Lessons Learned

From Natural Gas STAR Partners

OPTIMIZE GLYCOL CIRCULATION AND INSTALL FLASH TANK SEPARATORS IN GLYCOL DEHYDRATORS

Executive Summary

There are approximately 38,000 glycol dehydration systems in the natural gas production sector emitting an estimated 22 Bcf of methane per year into the atmosphere. Most dehydration systems use triethylene glycol (TEG) as the absorbent fluid to remove water from natural gas. As TEG absorbs water, it also absorbs methane, other volatile organic compounds (VOCs), and hazardous air pollutants (HAPs). As TEG is regenerated through heating in a reboiler, absorbed methane, VOCs, and HAPs are vented to the atmosphere with the water, wasting gas and money.

The amount of methane absorbed and vented is directly proportional to the TEG circulation rate. Many wells produce gas far below the original design capacity but continue to circulate TEG at rates two or three times higher than necessary, resulting in little improvement in gas moisture quality but much higher methane emissions and fuel use. Reducing circulation rates reduces methane emissions at negligible cost.

Installing flash tank separators on glycol dehydrators further reduces methane, VOC, and HAP emissions and saves even more money. Recovered gas can be recycled to the compressor suction and/or used as a fuel for the TEG reboiler and compressor engine. Economic analyses show flash tank separators installed on dehydration units payback costs in 4 to 17 months.

Method for Reducing Gas Loss	TEG Circulation Rates (gal/hr)	Value of Gas Saved ($/yr)[2]		Cost of Reducing Gas Loss	Payback (months)
		Energy-exchange	Electric Pump		
Reducing TEG circulation rates	50% to 200 % over-circulation[1]	390 to 39,400/yr[1]		Negligible	Immediate
Flash Tank Separators	150	2,130[3]	710[3]	$5,000-$5,600	6-17
	450	21,295[3]	8,762[3]	$7,000-$14,000	5-8

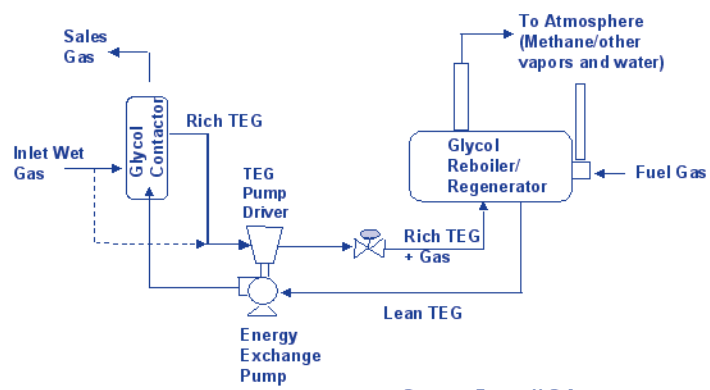
[1] Optimal circulation rates ranged from 30 to 750 gal TEG/hr.
[2] At $3.00/Mcf.
[3] Includes recovered natural gas liquids sales revenue.

This is one of a series of Lessons Learned Summaries developed by EPA in cooperation with the natural gas industry on superior applications of Natural Gas STAR Program Best Management Practices (BMPs) and Partner Reported Opportunities (PROs).

Technology Background

Many producers use triethylene glycol (TEG) in dehydrators to remove water from the natural gas stream and to meet pipeline quality standards. In a typical TEG system, shown in Exhibit 1, "lean" (dry) TEG is pumped to the gas contactor. In the contactor, the TEG absorbs water, methane, VOCs, and HAPs (including benzene, toluene, ethylbenzene and xylenes (BTEX)), from the wet production gas. The "rich" (wet) TEG leaves the contactor saturated with gas at sales pipeline pressure, typically between 250 and 800 psig. The gas entrained in the rich glycol, plus additional wet gas bypassing the contactor, expands through the energy-exchange driver for the TEG circulation pump. The TEG is then circulated through a reboiler where the absorbed water, methane, and VOCs are boiled off and vented to the atmosphere. The lean TEG is then sent through an energy-exchange pump back to the gas contactor, and the cycle repeats.

Exhibit 1: TEG system without Flash Tank Separator



Source: Exxon U.S.A.

Because the system described above is primarily designed to remove water from the gas stream, significant methane emissions can also result. Fortunately there are several steps that operators can take that will minimize gas loss:

1) Reduce the TEG circulation rate.

