

INTERRA GLOBAL FERROSORP®

MEDIA CHANGEOUT PROCESS GUIDELINES

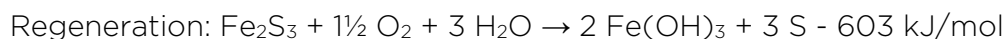
This process does not supersede any site, company, or government rules, regulations, or procedures. Field personnel should follow all site and company safety procedures, including entry into and working in any confined spaces, and observe all warnings and instructions on super sacks. The following are suggestions and general guidelines related to the FerroSorp media changeout process.

Performing a media changeout can be accomplished in different ways; the equipment and gas conditions vary at each site and both will affect the changeout process. The following is a guide to assist in common changeout practices. If you have questions regarding your specific location, contact Interra Global's technical support team.

CAUTION: POSSIBLE HEAT REACTION

A heat reaction can occur when spent media is exposed to oxygen. This heat reaction is controllable and can be mitigated by restricting oxygen and/or adding water to the spent media. A heat reaction may occur when there is not enough oxygen in the raw biogas to regenerate the media bed completely. A large volume of air moving through the media over a short period may create excess heat and cause a safety hazard. The use of water during changeouts dissipates heat and facilitates material handling.

When changing out media, the safest practice is to assume a heat reaction will occur when exposing spent media to the ambient air. Flooding the vessel with water and soaking the media over a 6-to-8-hour period will typically mitigate the potential heat reaction. Keep the vessel sealed when flooding to ensure ambient air does not enter the vessel. If flooding the tank is not practical, follow the guidelines in this document to ensure that any heat reaction is handled safely by spraying water and controlling the air exposure to the media. The potential heat reaction can be described through the following chemical reactions:



During absorption only, no elemental sulfur is formed. The Iron Hydroxide (Fe(OH)₃) media component is consumed and converted into Iron Sulfide (Fe₂S₃) and water with a small amount of heat rejected to the biogas stream. When oxygen is present, the Iron Sulfide is regenerated back into Iron Hydroxide and elemental Sulfur is formed, which is stored inside the media pellets within the pore volume. This reaction is exothermic, whereby the regeneration reaction creates ten times the amount of heat than the initial absorption reaction. In cases where the biogas stream contains sufficient free oxygen

(at a ratio of 3:1 O₂:H₂S or greater), the heat energy is continuously dissipated into the biogas over the course of normal operation. In cases with insufficient oxygen in the biogas, Iron Sulfide is still present on the spent media and will react with exposure to ambient air. It is important to ALLOW this reaction to occur under controlled conditions before final disposal of the media. While the media itself is inert and non-flammable, the elemental Sulfur formed during this process can pose a flammability risk. When saturated with water, the temperature of the media will not exceed 100° C. If temperatures at any point are observed to rise above 100° C, this would indicate the media has become dry and more water should be applied.

IMPORTANT: Care must be taken to ensure the temperature limits for elemental sulfur are not exceeded.

SULFUR		ICSC: 1166
PHYSICAL & CHEMICAL INFORMATION		
<p>Physical State; Appearance YELLOW SOLID IN VARIOUS FORMS.</p> <p>Physical dangers Dust explosion possible if in powder or granular form, mixed with air. If dry, it can be charged electrostatically by swirling, pneumatic transport, pouring, etc.</p> <p>Chemical dangers On combustion, forms toxic and corrosive gases of sulfur oxides including sulfur dioxide (see ICSC 0074). Reacts violently with strong oxidants, especially if powdered. This generates fire and explosion hazard.</p>	<p>Formula: S / S₈ Molecular mass: 256.5 (S₈) Atomic mass: 32.1 Boiling point: 445°C Melting point: 120°C (amorphous) Melting point: 107°C (r-sulfur) Melting point: 115°C (beta-sulfur) Density: 2.1 g/cm³ Solubility in water: none Flash point: 160°C c.c. Auto-ignition temperature: 232°C Explosive limits, vol% in air: 35-1400 g/m³</p>	

TREATMENT VESSEL, GAS FLOW, PIPING, AND VALVES

- Confirm acceptable gas composition levels before opening the vessel using site-specific processes to isolate and purge the treated gas.
- Do not perform a changeout when lightning is present.
- Do not allow ignition sources near the treatment vessel.

