Processor Best Practices and Opportunities

Lessons Learned from Natural Gas STAR

DCP Midstream and the Gas Processors Association

Processors Technology Transfer Workshop
Houston, Texas
April 24, 2007

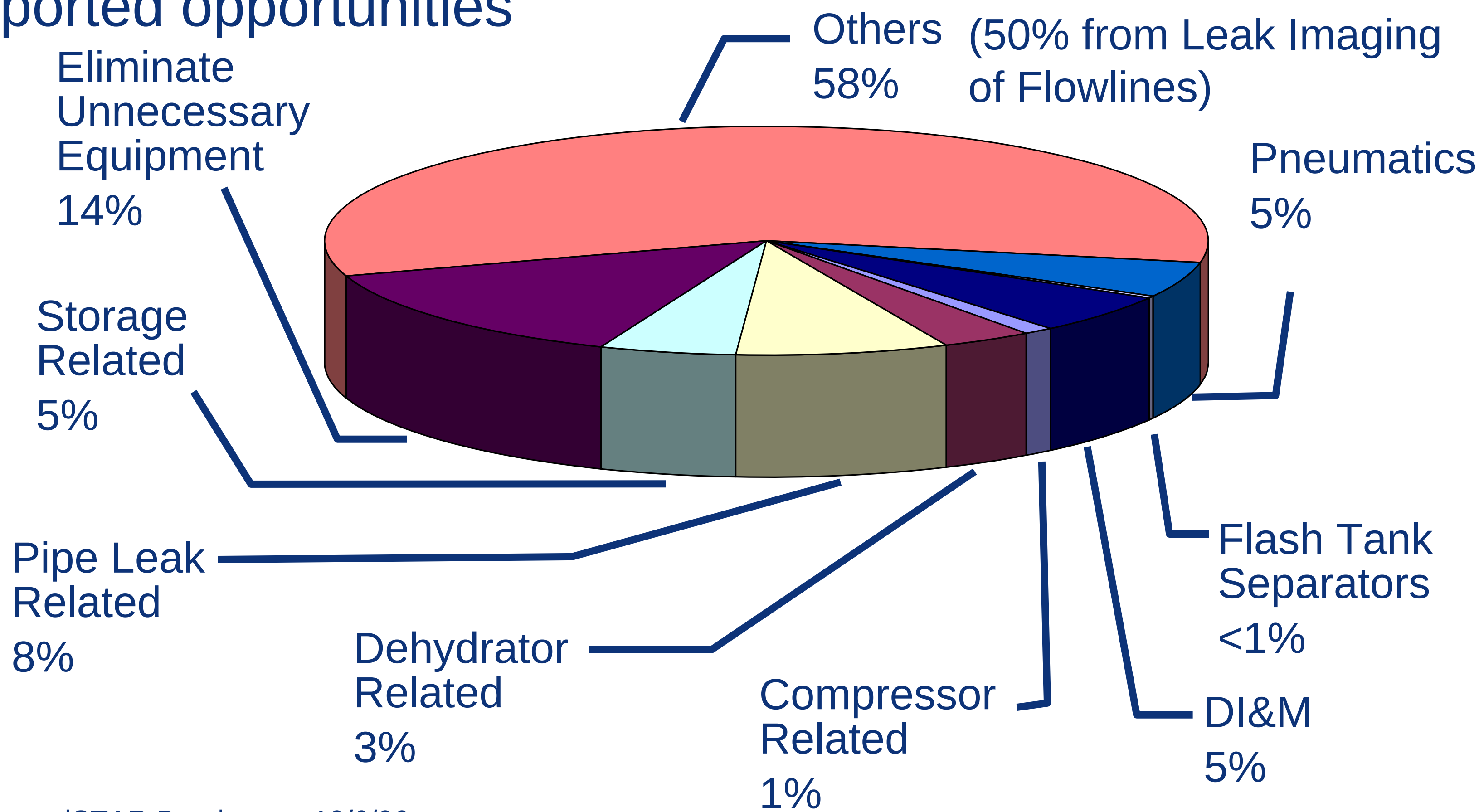
epa.gov/gasstar

Processor Opportunities: Agenda

- Industry Emissions
- Recommended Technologies and Practices
- Selected Methane Saving Opportunities
  - Pipeline Pigging
  - Installing Vapor Recovery Units
  - Dehydrators
    - Optimized glycol circulation rates
    - Flash tank separator (FTS) installation
    - Electric pump installation
- Discussion