Gas production fields experience declining production, as pressure is drawn off the reservoir. Wellhead glycol dehydrators and their TEG circulation rates are designed for the initial, highest production rate, and therefore, become over-sized as the well matures. It is common that the TEG circulation rate is much higher than necessary to meet the sales gas specification for moisture content. The methane emissions from a glycol dehydrator are directly proportional to the amount of TEG circulated through the system. The higher the circulation rate, the more methane is vented from the regenerator. Over-circulation results in more methane emissions without significant and necessary reduction in gas moisture content. Natural Gas STAR partners have found that dehydrator systems often recirculate TEG at rates two or more times higher than necessary. Operators can reduce the TEG circulation rate and subsequently reduce the methane emissions rate, without affecting dehydration performance or adding any additional cost.

2) Install a Flash Tank Separator

Most production and processing sector dehydrators send the glycol/gas mixture from the TEG circulation pump directly to the regenerator, where all of the methane and VOCs entrained with the rich TEG vent to the atmosphere. One industry study found that flash tank separators were not used in 85 percent of dehydration units processing less than one MMscfd of gas, 60 percent of units processing one to five MMscfd of gas, and 30 to 35 percent of units processing over five MMscfd of gas.

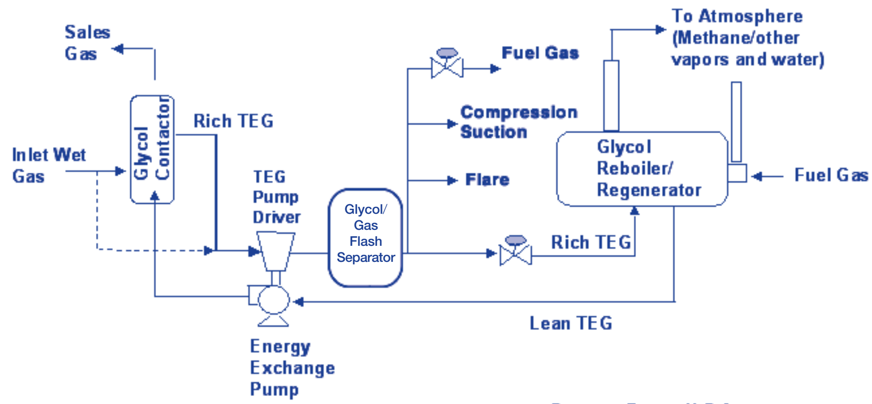
In a flash tank separator, gas and liquid are separated at either the fuel gas system pressure or a compressor suction pressure of 40 to 100 psig. At this lower pressure and without added heat, the gas is rich in methane and lighter VOCs but water remains in solution with the TEG. The flash tank captures approximately 90 percent of the methane and 10 to 40 percent of the VOCs entrained by the TEG, thereby reducing emissions. The wet TEG, largely depleted of methane and light hydrocarbons, flows to the glycol reboiler/regenerator where it is heated to boil off the absorbed water, remaining methane, and VOCs. These gases are normally vented to the atmosphere and the lean TEG is circulated back to the gas contactor. Exhibit 2 shows a TEG dehydrator with a flash tank separator.

Note: Installing flash tank separators on large dehydrators may be required to achieve compliance with Maximum Available Control Technology (MACT) standards under the oil and gas industry NESHAPs. When these installations are required by law, the partner should not include associated methane emissions reductions in their Natural Gas STAR Annual Reports.

NESHAP Regulations

On June 29, 2001 EPA finalized the National Emission Standards for Hazardous Air Pollutants(NESHAP) for Oil and Natural Gas Production Facilities (40 CFR 63 Subpart HH) and for Oil and Gas Transmission and Storage Facilities (40 CFR 63 Subpart HHH). These standards set a throughput floor of 3MMscf/day for production facilities and a higher 10MMscf/day for transmission and storage facilities. Above these floors operators need to install equipment to either reduce HAPs from dehydrator vents by 95 percent using closed-vent control systems or making process modifications, or combust HAPs below 20 ppmv. These standards are also triggered if total benzene emissions exceed 1 ton/year.

