Acid Gas Removal Options for Minimizing Methane Emissions

Lessons Learned from Natural Gas STAR

Processors Technology Transfer Workshop

Pioneer Natural Resources, Inc.,
Gas Processors Association and
EPA's Natural Gas STAR Program

September 23, 2004

Acid Gas Removal: Agenda

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion Questions

Methane Losses from Acid Gas Removal

- There are 291 acid gas removal (AGR) units in gas processing plants[1]
  - **Emit 644 MMcf annually[1]**
  - **6 Mcf/day emitted by average AGR unit[1]**
  - **Most AGR units use diethanol amine (DEA) process or Selexol™ process**

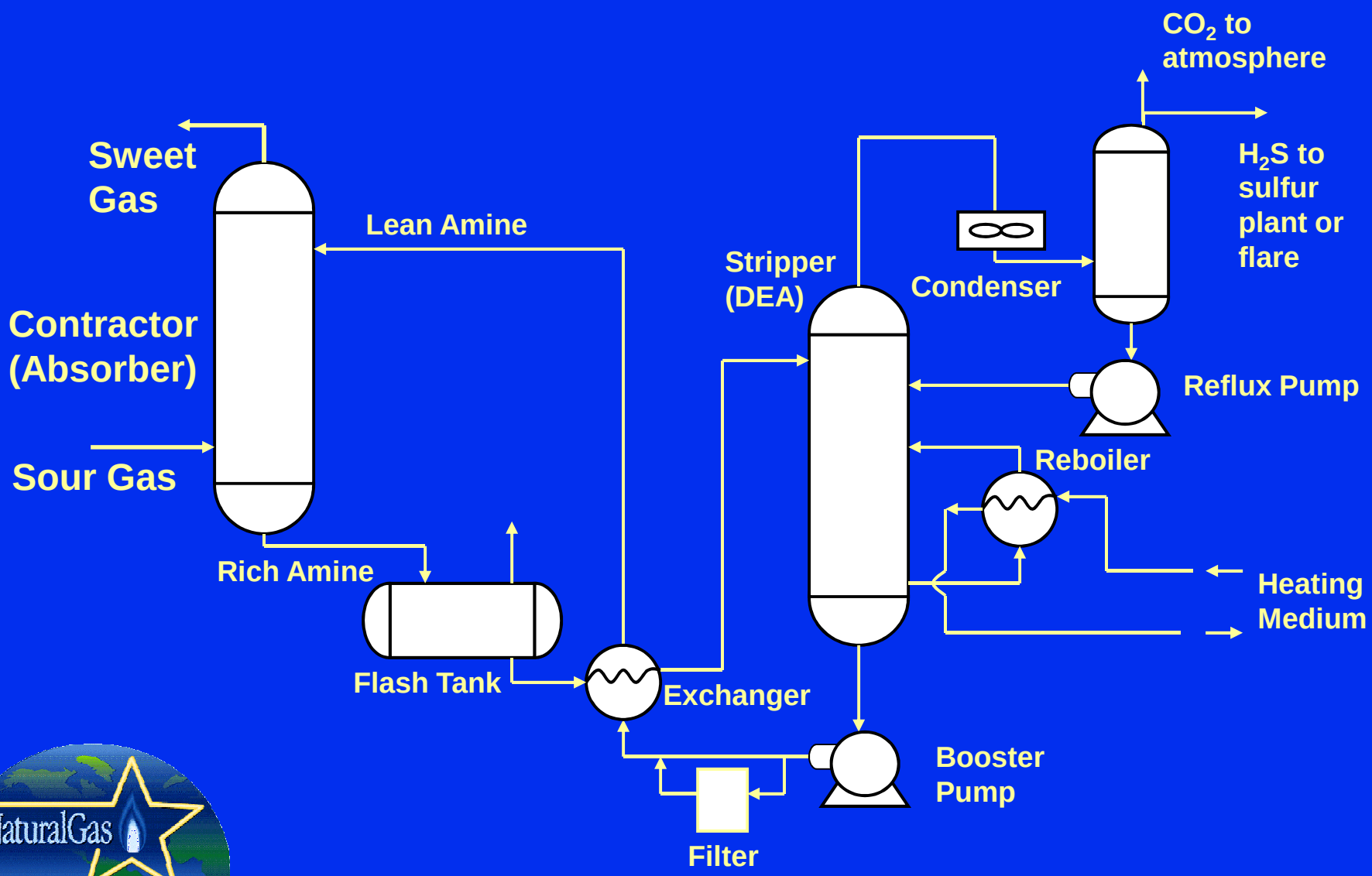
[1]Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2002