Processor Recommended Technologies and Practices

- 89% of the processing sector reductions came from Partner reported opportunities



Source: iSTAR Database – 10/6/06

Methane Losses from Pipeline Pigging

- Gas lost when launching and receiving a pig
- Fugitive emissions from pig launcher/receiver valves
- Gas lost from storage tanks receiving condensate removed by pigging
- Gas vented from pipeline blowdowns

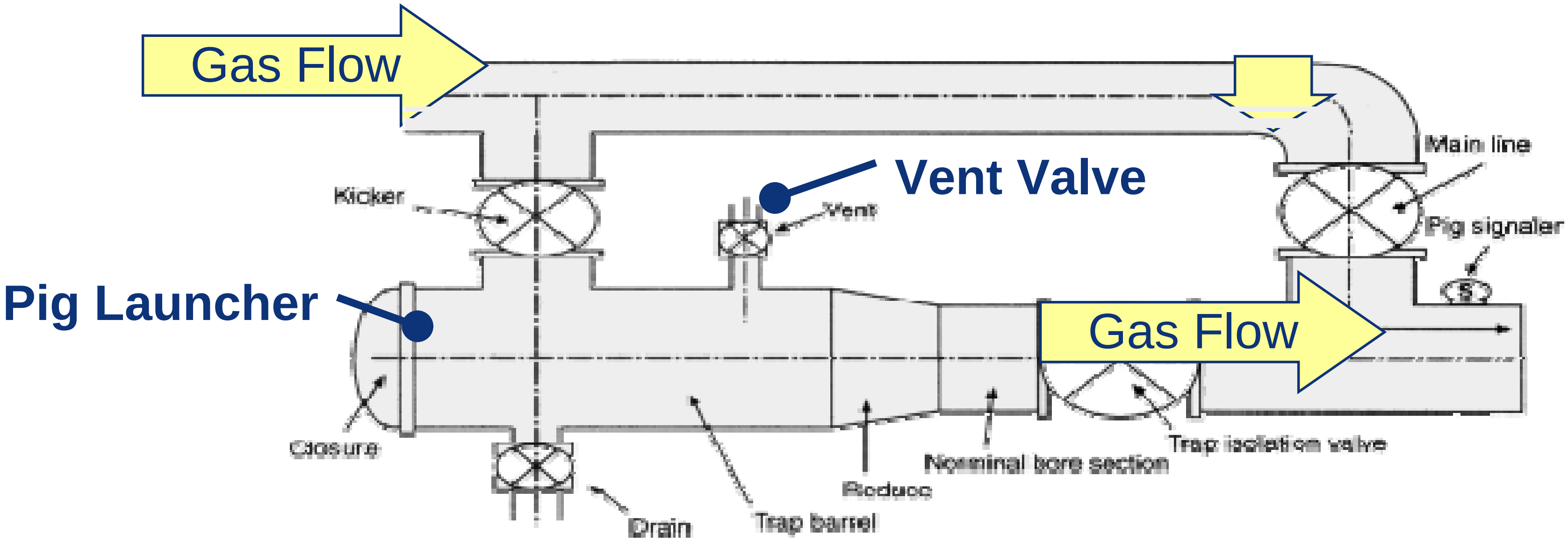
Pigging Pipelines

- Hydrocarbons and water condense inside pipelines, causing pressure drop and reducing gas flow
- Periodic line pigging removes liquids and debris to improve gas flow
  - Also inspect pipeline integrity
- Efficient pigging:
  - Keeps pipeline running continuously
  - Keeps pipeline near maximum throughput by removing debris
  - Minimizes product losses during launch/capture

Source: www.girardind.com/

How Does Pigging Vent Methane?