Exhibit 2: Dehydrator Schematic - with Flash Tank Separator



3) Use of electric pumps in place of energy-exchange pumps

Remote gas fields do not have electrical power and instead use “energy-exchange” pumps to power the lean TEG circulation pump. For every volume of gas absorbed in the rich TEG leaving the contactor, two more volumes of gas must be added from wet feed gas to supply enough power in the driver for the lean TEG pump. Therefore, using either a piston or gear type “energy-exchange” pump triples the amount of gas entrained with the TEG and vented to the atmosphere when there is no flash tank separator. Installing an electric motor in place of an energy-exchange pump eliminates this additional emissions source. Conventional piston type energy-exchange pumps also often leak rich (wet) TEG into the lean (dry) TEG. Leakage of only 0.5 percent can double the circulation rate necessary to maintain sales gas moisture content, thus increasing potential emissions. For more information on this practice, see EPA’s *Lessons Learned: Replacing Gas-Assisted Glycol Pumps with Electric Pumps.*

Economic and Environmental Benefits

Optimizing glycol circulation and installing flash tank separators provide several environmental and economic benefits:

- ★ Reducing glycol circulation to the optimum rate saves glycol replacement costs as well as fuel consumption in the reboiler.
- ★ Reducing VOC and HAP (BTEX) emissions improves ground level air quality. BTEX emission reductions can be significant for large dehydrators.
- ★ Using flash tank separators on dehydration units with a condenser on the reboiler vent improves the efficiency of the condenser by removing most of the non-condensable gas, primarily methane. A condenser recovers natural gas liquids (NGLs), and HAPs more efficiently than flash tank separators alone.
- ★ Using the gas recovered in the flash tank for fuel gas reduces operating costs.
- ★ Piping recovered flash tank gas to the suction of an upstream compressor (a common design practice in new installations) reduces production costs.
- ★ Piping a dehydrator's regenerator vent to a vapor recovery unit allows flash tank gas to be used as a stripping gas in the glycol reboiler.

Decision Process

Operators can estimate the costs and the benefits of optimizing the TEG circulation rate and installing a flash tank separator by following these five steps:

Step 1: Optimize Circulation Rate. Operators can easily calculate the optimal circulation rate by following a few simple calculations. First obtain the current circulation rate by reading the flow controller, which measures gallons of TEG circulated. For each gallon of TEG circulated, one standard cubic foot of methane is absorbed, and if the unit has an energy-exchange pump, two more cubic feet of gas will be necessary to drive the pump. All of this gas is vented to the atmosphere when there is no flash tank separator.

Five Steps for Evaluating TEG Circulation Rate Optimization and Flash Tank Separator Installation:

1. Optimize circulation rate.
2. Identify dehydration units without flash tanks.
3. Estimate capital and installation costs.
4. Estimate value of gas saved.
5. Conduct economic analysis.

Next, determine the minimum circulation rate necessary to dewater the gas stream. The minimum TEG circulation rate at a particular site is a function of the gas flow rate, the water content of incoming gas, and the desired water content of outgoing gas. The water removal rate is a function of the gas flow rate and the amount of water to be removed from the gas stream. The TEG-to-water ratio (how many gallons of TEG are required to absorb 1 pound of water) varies between 2 and 5 gallons of TEG per pound of water; the industry accepted rule-of-thumb is 3 gallons of TEG per pound of water removed. The greater the water removal rate or the higher the TEG-to-water ratio, the higher the TEG circulation rate must be. Some STAR partners report lower TEG-to-water ratios than the norm (i.e., <3 gallons TEG per pound of water), which lowers their optimal TEG circulation rates.

Problems can arise if the TEG circulation rate is too low; therefore a certain amount of over-circulation is desired. For instance, an overly restricted circulation rate can cause problems with tray hydraulics, contactor performance, and fouling of glycol-to-glycol heat exchangers. Therefore, operators should include a margin of safety, or "comfort zone," when calculating reductions in circulation rates. An optimal circulation rate for each dehydration unit typically ranges from 10 to 30 percent above the minimum circulation rate. The formulas used to determine the minimum and optimum TEG circulation rates are shown in Exhibit 3.