WORK PREPARATION: EQUIPMENT NEEDED

- Vacuum Truck
 - If there is no internal storage in the vacuum truck, use a roll-off container for the spent media
- Water Source for Cooling
 - At least 1,000 gallons per 20,000 pounds of media
 - Hose to reach vessel access points
- Infrared Temperature Gun
- Tools for Leveling, Loosening Media, and Opening Vessel
 - Shovel, rake, pick, wrenches, hammer
- Recommended Safety Equipment (Follow all site specific and local safety equipment requirements)

- H₂S Gas Detector
- SO₂ Gas Detector
- Purge Equipment (if purging with nitrogen)
 - A nitrogen cylinder with a pressure reducer for the gas purge
- Equipment to Move and Load Super Sacks
 - A crane, telehandler, or backhoe with appropriate attachments

PREPARING TO REMOVE SPENT FERROSORP MEDIA

GAS FLOW AND VESSEL PREPARATION

1. Follow your standard site process to stop gas flow to the treatment vessel and isolate the vessel from the gas stream.
2. Evacuate gas from the vessel.
 - a. Purge the treatment vessel with nitrogen, or
 - b. Ventilate following local regulations and site procedures.
3. Flood with water and seal the vessel. Keep it flooded and sealed overnight to remove potential heat reaction during spent media removal.
 - a. Drain the flooded tank just prior to starting the removal; observe all local regulations for water management and disposal
4. Prepare an area that is 2 square feet, level, and free of debris near the vessel to place a sample of the spent media from the vessel to monitor for a potential heat reaction.

DISPOSAL PREPARATION

Prepare an area or roll-off container for the intermediate dumping of spent media to monitor and cool (if there is heat reaction) before returning the spent media to the landfill. A dumping area should be level, free from flammable debris, and large enough to spread the spent media less than one foot deep.

NEW MEDIA LOADING PREPARATION

Prepare a staging area for the new super sacks that are to be loaded into the vessel.

- Confirm the area is dry or keep the super sacks on a truck or trailer
- Allow space to operate loading equipment between super sacks and the vessel

REMOVING SPENT FERROSORP MEDIA FROM THE VESSEL

1. If you did not flood the vessel overnight, closely monitor the heat rise throughout the spent media removal process. Use water and oxygen deprivation (by closing access points) to mitigate any heat reaction.
2. Open the top vessel access point and take a temperature reading.

- a. Remove two shovels full of spent media (1-2 gallons) from at least 12 inches deep in the bed and spread them in the prepared 2 square foot space for monitoring.
 - i. Use the temperature gun to monitor this sample. This will help predict any heat reaction during the change out and disposal as the sample will be getting oxygen exposure.
- b. To limit the amount of air exposure to the spent media and the potential heat reaction, open only one access point at a time.
3. If temperature control is required, saturate all the spent media with water at one access point at a time.
4. Begin to remove the spent media with a vacuum.
 - a. Monitor the temperature throughout this process. Spray with water to control the temperature, if necessary.
 - b. Vacuum the spent media working from the top down from the access point. If there is any clumping, use shovels and/or water spray to loosen the spent media and free it to be vacuumed.
 - c. Monitor the temperature of the spent media in the vacuum truck.
 - i. Check the temperature of the tank wall.
 - ii. Look for steam or vapors leaving the vent on the vacuum vessel.
 - iii. If a heat reaction is measured or steam observed:
 1. Spray water in the vacuum truck tank or immediately dump the truck.
 2. Increase the amount of water for saturation when resuming spent media removal to avoid heat reaction in the vacuum truck.
 - d. When the vacuum truck or roll-off container is full and needs to be emptied:
 - i. Monitor the temperature of the spent media in the treatment vessel.
 1. Use water to control temperature and/or close access points to limit oxygen exposure.
 - ii. Quickly but safely, dump the spent media in the prepared debris-free level area.
 1. Monitor the temperature of the spent media.
 - a. Saturate the spent media with water if you observe a heat reaction in excess of 100°C.
 2. Spread the spent media (no more than 1 foot deep) to allow for even oxygen contact distribution and to maximize convection cooling.
 - e. Continue to remove the spent media (see steps 4a above) until the vessel is emptied.
 - f. Clean and inspect the vessel.

- i. Remove all spent media that was not removed with the vacuum by spraying or sweeping.
 - ii. Inspect screens and/or foam pads for any damage and replace/repair as needed.
5. Monitor the spent media for at least 24 hours.

Confirm a stable ambient temperature. Allow the removed media to cool and dry before disposing of in a Class 2 landfill (non-hazardous) or other permitted disposal methods. (Note: although both unreacted and reacted FerroSorp media is non-hazardous, the site must follow the procedures for their internal and local regulations before disposal.)

LOADING NEW FERROSORP MEDIA INTO THE VESSEL

1. Use a crane or forklift to lift super sacks above the entry point.
2. Position the super sack over the manway. The super sack has a plastic string tied in a bow knot to open the super sack and expose the chute.
3. Load the new media from the super sacks evenly into the vessel.
 - a. Dust masks should be worn, as there will be dust from the pellets falling and impacting the vessel floor.
4. The new media should be as level as possible and distributed to the edges of the tank. Consider this throughout the process and begin to level when necessary for your vessel.
5. Fill the vessel with the calculated amount of new media.
6. When fully loaded, perform a final leveling of the media.
7. Close and seal all access points.