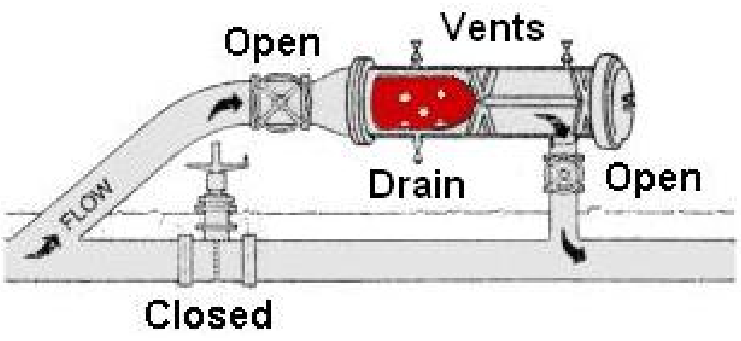
- Pig launchers have isolation valves for loading pigs, pressurizing pigs, and launching pigs with gas bypassed from the pipeline
- Launcher pressuring/depressuring loses methane out the vent valve



Source: www.girardind.com/

Pigging Vents Methane Twice!

- Methane lost through vent valve on the launcher and again through vent valve on the receiver
  - Once receiver is isolated from the line, it must be depressured to remove the pig
  - Liquids ahead of the pig drain to a vessel or tank
- MORE than twice: isolation valve leaks may cause excessive venting to depressure



Source: www.girardind.com/

Methane Recovery

- Pipeline maintenance requires pipe section blowdown before work can begin
- Gas in pipeline is usually vented to the atmosphere
- Use inert gas and pig
  - Inert gas can be used to drive a pig down the section of pipe to be serviced, displacing the natural gas to a product line rather than venting
  - Inert gas is then vented to the atmosphere, avoiding methane loss
- Route vent to vapor recovery system or fuel gas
  - One Partner reported connecting pig receiver vent to fuel gas to recover gas while working a tight isolation

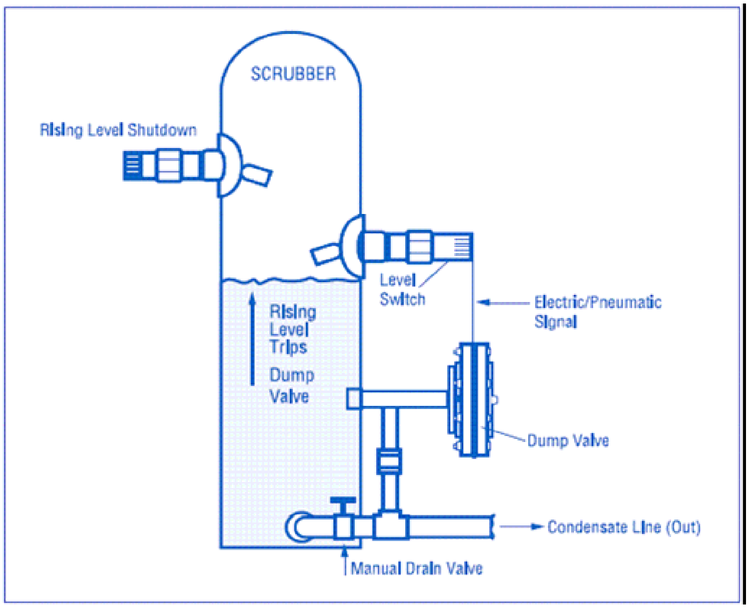
Is Recovery Profitable?

- One partner pigged gathering lines 30 to 40 times per year, collecting several thousand barrels of condensate per application
- Partner reported saving 21,400 Mcf/year from recovering flash gases
- Dedicated vapor recovery unit (VRU) was installed with an electric compressor at an installation cost of $24,000 and an annual operating cost of $40,000 mostly for electricity
- Large gas savings and increasing gas prices will offset costs