Exhibit 3: Calculating the Optimal TEG Circulation Rate

A 20 MMcf/d dehydrator has a TEG circulation rate set at 280 gal/hr, and the wet gas stream has 60 lb water/MMcf. A comfort zone of 15 percent over the minimum rate is desired. The optimal TEG circulation rate can be calculated as follows:

Given:

F = gas flow rate (MMcf/d)
I = inlet water content (lb/MMcf)
O = outlet water content (lb/MMcf) (Rule-of-thumb is 4)
G = glycol-to-water ratio (gal TEG/lb water) (Rule-of-thumb is 3)
L(min) = minimum TEG circulation rate (gal/hr)
W = Water Removal Rate (lb/hr)

Calculate: L(min) = Minimum TEG Circulation Rate (gal/hr)
L(min) = W * G

$$W = \frac{F*(I - O)}{24hr / day}$$

$$W = \frac{20*(60 - 4)}{24hr / day} = 46.66 \text{ lb water/hr}$$

G = 3

L(min) = 46.66 * 3 = 140 gal TEG/hr

This is the minimum circulation rate. Adding 15 percent over L(min) for the comfort zone yields an optimal circulation rate of 160 gal TEG/hr. For example:

L(opt) = Optimal circulation rateL(opt) = 140 gal TEG/hr * 1.15 = 160 gal TEG/hr

Natural Gas STAR partners and other industry experts have identified five common reasons operators of glycol dehydrators over-circulate TEG:

- Gas-powered energy-exchange pumps can contaminate lean glycol, making the glycol less effective at absorbing water from the wet gas stream. To compensate, operators over-circulate to attain the same dew point depression as would be attained by non-contaminated glycol circulating at a lower rate.
- Circulation rates are set to match the plant design capacity, rather than actual throughput.
- Higher rates ensure adequate dehydration at fluctuating gas throughput rates.
- Dehydration units are in remote locations making frequent adjustments inconvenient.
- Dehydrators are operated by independent contractors that have little incentive to optimize the circulation rate and reduce methane losses.

Step 2: Identify dehydration units without flash tanks. Most new dehydration units include flash tank separators as standard equipment. Approximately two-thirds of operating units, however, do not have flash tank separators; these are mainly smaller, older, or more remote units. Before proceeding to the next step, operators first should identify dehydration units without flash tank separators.

Step 3: Estimate capital and installation costs. For the purposes of this analysis, the cost of optimizing the glycol circulation rate is assumed to be very small (1/2 hour at $25/hour).

Before estimating the costs of purchasing and installing a flash tank separator, partners must choose a design and size that meets their needs. Selecting a flash tank depends on a number of factors including composition of the gas stream (i.e., recovery rate of gas liquids), construction code requirements, cost, and ease of implementation. Flash tank separators are manufactured in two designs—vertical and horizontal. In general, operations that have significant volumes of NGLs in their gas stream should use a three-phase horizontal separator (natural gas, TEG, NGLs) with a retention time of 10 to 30 minutes. Operations that do not have marketable amounts of NGLs can use a two-phase separator (natural gas, TEG) with a 5 to 10 minute retention time. Vertical vessels are best suited for two-phase systems.

Manufacturers sell a wide range of standard, "off-the-shelf" flash tank separators, which are specified based on settling time and volume. To determine the appropriate size of a flash tank separator, partners should calculate the settling volume required for each system.

Exhibit 4 presents the basic calculation for determining the necessary settling volume for a flash tank separator based on the TEG circulation rate. Additional volume might be necessary if operators also settle out NGLs in the flash tank separator for periodic pickup by a tank truck. For example, if the TEG circulation rate indicates a settling volume of 75 gallons, and 35 gallons of NGLs will be accumulated, the settling volume should be increased by 35 gallons.

Exhibit 4: Sizing the Flash Tank

Given: L = TEG circulation rate in gal/hr
T = retention time in minutes

Calculate: SV = liquid settling volume (gallons)
$SV = (L * T) \div 60$

Note: Add site-specific volume for accumulating NGLs for periodic pick-up.

The total cost of a flash tank separator depends on: (A) capital costs and (B) installation and operating costs.

(A) Capital Costs

Costs of flash tank separators can range between $2,500 and $5,000, uninstalled, depending on flash tank design and size. If the required size exceeds the largest standard flash tank available, operators can either have a custom tank built, install multiple flash tanks in parallel, or install a separate NGL accumulation tank.

(B) Installation and Operating Costs

Installation costs depend on location, terrain, foundation, weather protection (vessel fabrication codes are based on the amount of hydrogen sulfide in the gas), NGL accumulation and pickup capability, and automation and instrumentation. Information provided by flash tank separator manufacturing companies suggests an average installation cost of $1,200, including delivery, assembly and labor costs. This cost could increase by as much as 80 percent, depending on site-specific factors.

Flash tank separators installed at existing dehydration units are prefabricated, and include tubing, valves, and associated equipment. Installation can be performed with minimal downtime. To minimize installation costs, partners suggest installing a flash tank separator when a dehydration unit is being repaired or during other system overhauls.