What is the Problem?

- 1/3 of U.S. gas reserves contain CO_2 and/or N_2[1]
- Wellhead natural gas may contain acid gases
  - **H_2S, CO_2, corrosive to gathering/boosting, transmission lines and distribution equipment**
  - **Off-spec pipeline quality gas**
- Acid gas removal processes typically use DEA to absorb acid gas
- DEA regeneration strips acid gas (and absorbed methane)
  - **CO_2 (with methane) is typically vented to the atmosphere**
  - **H_2S is typically flared or sent to sulfur recovery**

[1]http://www.engelhard.com/documents/GPApaper2002.pdf

Typical Amine Process

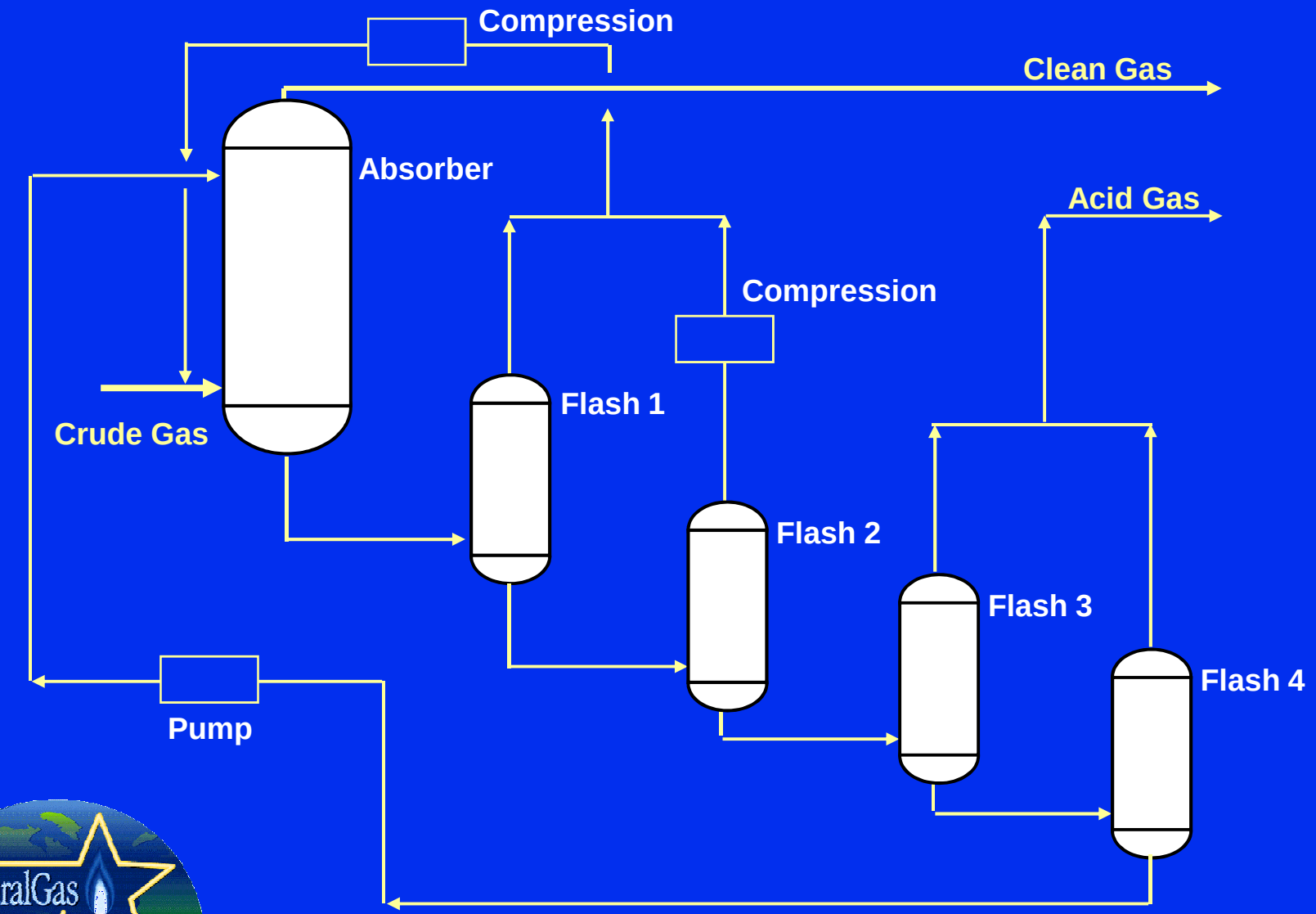


Reducing Emissions, Increasing Efficiency, Maximizing Profits

Methane Recovery - New Acid Gas Removal Technologies

- GTI & Uhde Morphysorb® Process
- Engelhard Molecular Gate® Process
- Primary driver is process economics, not methane emissions savings
- Reduce methane venting by 50 to 100%

Morphysorb® Process



Morphysorb® Process

- Morphysorb® absorbs acid gas but also absorbs some methane
  - **Methane absorbed is 66% to 75% lower than competing solvents[1]**
- Flash vessels 1 & 2 recycled to absorber inlet to minimize methane losses
- Flash vessels 3 & 4 at lower pressure to remove acid gas and regenerate Morphysorb®

[1]Oil and Gas Journal, July 12, 2004, p57

Is Recovery Profitable?

- Morphysorb® can process streams with high (>10%) acid gas composition
- 30% to 40% Morphysorb® operating cost advantage over DEA or Selexol™ [2]
  - **66% to 75% less methane absorbed than DEA or Selexol™**
  - **About 33% less THC absorbed[2]**
  - **Lower solvent circulation volumes**
- At least 25% capital cost advantage from smaller contactor and recycles[2]
- Flash recycles 1 & 2 recover ~80% of methane that is absorbed[1]