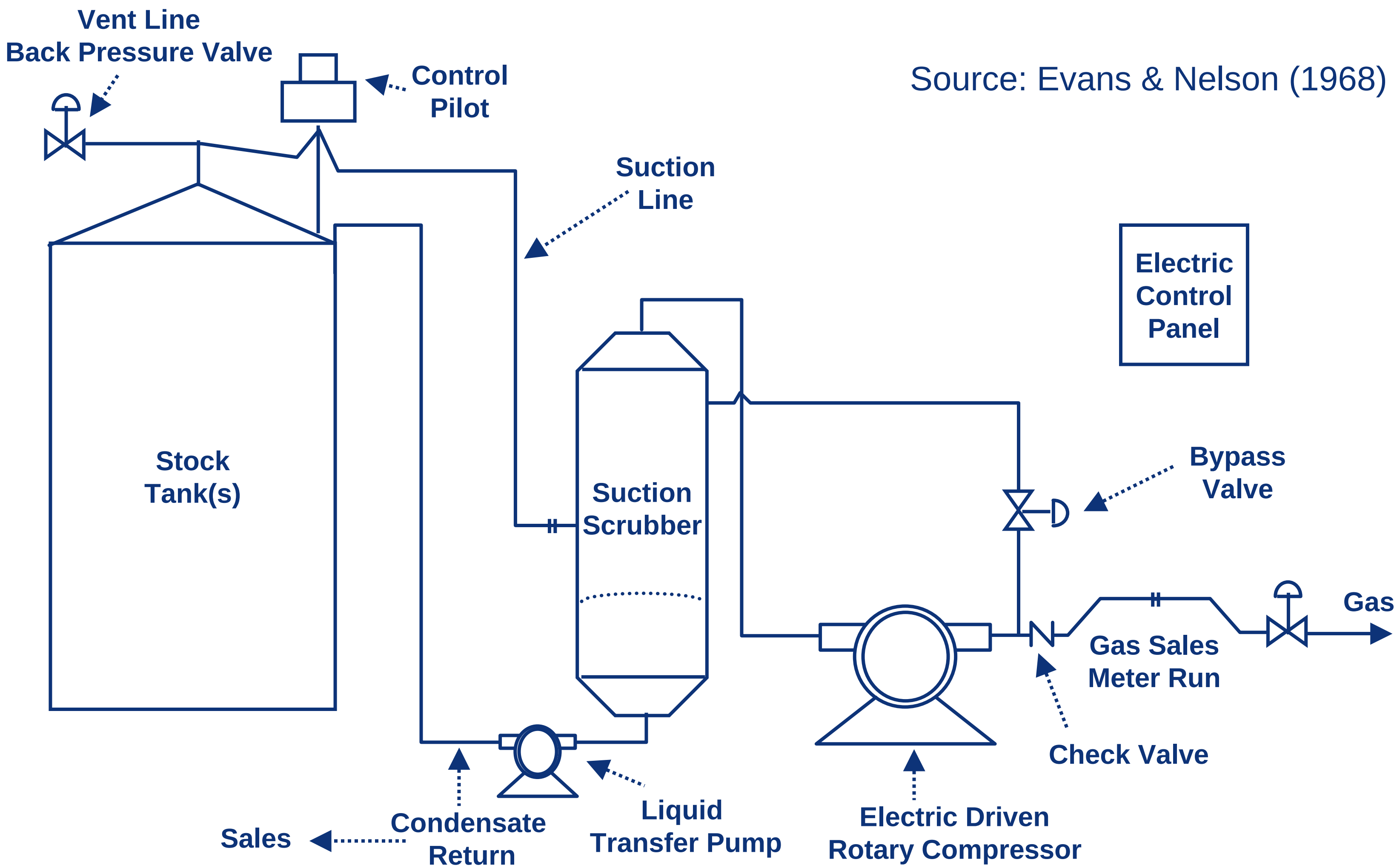
Gas Price ($/Mcf)	$5.00	$7.00	$10.00
Gas Saved (Mcf/year)	21,400	21,400	21,400
Annual Savings ($/year)	$107,000	$149,800	$214,000
Installed Cost	$24,000	$24,000	$24,000
Operating Cost	$40,000	$40,000	$40,000
Payback Period (years)	0.4	0.3	0.2

Vapor Recovery Units: What is the Problem?

