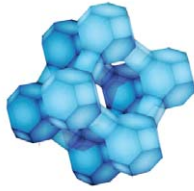


# Precautions and safe practices



**UOP handling guidelines for the  
GB metal oxide and/or metal  
carbonate series of adsorbents**

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This brochure is intended as a general discussion and it may not be applicable to particular operations. Operating conditions and equipment will vary from unit to unit, and actual operating experience with a unit should be considered before implementing guidance from this document. Owners and operators remain at all times responsible for the proper operation and maintenance of their units.

In addition, this document is intended for trained workers and assumes a full understanding of how to safely and lawfully perform the tasks referenced herein. Persons should not rely on this information as a substitute for professional training or for practices and procedures designed to ensure compliance with all applicable legal, industry and other requirements. This material does not constitute a warranty, express or implied, of results in any specific application or fitness for a particular purpose, and it does not create or modify any agreement with UOP.

# The nature of adsorbents and their operations



The UOP GB metal oxide and/or metal carbonate series of adsorbents are high capacity non-regenerative adsorbents used for arsine, mercury and sulfur removal from various hydrocarbon gas and liquid streams. Fresh, unused adsorbent is stable when dry, and can be loaded with appropriate protective equipment and appropriate confined space entry procedures. **However, once exposed to hydrocarbon streams containing sulfur, adsorbents form metal sulfides that have limited stability**

**and any exposure to air and moisture must be minimized. The metal sulfide form of the GB series adsorbents should not be exposed to mineral acids, flame or an ignition source or temperatures above 150°C since toxic vapors such as sulfur oxides and hydrogen sulfide may form.** Additional product safety information on the GB series is available in UOP's MSDSs, which are available by contacting your UOP representative.

## Loading fresh adsorbent

Proper handling and storage is important to ensure that the adsorbent does not become contaminated with water which could delay startup and result in loss of production time. In addition, it is critical that safe procedures are used to protect personnel.

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### Preparation

The UOP GB metal oxide and/or metal carbonate series of adsorbents consist of metal oxides/carbonates bound with alumina. In their fresh, unused state, these products present minimal handling risk when appropriate protective equipment is used. Appropriate protective equipment includes gloves, long sleeve shirts and pants or coveralls to protect against skin exposure; safety glasses, goggles or face shield to protect the eyes; and dust masks or respirators if dust might be generated. When exposed to water, the heat of adsorption can cause the adsorbents to get quite hot. Care should be taken to avoid contact with moist skin, mucous membranes and eyes.



The UOP GB metal oxide and/or carbonate series of adsorbents are normally shipped in airtight, non-returnable steel drums. To help prevent damage to the drums, always store them upright on pallets and do not stack them over three (3) pallets high. Individual drums should be

moved by mechanical means such as fork lift trucks equipped with drum rim or body clamps. Take care when moving adsorbent containers. Proper lifting techniques and equipment should be used. Full drums can weigh more than 300 pounds and full bags more than 2,100 pounds.

Drums are shipped under a slight vacuum to ensure product integrity, so it is important that drum seals are maintained prior to use. Drum lid bands and vent screws should remain tight when stored or moved and drums should not be handled in a manner that could puncture or dent the containers. The vent screw on the lid should only be loosened immediately prior to loading the adsorbent into the vessel.

Drums and bags should be stored in dry conditions and away from sunlight. For temporary storage, drums should be stored on pallets and both the drums and bags should be covered with tarps or other material to protect them from sunlight and/or precipitation. For longer term storage, drums and/or bags should be stored in a warehouse or similar climate-controlled environment.