[1]Oil and Gas Journal, July 12, 2004, p57, Fig. 7

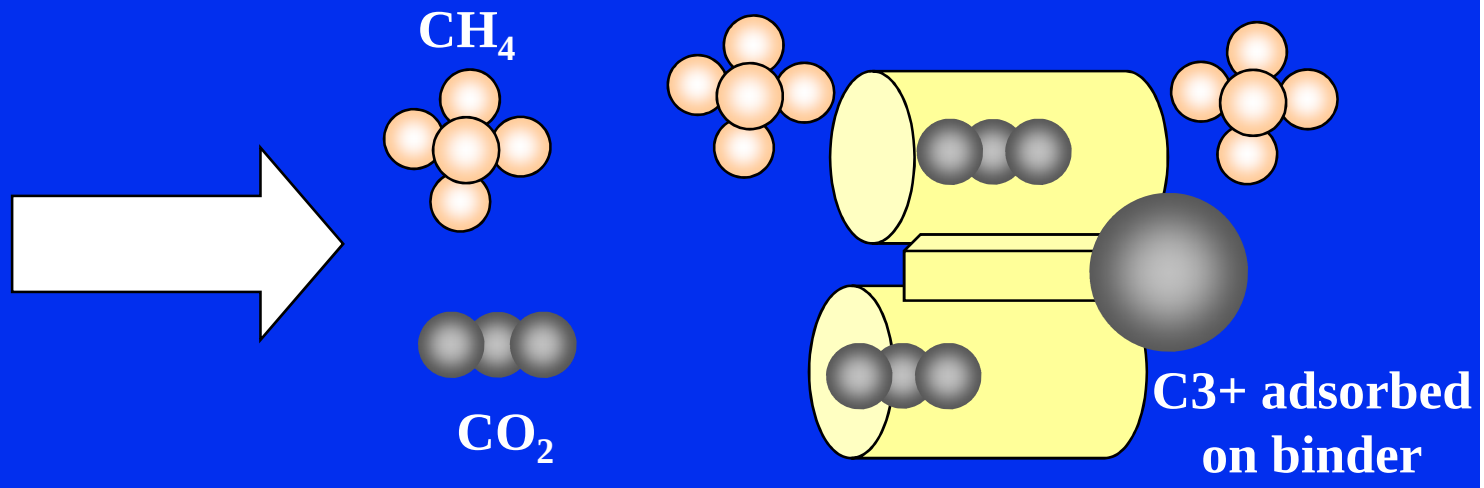
[2]GTI

Industry Experience - Duke Energy

- Kwoen plant does not produce pipeline-spec gas
  - **Separates acid gas and reinjects it in reservoir**
  - **Frees gathering and processing capacity further downstream**
- Morpysorb® used in process unit designed for other solvent
- Morphysorb® chosen for acid gas selectivity over methane
  - **Less recycle volumes; reduced compressor horsepower**

Methane Recovery - Molecular Gate® CO_2 Removal

- Adsorbs acid gas contaminants in fixed bed
- Molecular sieve application selectively adsorbs acid gas molecules of smaller diameter than methane
- Bed regenerated by depressuring
  - **5% to 10% of feed methane lost in "tail gas" depressuring**
  - **Route tail gas to fuel**