- Flashing losses
  - Occur when crude is transferred from a gas-oil separator at higher pressure to a storage tank at atmospheric pressure
- Working losses
  - Occur when crude levels change and when crude in tank is agitated
- Standing losses
  - Occur with daily and seasonal temperature and barometric pressure changes
- Scrubber dump valve losses
  - Solids or liquids freeze in the valve preventing closure
  - Natural gas is lost through condensate tank vents



Conventional Vapor Recovery Unit



Options for Vapor Recovery Units

- The solution to these losses are vapor recovery units to capture the emissions
- Recommended choices
  - Rotary compressors – require electrical power or engine driver
  - Sliding vane or rotary screw compressors
  - Scroll compressors
- Alternative, niche technologies
  - EVRU™ – replaces rotary compressor and contains no moving parts
  - Vapor Jet system – requires high pressure water motive
- Choices not recommended
  - Reciprocating compressors
  - Centrifugal compressors

Vapor Recovery Most Applicable to:

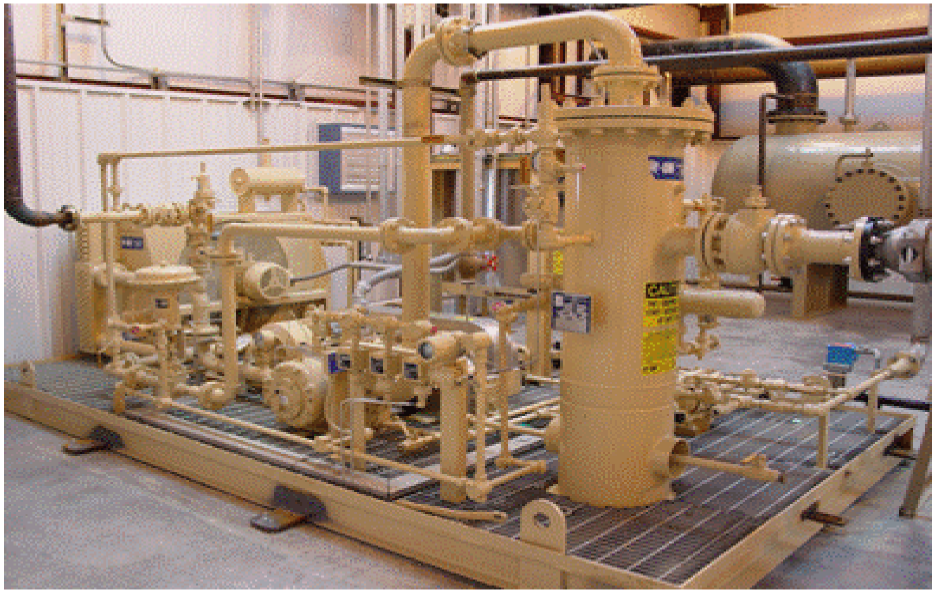
- Steady source and sufficient quantity of losses
  - Condensate oil stock tanks
  - Flash tanks
  - Gas pneumatic controllers and pumps
- Outlet for recovered gas
  - Access to low pressure gas pipeline, compressor suction, or on-site fuel system
- Tank batteries

Methane Savings: Vapor Recovery

- Vapor recovery can capture up to 95% of hydrocarbon vapors from tanks
- Recovered vapors have higher heat content than pipeline quality natural gas
- Recovered vapors are more valuable than natural gas and have multiple uses
  - Re-inject into sales pipeline
  - Use as on-site fuel
  - Recover valuable natural gas liquids

What is the Recovered Gas Worth?

- Value depends on heat content of gas
- Value depends on how gas is used
  - On-site fuel
    - Valued in terms of fuel that is replaced
  - Natural gas pipeline
    - Measured by the higher price for rich (higher heat content) gas
  - Gas processing plant
    - Measured by value of natural gas liquids and methane, which can be separated



Is Recovery Profitable?

Financial analysis for a conventional VRU project[1]						
Peak Capacity (Mcf/day)	Installation & Capital Costs[2] ($)	O&M[3] Costs ($/year)	Value of Gas[3] ($/year)	Annual Savings ($/year)	Simple Payback (months)	Internal Rate of Return
25	35,738	7,367	30,300	22,933	19	58%
50	46,073	8,419	60,600	52,181	11	111%
100	55,524	10,103	121,360	111,257	6	200%
200	74,425	11,787	242,725	230,938	4	310%
500	103,959	16,839	606,810	589,971	3	567%