Flash tanks are designed as simple pressure vessels, with few operating parts. Therefore, operating and maintenance (O&M) costs are negligible. Partners have found that flash tank separator maintenance can be accomplished during routine O&M practices for the dehydration unit.

Capital and installation costs for a range of flash tank types and standard sizes are provided in Exhibits 5A and 5B.

Exhibit 5A: Vertical Separator Sizes and Costs

Settling Volume (gallons)[1]	Diameter (feet)	Height (feet)	Capital Costs ($)	Installation Costs ($)	O&M Costs ($)
8.2	1.08	4	2,500	1,200 - 2,160	Negligible
13.5	1.33	4	3,300	1,200 - 2,160	Negligible
22.3	1.66	4	4,300	1,200 - 2,160	Negligible
33.6	2	4	5,000	1,200 - 2,160	Negligible

Note: Cost information provided by Sivalls, Incorporated.
[1] Settling Volume = half of total volume (not including NGL accumulation requirements).

Exhibit 5B: Typical Horizontal Three-Phase Separator Sizes and Costs					
Settling Volume (gallons) [1]	Diameter (feet)	Length (feet)	Capital Costs ($)	Installation Costs ($)	O&M Costs ($)
49	2	3	3,000	1,200 - 2,160	Negligible
65	2	5	3,200	1,200 - 2,160	Negligible
107	2.5	5	3,400	1,200 - 2,160	Negligible
158	3	5	4,800	1,200 - 2,160	Negligible
225	3	7.5	5,000	1,200 - 2,160	Negligible

Note: Cost information provided by Sivalls, Incorporated.
[1] Settling Volume = half of total volume (not including NGL accumulation requirements).

Step 4: Estimate value of gas saved. Gas savings can be achieved by optimizing the circulation rate alone, installing a flash tank separator, and in certain circumstances, doing both. Exhibit 6 shows how to determine the amount of gas savings from optimizing the TEG circulation rate with no flash tank separator. Additional savings from reducing TEG circulation rates include:

★ Lower fuel requirements for the regenerator. Reducing the load on a regenerator with a heat duty of 1,340 Btu/gal of TEG circulated could save between $545 and $54,456 per year, depending on the amount of overcirculation and the heating value of the natural gas.

★ Reducied frequency of glycol replacement. Industry experts estimate that 0.5 percent of TEG volume is lost per hour. Annual savings could range from $393 (if circulation rates are reduced from 45 to 30 gallons per hour) to $39,300 (if rates are reduced from 3,000 to 750 gallons per hour).

Installing a flash tank allows partners to recover most of the gas entrained in the TEG. The amount of gas saved from installing a flash tank is a function of the type of TEG circulation pump, the dehydrator's glycol circulation rate and the pressure in the flash tank separator. Typically, about 90 percent of the methane can be recovered from TEG using a flash tank separator.

The type of circulating pump used in the dehydrator has the largest effect on gas recovery. As a rule-of-thumb, each gallon of TEG leaving the contactor has one cubic foot of methane dissolved in it. Energy-exchange pumps require additional high-pressure gas in conjunction with that in the rich TEG flow to supply the energy necessary to pump the lean TEG back to the contactor. As a result, they increase the amount of methane entrained to three cubic feet per gallon of TEG circulated.

Exhibit 6: Calculating the Total Annual Savings from Optimizing TEG Circulation in Dehydrators with no Flash Tank Separator

Given:

A = TEG absorption rate (ft^3/gallon TEG) (Rule-of-thumb is 1)
E = Energy-exchange Pump gas, if applicable (ft^3/gallon TEG) (Rule-of-thumb is 2)
H = Hours per year (8,760)
P = Sales price of gas (Assume $3/Mcf)
L(original) = TEG circulation rate (gal/hour) before adjustment
L(optimal) = TEG circulation rate (gal/hour) after adjustment)

V = Value of Gas Saved ($/year)

$$V = \frac{(L(original) - L(optimal)) * (A + E) * H * P}{1,000}$$

Applying this formula shows that minor reductions in circulation rates can yield substantial savings as shown in the following examples. Note that savings should be reduced by 2/3 where lean glycol is pumped using an electric motor instead of an energy-exchange pump.