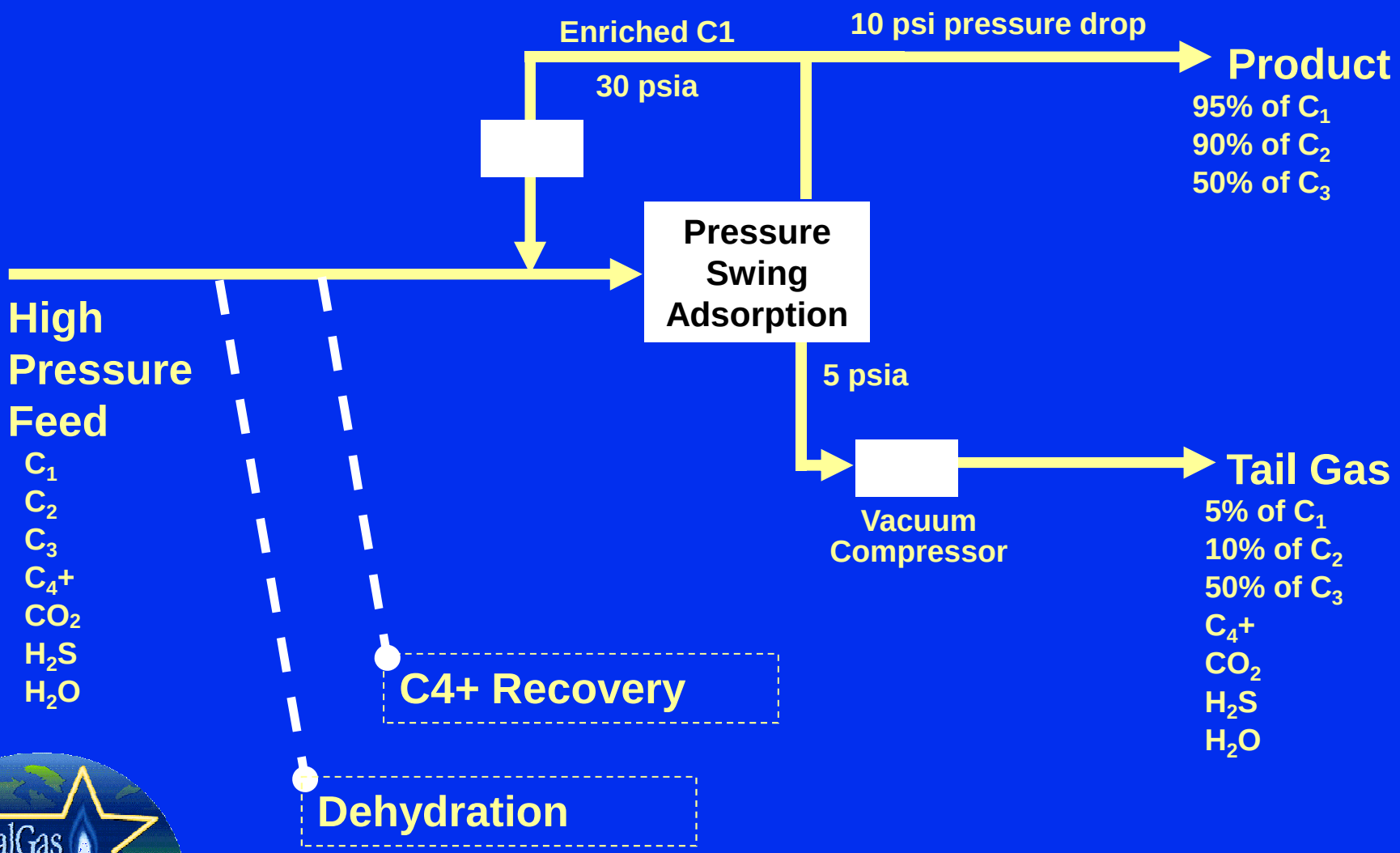
Molecular Gate® Applicability

- Lean gas
  - **Gas wells**
  - **Coal bed methane**
- Associated gas
  - **Tidelands Oil Production Co.**
    - 1 MMcf/d
    - 18% to 40% CO_2
    - Water saturated
  - **Design options for C_4+ in tail gas stream**
    - Heavy hydrocarbon recovery before Molecular Gate®
    - Recover heavies from tail gas in absorber bed
    - Use as fuel for process equipment

Engelhard Molecular Gate system at a facility in Southern Illinois

Source: http://www.engelhard.com

Molecular Gate® CO_2 Removal



Industry Experience - Tidelands Molecular Gate® Unit

- First commercial unit started on May 2002
- Process up to 10 MMcf/d
- Separate recycle compressor is required
- No glycol system is required
- Heavy HC removed with CO_2
- Tail gas used for fuel is a key optimization: No process venting
- 18% to 40% CO_2 removed to pipeline specifications (2%)

http://www.Engelhard.com/documents/CO2%20Removal-1.pdf

Is Recovery Profitable?

- Molecular Gate® costs are 20% less than amine process
  - **9 to 35 ¢ / Mcf product depending on scale**
- Fixed-bed tail gas vent can be used as supplemental fuel
  - **Eliminates venting from acid gas removal**
- Other Benefits
  - **Allows wells with high acid gas content to produce (alternative is shut-in)**
  - **Can dehydrate and remove acid gas to pipeline specs in one step**
  - **Less operator attention**

Comparison of AGR Alternatives

	Amine Process	Morphysorb® Process	Molecular Gate® CO_2
Absorbent or Adsorbent	Water & Amine	Morpholine Derivatives	Titanium Silicate
Regeneration	Reduce Pressure & Heat	Reduce Pressure	Reduce Pressure to Vacuum
Primary Operating Costs	Amine & Steam	Electricity	Electricity
Capital Cost	100%	75%	<100%
Operating Cost	100%	60% – 70%	80%

[1]http://www.gastechnology.org
[2]http://www.engelhard.com

Discussion Questions

- Have you studied either of these technologies?
- What are the barriers (technological, economic, lack of information, regulatory, focus, manpower, etc.) that are preventing you from implementing either of these technologies?