

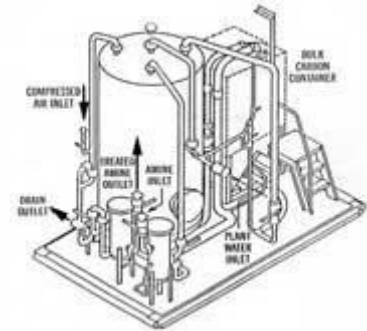
Purification of Amines and Glycols

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In the process of absorbing acid gas constituents, amine streams become contaminated with thermal and chemical degradation products, organic acids and/or iron sulfides. Contamination of the amine stream can cause foaming and carry over in the absorber or stripper, high steam and circulation rates, increased system corrosion and heat stable salt formation. A properly designed activated carbon system can reduce, and in many cases eliminate, the need for anti-foam agents, reduce amine make-up rates, reduce total system energy consumption, reduce corrosion, and improve scrubbing efficiencies and product quality.

Historically, many activated carbon systems have been under-designed and/or operated incorrectly. The activated carbon systems had insufficient contact time, and in many cases, the wrong activated carbon was used and the activated carbon was rarely changed. A properly designed activated carbon system should treat a 10-20% slipstream of the amine solution, have a minimum of 15 minutes empty bed contact time, and a superficial velocity of 2-4 gpm/ft². When the amine solution changes color and clarity, it is usually time to change the activated carbon, since this is usually indicative of the activated carbon being exhausted.

Figure 1 shows an effective activated carbon system. Besides having a properly designed and sized adsorber, the system also includes mechanical filtration both upstream and downstream of the activated carbon adsorber. The upstream filter removes suspended solids to ensure the activated carbon is used to adsorb contaminants, and the downstream filter will remove activated carbon fines which could cause foaming. A feature of this system is the activated carbon handling equipment which allows quick and easy change out of the activated carbon- without exposing personnel to spent activated carbon.



The activated carbon recommended is a hard, small mesh, steam activated carbon, having a broad range of pore diameters. This prevents short bed life, excessive fines, foaming, and the ability to remove a wide range of organic contaminants. The activated carbon should also be free of phosphorus, which could leach from the activated carbon bed in the form of phosphates. These phosphates could cause additional foaming in the amine stream.

In one instance, an activated carbon system was installed to reduce a severe foaming problem in the amine contractor. The amine solution was black in appearance and operating costs were very high. Table 1 shows the operating cost elements before and after the activated carbon system was put into service. Because the activated carbon treated amine did not carryover from foaming, the amine make-up and antifoam consumption was reduced. The refinery was able to increase the amine strength and reduce circulation that resulted in steam savings. Finally, the filter cartridge usage was reduced because the activated carbon removed organic acids from the amine stream resulting in lower tendency to create iron sulfide. All of these reductions resulted in a first year savings of \$147,800 (Table 2). Second year savings increased to \$205,800 as the refiner was able to further reduce antifoam addition, filter cartridge replacement and amine make-up.

As a side benefit, the product gas quality improved to where the refiner was able to reduce H₂S concentration from 10-40 ppm to at or near non-detectable levels. Heat stable salts were reduced to a low level of 5 ppm. Although activated carbon does not adsorb heat stable salts, it will remove the precursors to their formation.

A similar application for activated carbon is the removal of dissolved impurities from glycol streams that could cause foaming. The reduced foaming tendency of the glycol provides better contact with the gas that improves drying efficiency. In this application, the activated carbon system can be installed on the rich side. Due to the higher viscosity of the glycol, the maximum superficial velocity recommended is 2 gpm/ft².

Table 1
Operating Cost Elements Before and After Activated Carbon System Installation

	Pre-System	Post-System	Reduction
Amine Circulation (gpm)	300	265	35
Anti-foam Consumption (Drums/Year)	4-5	1-2	3
Filter Cartridges (No. Used/Day)	30-40	12-15	20
Amine Make-Up (Gal/Month)	1,400	1,000	400
Steam Usage (Lbs./Month)	18,000	16,000	2,000

Unit Cost
DEA- \$0.40/LB.
Steam - \$4.44 / 1,000 lbs.
Filter Cartridges - \$7.37
Anti-foam - \$4,000 / Drum

Table 2
First Year Savings

Amine Make-Up	\$20,000
Steam	\$77,800
Filter Cartridges	\$54,000
Anti-foam	\$12,000
Activated Carbon Usage	-\$16,000
TOTAL	\$147,800