In situations where entry to the vessel is required, confined space safe work practices must be followed. Many countries have specific regulations for confined space work. Personnel should review these regulations and other precautions and practices, and ensure that they are followed. The required precautions and practices include, without limitation, the following:

- Removing hazardous materials from the vessel prior to entry.
- Isolating the confined space from sources of hazardous materials or energy by installing blind flanges to inlet and outlet nozzles and decoupling pumps and instrumentation.
- Providing adequate ventilation to prevent accumulation of flammable materials, combustible dusts, toxic contaminants or an environment that is oxygen deficient or excessive.
- Testing for oxygen, flammable gas, and suspected toxic materials prior to entering the vessel.
- Using safety attendants outside the vessel to monitor and communicate with personnel in the confined space.
- Having notification and response procedures in place for emergency situations such as injury or loss of consciousness to personnel within the confined space.
- Equipping personnel entering the vessel with the appropriate safety equipment, which may include the use of safety harnesses and/or self-contained breathing apparatus.
- Training personnel authorized to work as safety attendants, rescue personnel or persons entering the confined space.
- Conducting pre-job discussions with personnel involved with the work about the potential hazards of the confined space work.



## Loading

Minimize exposure of the adsorbent to moisture by loading in dry weather and not leaving open containers exposed to the atmosphere.

If flammable vapors such as hydrocarbons are present in the loading area, grounding is especially important to avoid discharge of static electricity that could cause an explosion or fire. Even conductive footwear and conductive walking surfaces may not prevent electrostatic buildup on the human body. As one example, removal of outer garments in low humidity conditions can generate sparks.

Take care when moving adsorbent containers. Proper lifting techniques and equipment must be used, since containers must normally be lifted to the top of the vessel using hoists or cranes. Proper lifting techniques must be performed in accordance with government regulations and/or other precautions and practices including, without limitation, the following:

- Conducting a visual inspection and functional check of hoisting and lifting equipment prior to its use to identify any defects.
- Keeping loads within the load limits of the lifting equipment.
- Training operators in proper operating and inspecting procedures.

- Isolating the area under the lifting path using ropes or signs and keeping personnel clear of the area.
- If pneumatic trucks are used to transfer adsorbent into the vessel through a hose, keeping the hose outlet pointed away from personnel.
- Making sure that the transfer and the receiving systems are electrically grounded to help dissipate any static charge, since **static electricity can build up during transfer operations.**
- Using tag lines on loads that must be guided into position or where load movement can be potentially hazardous.
- Opening the vent screw on the drum lid before removing the drum lid band just prior to loading the adsorbent into the vessel.

### General loading instructions

The objectives of the loading operation are to:

- Obtain a uniform, maximum packed density
- Minimize settling and migration of adsorbent
- Keep adsorbent bed layers level, not cone shaped
- Obtain uniform gas flow through each adsorber by loading all adsorbers in the same way.

The ideal way to pack UOP GB metal oxide and/or carbonate adsorbent to obtain these conditions is at such a rate and in such a manner that the adsorbent beads fall uniformly over the surface of the adsorber bed, and that each bead settles into place before another bead falls on it. This provides a uniform, maximum packed density and prevents settling of the adsorbent bed.

Prior to placing the loaded vessel into service, flush air from the vessel with high purity nitrogen (minimum 99.9%) and leak test the flanges opened during the loading procedure.

After loading and before introducing any hydrocarbon stream into the UOP GB metal oxide and/or carbonate adsorbent, remove the air using a high purity nitrogen purge. Since a rate that will ensure good nitrogen distribution in the vessel is seldom available, use alternate purging with number of pressurization and depressurization steps in the downflow direction to enhance air removal. Continue the process until less than 0.5% oxygen is present in the outlet. At the end of the purge, leave a nitrogen blanket on the adsorbent vessels until startup.

# Start-up and operation of adsorption systems

For gas phase systems, increase pressure down flow slowly with feed (less than 50 psi/minute) to operating pressure by cracking open the inlet (top) valve or small pressure change bypass valve. When the vessel is at feed pressure, open the inlet valve fully and crack open the outlet (bottom) valve to slowly increase pressure downstream. **(If the hydrogen level in the process is above approximately 10 vol%, special start-up procedures are necessary to minimize the impact of an exothermic reaction that may occur. Contact your UOP representative immediately for information about these procedures.)** Once the downstream is pressured up, establish flow through the vessel by opening fully the outlet valve. Some temperature