1 – For VRUs with low discharge pressure

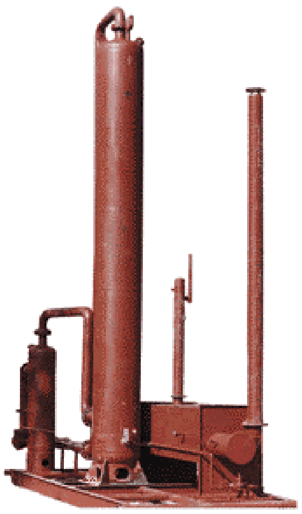
2 - Unit cost plus estimated installation at 75% of unit cost, updated to 2006 capital costs

3 - Operation & Maintenance

4 - $7/Mcf x 1/2 capacity x 365 days/year

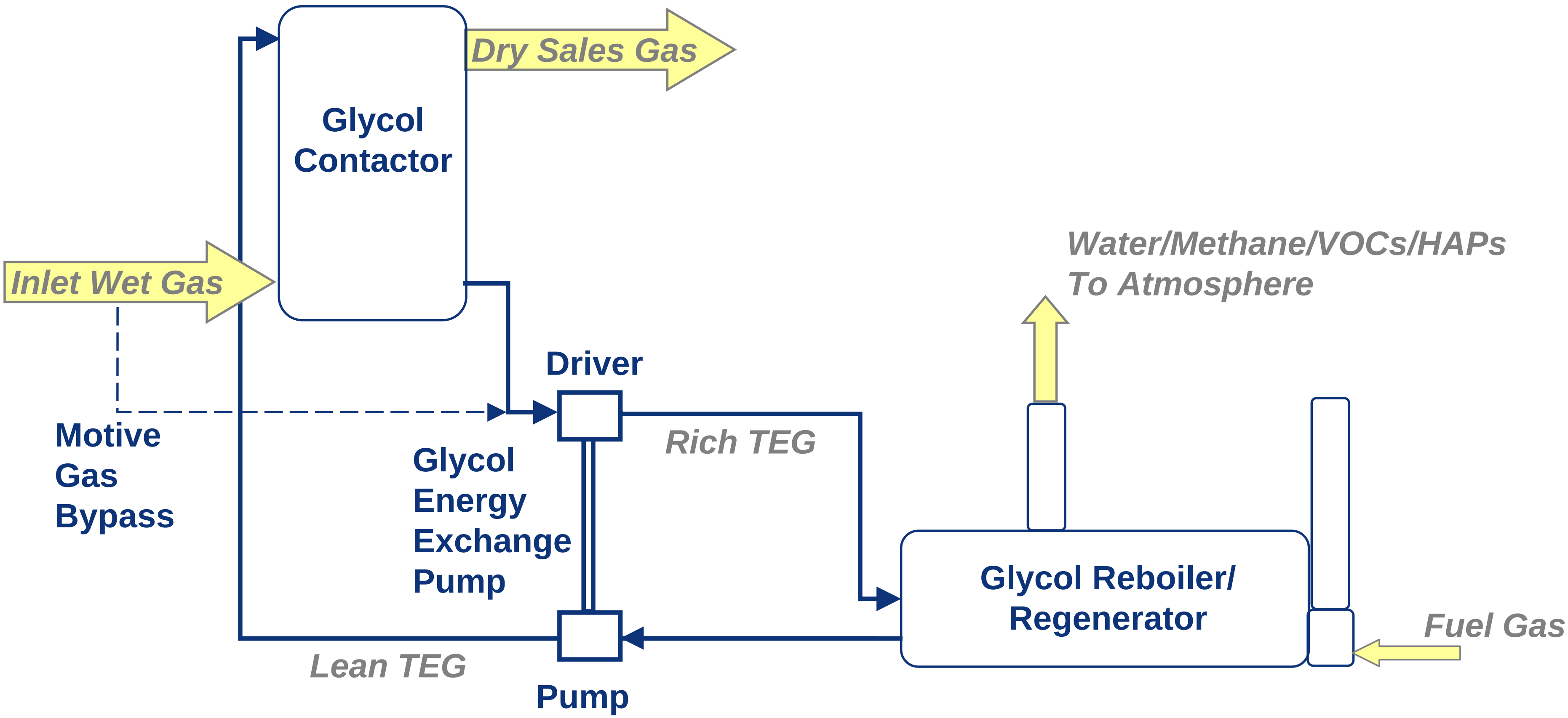
Dehydrators: What is the Problem?