Original Circulation Rate	Optimal Circulation Rate	Annual Methane Savings (Mcf)	Annual Savings (@ $3/Mcf)
45	30	394	$1,182
90	30	1,577	$4,731
225	150	1,971	$5,913
450	150	7,884	$23,652
675	450	5,913	$17,739
1350	450	23,652	$70,956
1125	750	9,855	$29,565
2250	750	39,420	$118,260

Exhibit 7 shows how to calculate the amount of methane vented in the absence of a flash tank separator, as well as the value of the gas that could be saved by using a flash tank separator. This example assumes that TEG circulation rates are optimized.

Exhibit 7: Amount of Gas Vented without a Flash Tank and Potential Savings

Assume a dehydration unit with an energy-exchange pump circulates 150 gallons of TEG per hour, with a recovery rate of 90 percent, and a gas price of $3 per Mcf.

Given: L = TEG circulation rate (gal/hr)

G = Methane entrainment rate (rule-of-thumb is 3 cubic ft/gal for energy-exchange pumps; 1 cubic ft/gal for electric pumps)

Calculate: V = amount of gas vented annually (Mcf/yr)

V = (L * G) * 8,760 (hours per year) ÷ 1000 cf/Mcf

V = 150 gal/hr * 3 scf/gal * 8,760 hrs/yr ÷ 1000 cf/Mcf

V = 3,942 Mcf/yr

Savings = 3,942 Mcf X 0.9 X $3/Mcf = $10,643 per year

Exhibit 8 compares the potential savings using a flash tank separator, calculated for energy-exchange and electric pumps at different circulation rates. As the exhibit shows, smaller dehydration units, and units with electric circulation pumps, have a lower economic potential for paying out the cost of a flash tank separator.

Exhibit 8: Potential Savings of using a Flash Tank Separator

TEG Circulation Rates (gal/hr)	Energy-exchange Pump		Electric Pump	
	Mcf/y	$/yr	Mcf/y	$/yr
30	710	2,129	237	710
150	3,548	10,643	1,183	3,548
300	7,096	21,287	2,365	7,096
450	10,643	31,930	3,548	10,643

It is important to note that additional revenue can be generated from the sale of natural gas liquids (NGLs). When treating rich production gas, NGLs often condense and are separated out in the flash tank separator. The quantity varies based on temperature, pressures in the contactor and the flash tank, produced gas composition, and gas entrainment in the TEG. This is a very site-specific evaluation, beyond the scope of this study.

Step 5: Conduct economic analysis. As demonstrated in Step 4, the optimization of glycol circulation to a lower rate will always save money. Therefore partners should always take this action first, regardless of whether or not they decide to install a flash tank separator. The remainder of this analysis focuses on flash tank separators, and assumes that the glycol circulation rate has already been optimized.

Once the capital and installation costs and the value of gas saved have been estimated, partners should conduct an economic analysis. One straightforward way to evaluate the economics is through a discounted cash flow analysis, in which the first year costs for installing the flash tank separator are compared against the discounted value of the saved gas (plus sales of NGLs) over the economic life of the project.

Exhibits 9A and 9B present hypothetical results of this type of analysis. For all but the smallest systems, installation of a flash tank separator at a dehydration unit with an energy-exchange pump will pay-out in less than a year, while a unit with an electric pump should pay-out in less than two-and-a-half years.

Exhibit 9A: Economics of Installing a Flash Tank Separator on a Dehydrator with Energy-exchange Pump

TEG Circulation Rate (gal/hr)	Capital and Installation Cost ($) [1]	Gas Savings[2] $/yr	Total Savings[3] $/yr	Payback Period (months)	Return on Investment[4]
30	5,160	2,129	2,158	29	31%
150	5,560	10,643	10,792	6	193%
300	7,160	21,287	21,573	4	301%
450	13,920[5]	31,930	32,365	5	232%

[1] Horizontal flash tank, 80 percent contingency on installation, 30 minute settling time plus weekly volume of accumulated NGL, where recovered.
[2] Gas valued at $3.00/Mcf.
[3] Higher total savings include natural gas liquids recovery (if present) at 1 percent of recovered gas, valued at $21/barrel. This NGL recovery rate is for these examples only, each site must individually evaluate this potential.
[4] IRR based on 5 years.
[5] Cost for two parallel FTS (for custom size) as settling volume exceeds standard size FTS.