rise\* is expected due to adsorption of the carrier stream. For liquid systems, increase to operating pressure by slowly introducing feed into the bottom of the vessel at less than 25 psi/minute by cracking open an inlet or bypass valve. When the vessel is at feed pressure, open the inlet or bypass valve fully then slowly open the flare line valve to start filling the vessel up flow. Open the flare line valve so that the rate of filling is about 50% of the design feed rate. Typically a sight glass at the top of the vessel is used to determine when the vessel is full. Do not allow the liquid to enter the flare line. Some temperature rise\* is expected due to adsorption of the carrier stream. Once the vessel is filled, close the flare line and bypass

line (if used) and open the feed line. Use a bypass line if available or crack open the outlet line to increase pressure in the downstream system. Once the outlet system is pressured up, open the outlet line, close the bypass line (if used) and establish normal flow.

***\* Note: In the unlikely event that the outlet temperature increases to more than 100°C during filling, immediately stop the flow, drain the vessel and purge with high purity nitrogen to flare. Contact your UOP representative for assistance.***

***\* Note: In the unlikely event that the outlet temperature increases to more than 100°C when flow is established, immediately stop the flow, depressurize the vessel and purge with high purity nitrogen to flare. Contact your UOP representative for assistance.***



# Preparing spent GB metal oxide and/or carbonate series adsorbent for unloading

Read and understand this section thoroughly before opening a used GB series adsorbent system to the atmosphere.



When used as intended, UOP GB metal oxide and/or carbonate series of adsorbents react with sulfur compounds, arsine and elemental mercury (where present) contained in the process stream to form copper sulfide and where applicable, mercury sulfides. Therefore, the resulting spent UOP GB metal oxide and/or carbonate adsorbent will contain a mixture of copper sulfide, copper arsenide, potentially mercury sulfide, hydrocarbons, and alumina. These compounds are generally stable under ambient conditions as long as they are not exposed to oxygen, and a high purity (minimum 99.9%) nitrogen purge must be used during unloading. However, in addition to these components, other trace contaminants from the process stream may be adsorbed by or deposited on the GB series adsorbents. These other trace compounds

can become concentrated on the adsorbent during its use and **may cause the spent adsorbent to exhibit toxic, flammable or unstable characteristics.** Among the contaminants of greatest concern are hydrogen sulfides, iron sulfides (from metal scale in the vessel) and residual hydrocarbons.

To help minimize the presence and reaction of these other trace contaminants, it is essential that certain precautionary practices be employed prior to and during unloading the adsorbent from the vessel. Importantly, the bed must be completely purged with high purity nitrogen prior to unloading to remove trace contaminants and create an inert atmosphere free of oxygen and water. **An inert atmosphere must also be maintained during unloading operations to ensure that any remaining trace contaminants do not become displaced or react with oxygen or moisture contained in ambient air to create a hazardous atmosphere.**

## General nitrogen purging instructions

1. Isolate the vessel containing the UOP GB metal oxide and/or carbonate adsorbent and depressurize it.
2. Install blind flanges on all inlet and outlet lines except the flare line. Connect a nitrogen source at the opposite end of the vessel.
3. Purge with nitrogen with a minimum purity of 99.9%.
4. Vent purging gas to flare to destroy hazardous compounds.

5. Note that the amount of available nitrogen is typically inadequate to provide the gas at velocities needed for effective flow distribution within the adsorbent bed. To improve the effectiveness of the nitrogen purge step the following is recommended:

- Repetitive pressuring and depressuring of the bed with nitrogen can improve the effectiveness of the purge step. It is best to pressure up and depressurize down, down flow through the bed to avoid lifting the UOP GB metal oxide and/or carbonate adsorbent and/or support balls. If downward flow is not possible for the purge step, contact your UOP representative for specific recommendations.
- Continue to pressure and depressurize the vessel to flare with nitrogen until the outlet mixture contains less than 10% of the lower explosive limit (LEL) for any flammables and no toxic compounds. The LEL in air of several common fluids is shown in Table 1.

Table 1  
LEL of Some Common Fluids

| Fluid    | Volume % in Air |
|----------|-----------------|
| Benzene  | 1.4             |
| Ethane   | 2.9             |
| Hydrogen | 4.0             |
| Methane  | 5.0             |
| n-Butane | 1.6             |
| Propane  | 2.1             |

If you encounter any difficulties or have questions using the above procedures, contact your UOP representative immediately.