- Produced gas is saturated with water, which must be removed for gas transmission
- Glycol dehydrators are the most common equipment to remove water from gas
  - 36,000 dehydration units in natural gas production, gathering, and boosting
  - Most use triethylene glycol (TEG)
- Glycol dehydrators create emissions
  - Methane, Volatile Organic Compounds (VOCs), Hazardous Air Pollutants (HAPs) from reboiler vent
  - Methane from pneumatic controllers



Source: www.prideofthehill.com

Basic Glycol Dehydrator System Process Diagram



Methane Recovery: Three Options

- Optimized glycol circulation rates
- Flash tank separator installation
- Electric pump installation

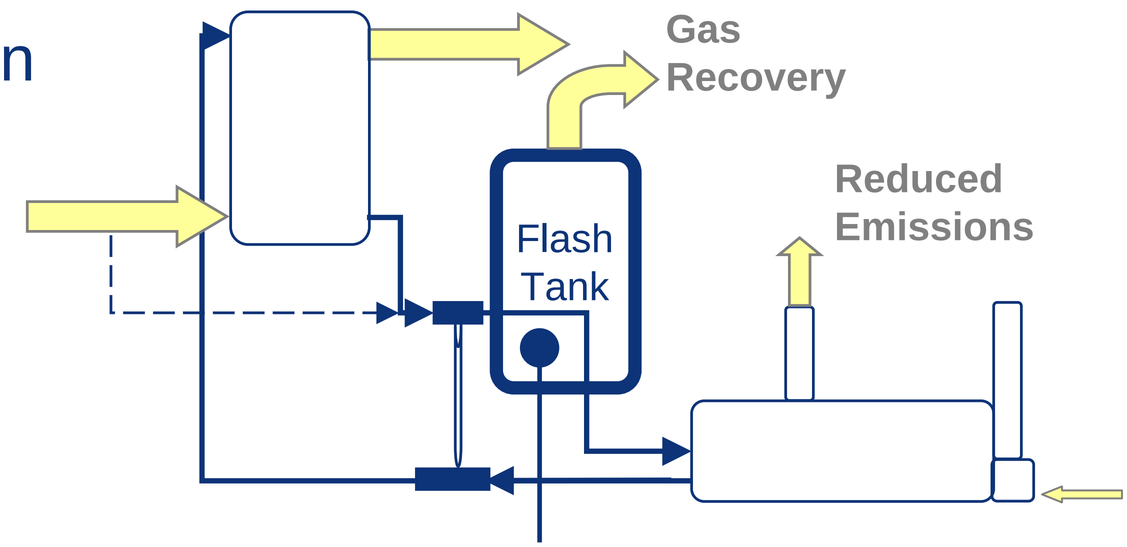
Glycol Dehydrator Unit
Source: GasTech

Optimizing Glycol Circulation Rate

- Gas pressure and flow at gathering/booster stations vary over time
  - Glycol circulation rates are often set at a maximum circulation rate
- Glycol overcirculation results in more methane emissions without significant reduction in gas moisture content
  - Partners found circulation rates two to three times higher than necessary
  - Methane emissions are directly proportional to circulation
- Lessons Learned study: optimize circulation rates

Flash Tank Recovers Methane

- Recovers about 90% of methane emissions
- Reduces VOCs by 10 to 90%
- Must have an outlet for low pressure gas
  - Fuel
  - Compressor suction
  - Vapor recovery unit

