

If it is impossible to completely flush the pipe system then that has to be secured properly or to separate it reliably from all other gas-carrying parts of the system, no work at the filter tank shall be carried out.

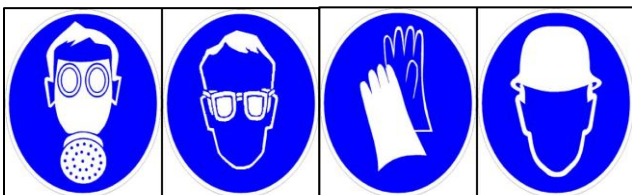
The work area has to be carried out securely against unauthorized access. If any internal traffic routes pass through the work area, they are to be shut off.

If no other, separately controllable gas filters exists, the generated gas must be stored, burned through an emergency flare or vented into the atmosphere. If the gas can't be stored, the use of the emergency flare is preferred to venting into the atmosphere. Additional measures necessary for these operations are dependent on the specific circumstances and cannot be given in general.

The following steps have to be completed in the order shown:

- Turn off gas consumers if they cannot be operated via an additional gas filter tank, which is separate and gas-proof from the area to be flushed. Close valves in the gas line from the gas filter tank to all consumers, e.g. CHP. If several valves are installed in a gas line system, all valves have to be closed.
- Open shut-off valves in the gas line between the gas source and emergency flare, or vent and prevent automatic closure. Close shut-off valve in the gas pipe leading to the gas tank.
- Close shut-off valve in the gas inlet pipe to the gas tank. If several valves are installed in the gas line, all valves have to be closed.
- Shut-off valves in the gas line from the gas source (digester) to the gas tank are to be secured by warning signs against unauthorized opening.

During the change process protective clothing should be worn.



Flushing with Nitrogen

Attention! If possible, always stand on the windward side in front of the filter tank. Pressurized gas still remaining in the filter tank is then released by opening an exhaust valve.

After the gas has been released by the internal pressure of the filter tank, the exhaust adaptor should be opened, and a gas cylinder filled with nitrogen should be connected to the inlet valve. Provided that the compressed air hose or the pipes to the filter tank require no other restrictions, the pressure reducer on the gas cylinder should be regulated to not more than 2.5 bar.

The amount of nitrogen used for flushing must be at least twice the volume of the empty filter tank - including dead volume. Then the success of inerting must be checked. The methane concentration should be below 1% by volume (20% LEL) Lower Explosive Limit and the concentration of hydrogen sulfide below 7.1 mg / m³ (5 ppm). Otherwise flushing with nitrogen must be continued until methane and hydrogen sulfide concentrations are met.



Removing the desulfurization pellets

Note: Please follow the removal instruction of the provider for the currently used desulfurization material if it is not Ferrolox[®] G. After all pipes and the filter tank have been sufficiently flushed the desulfurization pellets Ferrolox[®] G can be removed. For this purpose any flanges or other caps on the outlet have to be removed.

Protective clothing like **Hand Gloves, Safety Helmet**, safety must be worn on all the precautions has be followed

Attention!

In contact with oxygen spontaneous heating of Ferrolox[®] G is possible. It is important to ensure that the temperatures in the gas and at the vessel wall remain under 60 °C (140 °F). Stricter regulations on the part of the filter tank prevail. Attention! The temperature usually increases after a few minutes, but very rapidly! The risk of significant heating can be minimized by maintaining a continuous concentration of oxygen during the operation of the gas filter that reaches at least double the concentration of hydrogen sulfide. However spontaneous heating cannot be ruled out entirely.

It must be ensured that sufficient space for the unloading of the material is available. If possible, the material has to be filled into a suitable heat-resistant container or hutch immediately.

If not available the material should be released onto the floor. To avoid excessive heating, the desulfurization pellets Ferrolox[®] G should be spread out immediately after emptying in an open area. Larger amounts have to be emptied and spread out in batches.

In case of spontaneous heating Ferrolox[®] G should be cooled with water immediately. In order to prevent inhaling the potentially toxic fumes the water should be sprayed with a hose and nozzle from a sufficient distance, and sprayed from the windward side.

If the material does not completely empty from the filter tank, carefully assist using a sweeper or shovel, without causing damage to the tank. After emptying the filter tank it should be cleaned to the greatest extent possible with a broom or something similar.

All sieves and gas routes must be cleared of remaining particles. Subsequently the gas filter outlet can be closed.

Storage and disposal of Ferrolox[®] G

For intermediate storage Ferrolox[®] G has to be kept in a dry and wind protected place.

In Germany the desulfurization material Ferrolox[®] G is classified as nonhazardous waste and under certain conditions it can be used in agriculture.