# Unloading and handling of spent adsorbent

Read and understand this section thoroughly before opening a used GB series adsorbent system.



UOP recommends that UOP GB metal oxide and/or carbonate adsorbent unloading be conducted with high purity nitrogen (minimum 99.9%). UOP recommends that a nitrogen blanket be maintained on the vessel during unloading operations as trace hazardous contaminants can remain on the adsorbent, even after nitrogen purging. Always assume that some hazardous contaminants remain on the UOP GB metal oxide and/or carbonate adsorbent. In addition, always assume a hazardous atmosphere exists within the vessel. Do not enter the vessel unless confined space entry procedures that include provisions for safe entry under inert/hazardous atmosphere are followed.

UOP recommends that the UOP GB metal oxide and/or carbonate adsorbent be unloaded under inert

conditions. Therefore, the area around the vessel must be isolated and safe procedures for working in a hazardous/inert atmosphere must be implemented.

Furthermore, hazardous materials may be released during unloading of spent adsorbent that could create a toxic, flammable or reactive environment.

## **Be prepared for these situations.**

Test the area around the unloading operations to establish a safe perimeter and restrict access within that perimeter to individuals who are outfitted and trained to work in a hazardous atmosphere. Implement standard grounding procedures and have firefighting equipment available.

Personnel involved with the unloading operation that are working outside the hazardous atmosphere perimeter should wear gloves, long sleeve shirts and pants or coveralls to protect against skin exposure, safety glasses, goggles or face shields to protect the eyes, and dust masks or respirators if adsorbent dust might be generated.

Due to the hazardous nature of the spent material, UOP recommends that materials be immediately offloaded into containers approved for transportation of hazardous/dangerous goods per appropriate United Nations and other requirements. Selection of the specific container should be established beforehand in consultation with the disposal/treatment/ transportation company who will be receiving the spent material.

**Note:** Due to the possible presence of mercury, sulfur, arsenic, and other contaminants, the spent UOP GB metal oxide and/or carbonate adsorbent is likely to be considered a hazardous waste by most governmental authorities when generated (i.e. removed from the vessel). Other hazardous characteristics of the material may also affect waste classification. Packaging, storage, transport, treatment and disposal of hazardous waste are strictly controlled by governmental regulations. The facility owner and operator should review these regulations before initiating unloading activities, and should incorporate all regulatory requirements into the unloading procedures.

## **General unloading instructions**

UOP recommends that purging be conducted with high purity nitrogen (minimum 99.9%). After completion of the repetitive purges described above, start the nitrogen purge from the bottom of the vessel and open the loading port at the top of the vessel. Personnel equipped and trained to operate in an inert/ hazardous atmosphere should monitor the oxygen and LEL at the top of the vessel to ensure that the vessel has an inert atmosphere.

Personnel equipped and trained to operate in an inert/hazardous atmosphere outside the top manway can then vacuum out the inert balls

on top of the bed into transport containers located at the drumming station on the ground.

There should be a stainless steel screen on top of the UOP GB metal oxide and/or carbonate adsorbent bed under the inert balls. To make unloading easier, secure the screen to the top of the vessel. This usually can be done without entering the vessel. The screen can normally be secured using a harpoon-type tool with a long handle. If this approach is unsuccessful or unavailable, personnel equipped and trained to operate in an inert/hazardous atmosphere will need to enter the vessel under confined space procedures and secure or remove the screen.

#### **UOP GB metal oxide and/or carbonate adsorbent vacuuming removal option:**

**1.** The adsorbent is typically removed through the top manway by personnel equipped and trained to operate in an inert/hazardous atmosphere from outside the manway. The product should be discharged into clean, dry and sealable nitrogen purged UN approved transport containers. (A nitrogen purge is also required on the dust collector). *Please note: UOP GB metal oxide and/or carbonate series of adsorbents **SHOULD NOT** be unloaded into non-metallic containers.*

**2.** Once the adsorbent is removed to below the bottom port, the bottom manway/(dump) port can be opened and personnel equipped and trained to operate in an inert/hazardous atmosphere can enter under confined space procedures through the top manway and use the vacuum hose inserted through the bottom entry to remove any remaining adsorbent.