Exhibit 9B: Economics of Installing a Flash Tank Separator on a Dehydrator with Electric Pump					
TEG Circulation Rate (gal/hr)	**Capital and Installation Cost ($) [1]**	**Gas Savings[2] $/yr**	**Total Savings[3] $/yr**	**Payback Period (months)**	**Return on Investment[4]**
30	5,160[5]	710	719	No	No
150	5,160[5]	3,548	3,596	17	64%
300	5,160[5]	7,096	7,110	9	136%
450	7,160	10,643	10,671	8	149%

[1] Horizontal flash tank, 80 percent contingency on installation, 30 minute settling time plus weekly volume of accumulated NGL, where recovered.
[2] Gas valued at $3.00/Mcf.
[3] Higher total savings include natural gas liquids recovery (if present) at 1 percent of recovered gas, valued at $21/barrel. This NGL recovery rate is for these examples only, each site must individually evaluate this potential.
[4] IRR based on 5 years.
[5] Cost for minimum standard tank size.

These exhibits also illustrate the effect of NGLs in the analysis. Because energy-exchange pumps entrain three times more natural gas with the rich TEG than electric pumps, the TEG releases more NGLs in the flash tank separator. As a result, a glycol dehydration system with an energy-exchange pump requires a flash tank with a larger holding capacity. The increased revenues from NGL sales justify the additional cost of the larger tanks. With an electric pump, NGLs are not present in economic quantities in the TEG, thus minimum sized standard tanks can be used for circulation rates between 30 and 300 gal/hr. However, when the 450 gal/hr tank is needed, a very small amount of NGLs can be collected and sold to reduce the cost of the flash tank.

The economics of both installing a flash tank separator and optimizing glycol circulation rates depends entirely on whether the site has a beneficial use for all the gas recovered in the flash tank. Partners have reported cases where well-head dehydrator installations did not include an engine-driven compressor, and the reboiler fuel gas consumption was well below the amount of gas recovered in a flash tank. In this case, the excess recovered gas would have to be vented from the flash tank. In this type of operation, optimizing glycol circulation has an economic value in reducing the gas vented from the flash tank. Site-specific fuel use would be required to evaluate the savings from employing both the flash tank and optimizing circulation.

Lessons Learned

TEG circulation rates at glycol dehydrators are often two to three times higher than the level needed to remove water from natural gas. Most production dehydrators do not have flash tanks, which can be an effective method for recovering valuable methane from TEG that would otherwise be vented to the atmosphere. Natural Gas STAR partners offer the following lessons learned:

- ★ To keep the circulation rates near optimum, educate field O&M personnel or contractors on the method for calculating and adjusting circulation rates, including estimates of a "comfort zone." Incorporate circulation rate adjustment into regular O&M practices.
- ★ Operators should not reduce the quantity of glycol in the system, rather than the circulation rate; this will not achieve the desired savings. Reducing the quantity of glycol can cause problems with tray hydraulics, contactor performance, and fouling of glycol-to-glycol heat exchangers.
- ★ Identify all operating dehydrators without flash tank separators and collect the necessary information to evaluate the economics of flash tank installation.
- ★ Where industrial power (440 volt or higher) is available, replacing an energy-exchange pump with an electric motor-driven pump can reduce the gas entrained with the TEG by as much as two thirds, significantly reducing methane emissions. Where only 220-volt service is available, a hybrid pump that combines gas-energy exchange with electric power to reduce methane absorption can also reduce methane absorbed by the TEG and lower emissions (see EPA's *Lessons Learned: Replacing Gas-Assisted Glycol Pumps with Electric Pumps*).
- ★ Route recovered methane to the compressor suction or to fuel use. Partners have reported that recovered methane sometimes contains too much water to be used for pneumatic instrument systems.
- ★ Collect marketable natural gas liquids from the flash tank separator as a potentially significant source of additional revenue.
- ★ Over time, the seals on gas-powered energy-exchange pumps can leak, contaminating the lean glycol and reducing dehydration effectiveness. Operators should not compensate for the contaminated glycol by increasing the TEG circulation rate. Instead, the energy-exchange pump should be evaluated for repair or replacement.
- ★ Record reduction at each dehydrator and report them with your Natural Gas STAR Annual Report. Note: methane savings obtained by installing technologies required by the NESHAP regulations should not be reported to the Natural Gas STAR voluntary methane reduction program.

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United States
Environmental Protection Agency
Air and Radiation (6202J)
1200 Pennsylvania Ave., NW
Washington, DC 20460

EPA430-B-03-013
December 2003