Following a recommendation of the Working Group of the German Federal States on fertilizer traffic control, with elemental sulfur loaded Ferrolox[®] G is legally classified as "processing aids using elemental sulfur of industrial origin" after usage for gas treatment in biogas plants. Thus this product is a kind of fertilizer according to DÜMV Guideline 1.5.9 "Elemental Sulfur," that may be added to the fermentation residue of the biogas plant before the application in agriculture.

To prevent the possible reformation of hydrogen sulfide from the sulfur contained in the loaded material, Ferrolox[®] G should only be added shortly before application or agricultural use of the digestate into the digestate storage tank. This applies mainly to covered digestate storage tanks, whose gas chamber is connected to the gas tanks of the biogas plant.

If any agricultural use of the loaded Ferrolox[®] G is not possible we recommend disposal of the loaded desulfurization pellets Ferrolox[®] G using waste code **ASN EWC 060603** - "wastes containing sulphides other than those mentioned in 060602" according to the European Waste Catalogue (EWC).

In Germany many municipal waste landfills and construction landfills accept the loaded desulfurization material Ferrolox[®] G, which is a nonhazardous waste, after submission of a declaration analysis.

Re-filling the filter tank:

It must be ensured that all the openings of the filter tank except for the filling opening are closed and gas-proof. For Big bags we recommend the use of a filling adapter and hose extension (see photo). This ensures a gentle filling of the material into the tank. Attention should be paid to keep the hose end close to the material surface.



During the filling process, the hose should be lifted consistently, so that it always remains above the surface of the material and does not get jammed in the material. This is even more important for large drop heights!

Set-up of filter tank with Ferrolox[®] G

After filling, flushing with nitrogen has to be repeated (see above) with at least twice the volume of the filter tank. Afterwards the filling opening then can be resealed gas proof.

The system has to be tested for leak tightness, by soaping with nitrogen pressurizing system. It is sufficient to fill the tank with 10 - 20% of its volume.

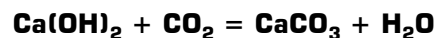
Once the system is successfully tested for leaks the nitrogen can be discharged via the exhaust valve.

Now filling with biogas can be initiated. One has to note that the procedure is different for Ferrolox[®] G and Ferrolox[®] G (k).

The below following steps are for Ferrolox[®] G and must be performed in the order shown:

All valves in the gas inlet pipe to the filter tank, all closed valves in the pipe to the fermentation tank have to be **opened**.

If any **emergency** flare is present, open its valves and close the exhaust valve. Otherwise keep the exhaust valve opened. Then open the shut-off valve in the gas line to the gas source. On contact of sewage or biogas with the desulfurization pellets, the exothermic reaction of CO₂ with the Ca(OH)₂ takes place thus excessive heating occurs.



It is important to ensure that the temperatures of the gas and on the vessel wall always remain below >60 °C (140 °F). Stricter regulations by the manufacturer of the filter tank have priority. The gas stream is to be reduced and controlled accordingly at the beginning (about 30 - 40 minutes). **Attention! The temperature usually increases after a few minutes, but very rapidly!**

Make sure the temperature is below 60 °C (140 °F), if not the gas flow must be stopped immediately until the temperatures are significantly lower.

As soon as the filter contains **usable gas** then all valves in the gas lines can be opened to the consumers. If any vents are available, the pipes can be de-aerated. After closing all valves and vents the consumer can be activated.

Accumulated water behind the gas filter tank should be drained by opening the condensate trap.

Existing dust filters upstream to the consumer must be replaced with new and clean filters.

The Ferrolox[®] G (k) has been conditioned at the factory, thus has been charged with **CO₂**, so that a large part of the described chemical reaction has already taken place. For technical reasons, however, it cannot be guaranteed that the reaction has been completed. Accordingly, the temperature profile should also be observed and regulated.

In a modification of the above points, the start-up with **Ferrolox[®] G (k)** can proceed as follows:

All valves in the gas inlet pipe to the filter tank and all closed valves in the pipe to the gas source have to be opened. The exhaust valve has to be closed.

The gas filter tank can be filled now completely with sewage gas/biogas. After filling the filter tank, the concentration of gas is depending dead volume of the filter tank and about 80 - 90%. Whether this mixture can be utilized by the consumer or not (e.g. CHP)

depends on their technical specification and must be assessed by the operator of the biogas/sewage plant.

If the gas cannot be used it must be either burned by means of the emergency flare or discharged through an outlet valve into the atmosphere.

Depending on the structure of the pipeline systems it may be necessary to burn multiple tank volumes of freshly generated gas by means of the emergency flare.

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