



# The CONTACTOR™

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## Keeping Amine in the System

Any amine-based gas treatment solvent contains at least one, and sometimes two or even more amines, each of which is volatile to a greater or lesser extent. Thus, amine can be lost from an absorber by vaporizing into the gas. In addition, it can be entrained as droplets and mist with the treated gas. Solvent losses by these paths can be largely prevented by water washing the exiting gas streams. (Losses through leaks and spills, of course, are another matter and are usually maintenance and housekeeping issues.) In this issue of the Contactor the efficacy of water washes and how they are carried out is examined through a specific example.

### Where to Wash and with What

Amine treating takes place in a closed circuit using an absorber, a solvent regenerator, possibly a small flash gas treating column, and ancillary equipment such as pumps, heat exchangers, and a flash tank. Conventional wisdom is to use a stripped solvent that is five to ten degrees hotter than the sour gas entering the absorber. This goes some way towards preventing condensation of high boiling hydrocarbons into the solvent which may result in foaming with all its accompanying problems. Another less discussed reason for using a solvent hotter than the gas is to ensure there is a small water loss from the system rather than a water gain. Water, of course, must be kept in balance in the solvent circuit and it's a lot easier to add back water to the system than it is to remove it (without at the same time removing expensive amine). So there are a couple of reasons for keeping the lean solvent hotter than the raw gas.

Potential amine losses just from vaporization alone into the gas being treated may not be trivial. For example, without taking solvent recovery measures, in a plant producing 200 MMSCFD of treated gas at 46°C using a solvent with 46 wt% MDEA and 4.3 wt% piperazine the *annual* amine vaporization loss is several thousands of gallons of MDEA and several tens of tons of piperazine! The cost to replace this evaporated amine is roughly

\$450,000 of which 80–85% is for piperazine. This is not only because piperazine is a costlier chemical than MDEA, but it is also more volatile. In piperazine-activated MDEA systems, water washing of product gases is almost always done. In fact, it should be considered mandatory with piperazine. An additional concern with any blended amine system (most proprietary amines are blends) is that one amine component in the blend is usually more volatile than the other (piperazine has a much higher vapor pressure than MDEA) so vaporization constantly changes the blend composition, possibly leading to poorer treating performance over time. But, significant economic consequences can be easily avoided by water washing all product gases.

Figure 1 shows a typical amine treating flow sheet. Water washing the acid gas produced in the regenerator is rather straightforward. It is quite common for there to be a few reflux trays at the top of this column, fed by the water produced by the overhead condenser. Getting amines down to parts per billion in the acid gas is also straightforward; however, using reflux trays is not always necessary. Sometimes the condenser itself is sufficient to produce less than 1 ppb amine in the acid gas. It depends to a large extent on the temperature of the stripper overhead. ProTreat® provides solid guidance as to how many reflux trays (if any) are needed to achieve a given level of recovery.

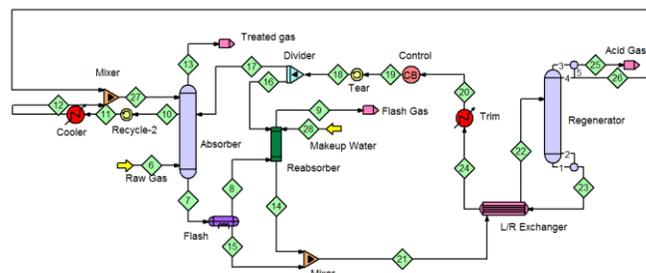


Figure 1 Typical Amine Treating Flowsheet

Recovering amines from the treated gas can be done by using either fresh makeup water or, if inadequate makeup water is available, by with-

drawing part of the condensate from the regenerator reflux drum and feeding it to the uppermost of a two- or three-tray wash section at the top of the absorber.

Absorber wash trays are commonly bubble cap type because they operate without weeping even at the extremely low liquid loads (flow rate per unit of tray active area) typical of water washes. However, at these very low liquid loads, the quality of gas-liquid contacting may be poor (extremely low L/V ratio). Contacting can be improved by recirculating wash liquid at much higher flow rates, adding fresh wash water, and allowing enough of the wash liquid to enter the absorption section from the bottom wash tray to maintain level control on a small wash-liquid holdup drum in the wash circuit. Lean amine is fed to the absorber immediately below the wash section. This scheme is shown in Figure 1.

It may or may not be worthwhile to wash flash gas from the reabsorber. This column is usually packed and is quite short. It recovers acid gases from flashed hydrocarbon before the flash gas is discharged, possibly to be used as fuel gas. If simulation shows sufficient economic benefit from recovering amine from this unit, a short packed section fed with makeup water will work well.

By way of example, the treated gas in the case described above contains 2.2 ppmv MDEA and 9.1 ppmv piperazine. A simple wash using two bubble-cap trays with 25 USgpm of water reduces these values to < 1 ppbv and 20 ppbv for MDEA and piperazine, respectively. However, in this particular case, this much water flow exceeds the makeup needs for the unit as a whole. Therefore, 50% of the condensate from the overhead condenser was withdrawn and circulated it back to the top wash tray in the absorber.

The condensate is 0.3 wt% MDEA and 0.013 wt% piperazine. Two wash trays with this condensate as wash liquid is simulated to produce a treated gas with 130 ppbv MDEA and 8 ppbv piperazine. Losses amount to under \$100 per year from vaporization! If the wash trays were to require higher circulation rates for satisfactory hydraulic performance, amine losses would go up because the recirculating wash fluid would be considerably higher in amine. Nevertheless, losses would be enormously reduced. Note, however, that adding makeup water to a high flow-rate recirculation will be quite ineffective in further reducing losses because the added water will tend to be lost in a sea of recirculation.

The acid gas from the regenerator is already at the parts per trillion level for both amines

even without reflux trays in the column. In this case there is nothing to be gained from adding a refluxing section. However, this is not always the case, and sometimes amine losses with the acid gas can be substantial. In the present case the gas going overhead from the regenerator was only 76°C, quite cold by gas treating standards. Temperatures of 110–120°C are more usual, in which situation the amine concentrations might be high enough to make the inclusion of reflux trays in the regenerator worthwhile.

Whether to water (or condensate) wash varies a great deal from case to case, and only a reliable simulation can help make the right decision. But failing to wash product gases can result in very costly amine losses from the unit. Such losses are easy to prevent.

We have not discussed entrainment or foaming losses because simulation tools do not usually address this issue. Nevertheless, reducing the amine content of the solution in a water wash section tends both to decrease solution viscosity and increase solution surface tension. These collectively help to reduce the foaming tendency and may be useful mitigation measures to stop foam from growing outside of the tower. Additionally, recourse can be had to vendor tray and packing design manuals and to the vendors themselves for an assessment of likely entrainment rates from trays and packing. Water and condensate washing in conjunction with using carefully-selected demisting pads at the top of contactors can reduce amine losses from entrainment to essentially zero.



To learn more about this and other aspects of gas treating, plan to attend one of our training seminars. Visit [www.protreat.com/seminars](http://www.protreat.com/seminars) for details.

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