

Application Bulletin

Purification of Amines with Granular Activated Carbon

Description

In recent years, there has been a steady increase in the use of ethanolamines in scrubber systems to purify gas streams by absorbing acid gas constituents. These recirculating liquid scrubber streams may consist primarily of mono-, di- or tri-ethanolamine, methyl diethanolamine, or other amines.

In the process of absorbing acid gas constituents such as CO₂, H₂S and COS, the amine stream picks up a wide range of other organics which eventually foul the scrubbing solvent. Some recirculating amine streams perform fairly well for a certain period of time without difficulty, but in the majority of cases, foaming, corrosion, loss of efficiency, and other problems appear which affect operation costs. The presence of degradation products in the amine accelerates corrosion, requires more reclaimer dumping and filter changes, and will result in a need for higher quantities of amine makeup.

In these cases, mechanical filtration equipment for removal of suspended solids may provide some measure of improvement. Usually, however, mechanical filtration yields only a marginal improvement in amine quality, and the difficulties remain with the system.

Field experience with recirculation amine streams in various refineries, CO₂ processing plants, gas transmission companies, and other gas processes indicates six basic and common problems:

1. Lost production caused by off-specification product gas
2. Foaming and carryover in the absorber or stripper
3. Absorber corrosion
4. Loss of amine scrubbing efficiency
5. High amine makeup
6. Increased energy requirements in reboilers

Losses of product quality or operating efficiency can be costly to overall plant operation. However, a cost-effective and simple remedy is available for restoring amine quality on line without service interruption. This method is adsorption of the dissolved organics from the amine solution with Calgon Carbon products.

The Benefits of using Carbon Adsorption

The benefits of carbon adsorption in the correction of each of the six problem conditions are described briefly as follows:

- **Avoids downtime caused by a drop in product gas quality** - A fouled amine scrubbing solution can produce off-specification product gas, causing an interruption in production until the problem is cleaned up. Activated carbon removes the fouling agents from the amines, thereby maintaining a high level of scrubbing efficiency and avoiding costly downtime.
- **Prevents amine foaming and carryover in the absorber and stripper** - Foaming can be caused by suspended solids and dissolved or entrained hydrocarbons in the amine solution. This reduces the gas/liquid transfer rates at their interfaces.



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While suspended solids can be removed by mechanical filtration, granular activated carbon strongly adsorbs dissolved hydrocarbons and degradation products, and removes them from the recirculation stream. The reduction of foaming maintains high unit capacity, while reducing the need for anti-foam agents.

Reports from many installations using Calgon Carbon Sorbamine and SGL granular activated carbons on recirculating amine streams show that foaming has been eliminated.

- **Helps control corrosion** - The high carbon steel corrosion rate experienced in amine systems has been a cause of great concern. It has been found that acids and acid-forming molecules are adsorbed on the activated carbon, and this provides some measure of corrosion control. Also, activated carbon can remove hydrogen sulfide and, therefore, minimize erosion.
- **Maintains amine efficiency and plant capacity** - In systems where activated carbon is not used, there can be a definite buildup of hydrocarbons and degradation products in the amine with a corresponding darkening of color and loss of amine efficiency. Systems contaminated to this extent can experience reduced capacity and high corrosion rates, and eventually need larger quantities of makeup amine. The use of granular activated carbon in the system can minimize makeup requirements.
- **Reduces level of amine consumption** - The use of activated carbon prevents foaming and carryover losses of amine resulting in reduction of amine makeup.
- **Reduces energy requirements** - Increased scrubbing efficiency achieved with granular activated carbon can permit a reduction of the amine recirculating rate and/or lowering of the amine concentration required, thereby reducing reboiler steam consumption.

Parameters for Carbon System Design

The design of carbon systems will vary somewhat depending on individual requirements. It is advisable to consult with a Calgon Carbon adsorption specialist to ensure that an optimum system design is provided.

For the highest efficiency, the activated carbon should be installed on the lean cold stream. Entrapped gases are at a minimum at this point in the amine cycle. In side stream applications, recirculation flows of 10 percent or higher are used. A higher percent slip stream has the advantage of faster cleanup in the event there should be a surge of higher level contamination. In some cases full flow treatment has also been used. The recommended flow rate is 4 gallons per minute per square foot of cross-sectional bed area (or approximately 20 minutes of superficial contact time).

The tables below give the characteristics of the carbon columns to be considered in designing for some typical side streams.

Slip stream GPM	Column Cross-Sectional Area Required Ft ²	Column Diameter Bed Height is 10'	Carbon Requirements lbs.
4	1	1.1	280
12	3	2.0	840
20	5	2.5	1445
40	10	3.5	2800
80	20	5.0	5600

Slip stream m ³ /h	Column Cross-Sectional Area Required m ²	Column Diameter Required mm (Bed Height is 3000 mm)	Carbon Requirements kg.
1	0.11	375	147
2	0.22	530	295
4	0.44	750	590
8	0.88	1,060	1180
16	1.76	1,500	2360



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As can be determined from these tables, the amount of carbon used is small in comparison to the significant process savings and advantages to be obtained. Due to gas conditions and process variables, the life of the carbon bed varies from stream to stream.