**3.** Vacuum out any remaining balls into separate containers until no adsorbent is observed under the floating screen or metal bed support screen. Remove the inert entry person and shut off the nitrogen purge.

#### **UOP GB metal oxide and/or carbonate adsorbent manual removal option through the bottom port:**

**1.** UOP recommends that top loading shipping bins or totes capable of holding four (4) drums of adsorbent be used for emptying vessels through the bottom port. Use of larger bins will speed up the unloading operation as the adsorbent will likely free-flow by gravity at a fairly quick rate. If a bin will not fit under the dump port, dumping will have to be done into nitrogen purged drums. All containers should be maintained with a nitrogen purge and be plastic-lined. *Again, please note: UOP GB metal oxide and/or carbonate series of adsorbents **SHOULD NOT** be unloaded into non-metallic containers.*

**2.** Position personnel equipped and trained to operate in an inert/hazardous atmosphere at the open manway at the bottom of the vessel. These personnel should be equipped with garden-type hoes to help remove the adsorbent from the vessel. Take care not to dislodge or damage either the floating screen in an inert bed support system or the top screen in a metal bed support system. The bottom port flange can be used control or stop the flow of product out of the dump port when changing bins or drums.

**3.** Once most of the adsorbent has been removed from the vessel, remove the inert bed support material above

the floating screen or top bed support screen into separate containers being careful not to dislodge or damage the floating screen or the top metal bed support screen. Vacuuming the ceramic material from outside the vessel may be the easiest way to accomplish this step. Check from outside the vessel to ensure that no adsorbent is under the floating screen or on the top bed support screen, and then shut off the nitrogen purge on the vessel.

**4.** After all of the adsorbent has been removed, prepare the atmosphere in the vessel for safe entry. Remove the nitrogen purge line and attach an air mover so that air is expelled out of the bottom of the vessel below the bed support. The air will carry any remaining vapors out of the vessel and away from personnel. Monitor for the presence of any hazardous contaminants as well as the oxygen level in the vessel and at the outlet of the air mover to ensure that the nitrogen and hazardous contaminants have been removed. Once safe levels have been established, personnel can access the vessel under appropriate confined space entry procedures. Always leave the air mover on while personnel are in the vessel and periodically monitor the vessel atmosphere to ensure safe levels are maintained.

**5.** For the inert bed support, vacuum or remove by buckets the remainder of the inert bed support material and proceed to internal vessel inspection.

**6.** For a metal bed support system proceed to internal vessel inspection.

# Disposal

The spent GB adsorbent is hazardous and should be disposed of or reclaimed in accordance with all governmental requirements. It is technically feasible to reclaim the active copper component in the adsorbent and, where applicable regulations permit, the reclaimed copper may be returned to the open market.

For GB Mercury Removal Unit products, a key consideration is the safe disposal and/or recovery of the adsorbed mercury following reactor discharge. One feature of the GB range of products is that they are compatible with a well established process of mercury reclamation. This process includes the removal of mercury at elevated temperatures followed by vacuum distillation at specifically licensed mercury handling facilities. Following mercury reclamation, the active copper component of the spent GB product can be recovered via a smelting process. You may contact UOP for assistance in placing GB users in contact with spent mercury guard processing facilities.

***As a reminder, due to the possible presence of mercury, sulfur, arsenic and other contaminants, the spent UOP GB metal oxide and/or carbonate adsorbent is likely to be considered a hazardous waste by most governmental authorities. Other hazardous characteristics of the material may also affect waste classification. Packaging, storage, transport, treatment and disposal of hazardous waste are strictly controlled by governmental regulations.***



## **Emergency Assistance - 24 hour Emergency Telephone Numbers:**

**Medical or release emergencies (PROSAR) :** + 1-800-498-5701 or  
+ 1-651-523-0309

**Transportation (CHEMTREC) :** + 1-800-424-9300 or  
+ 1-703-527-3887



### **Find out more**

For more information, contact your  
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