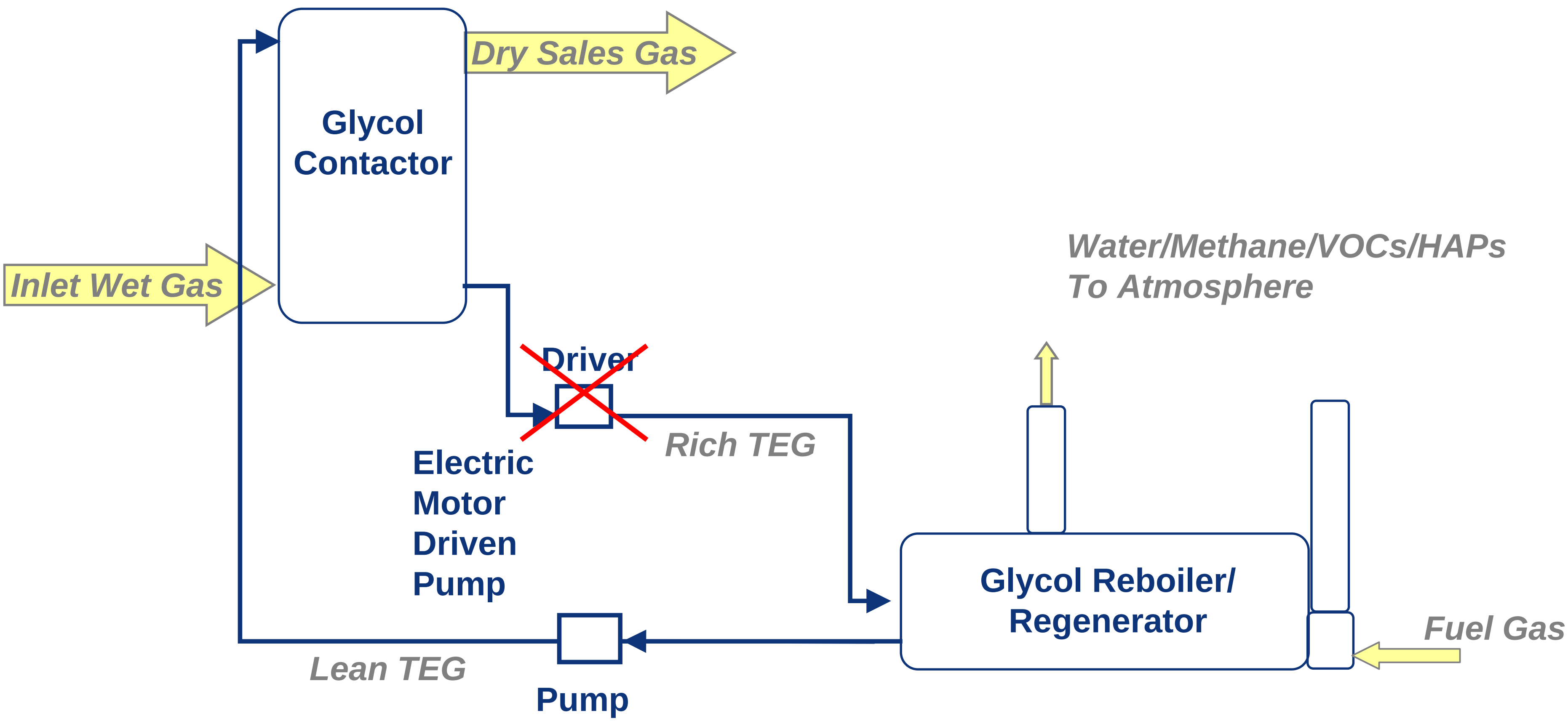


Low Capital Cost/Quick Payback

Flash Tank Costs

- Lessons Learned study provides guidelines for scoping costs, savings and economics
- Capital and installation costs:
  - Capital costs range from $3,500 to $7,000 per flash tank
  - Installation costs range from $1,200 to $2,500 per flash tank
- Negligible Operational & Maintenance costs

Electric Pump Eliminates Motive Gas



Overall Benefits

- Financial return on investment through gas savings
- Increased operational efficiency
- Reduced O&M costs (fuel gas, glycol make-up)
- Reduced compliance costs (HAPs, BTEX)
- Similar footprint as gas assist pump

Is Recovery Profitable?

Three Options for Minimizing Glycol Dehydrator Emissions

Option	Capital Costs	Annual O&M Costs	Emissions Savings	Payback Period[1]
Optimize Circulation Rate	Negligible	Negligible	394 to 39,420 Mcf/year	Immediate
Install Flash Tank	$6,500 to $18,800	Negligible	710 to 10,643 Mcf/year	4 to 11 months
Install Electric Pump	$1,400 to $13,000	$165 to $6,500	360 to 36,000 Mcf/year	< 1 month to several years

[1] Gas price of $7/Mcf

Discussion

- Industry experience applying these technologies and practices
- Limitations on application of these technologies an practices
- Actual costs and benefits