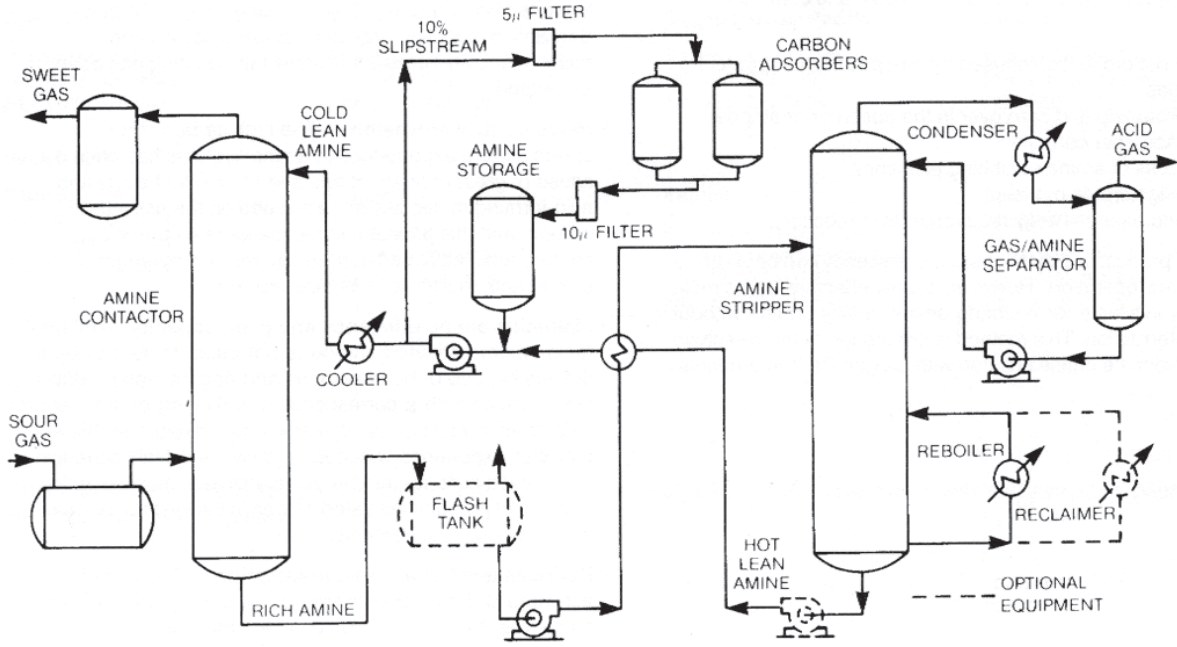
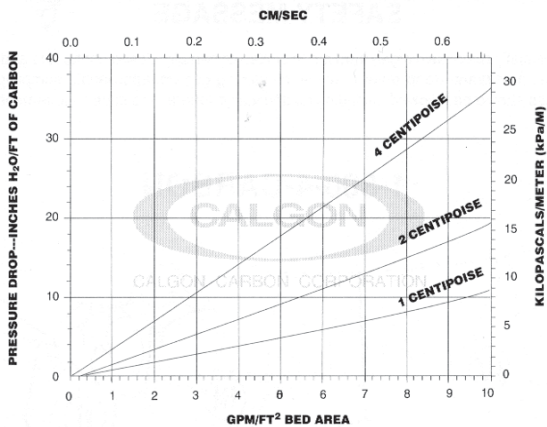
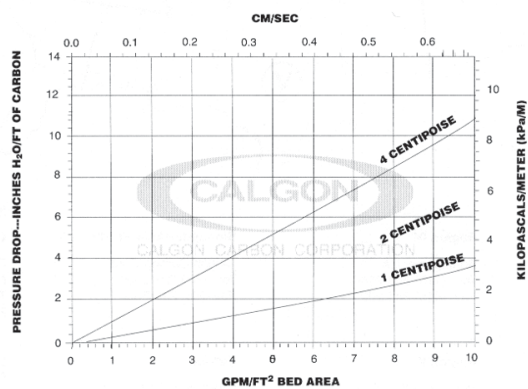


Figure 1 — Amine Purification with Granular Activated Carbon

PRESSURE DROP CALGON CARBON SORBAMINE 8X30 CARBON



PRESSURE DROP CALGON CARBON SORBAMINE 4X10 CARBON



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Granular Activated Carbon from Calgon Carbon Corporation

Calgon Carbon Corporation is experienced in the manufacture and application of granular activated carbon to serve a wide variety of purposes throughout the world. Much of the technology of adsorption has been developed in our laboratories and at field installations. Some capabilities that make Calgon Carbon unique in serving your specific needs are:

- World's largest producer of granular activated carbon
- Full service capability which can include adsorption equipment, carbon handling equipment, activated carbon product and spent carbon reactivation.
- Advanced analytical capabilities
- Specialized technical support

Our adsorption specialists will work with you to determine how granular activated carbon can best serve your requirements.

Safety Message

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable federal and state requirements.

Limitations of Liability: The Supplier's liability and the purchaser's exclusive remedy for any cause of action arising out of this transaction, including, but not limited to, breach of warranty, negligence and/or indemnification, is expressly limited to a maximum of the purchase price of spare parts or equipment sold hereunder. All claims of whatsoever nature shall be deemed waived unless made in writing within forty-five (45) days of the occurrence giving rise to the claim. In no event shall the Supplier for any reason or pursuant to any provision of the warranty be liable for incidental or consequential damages, or damages in excess of the purchase price, nor shall the supplier be liable for loss of profits or fines imposed by governmental agencies.



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