Optimizing Nitrogen Rejection Units

Lessons Learned from Natural Gas STAR

Processors Technology Transfer Workshop

Gas Processors Association,
Devon Energy, Enogex,
Dynegy Midstream Services and
EPA's Natural Gas STAR Program

April 22, 2005

Agenda

- Nitrogen Contamination in Natural Gas
- Methane Losses from Nitrogen Rejection
- Methane Recovery
- Partner Experience
- Is Recovery Profitable?
- Discussion Questions

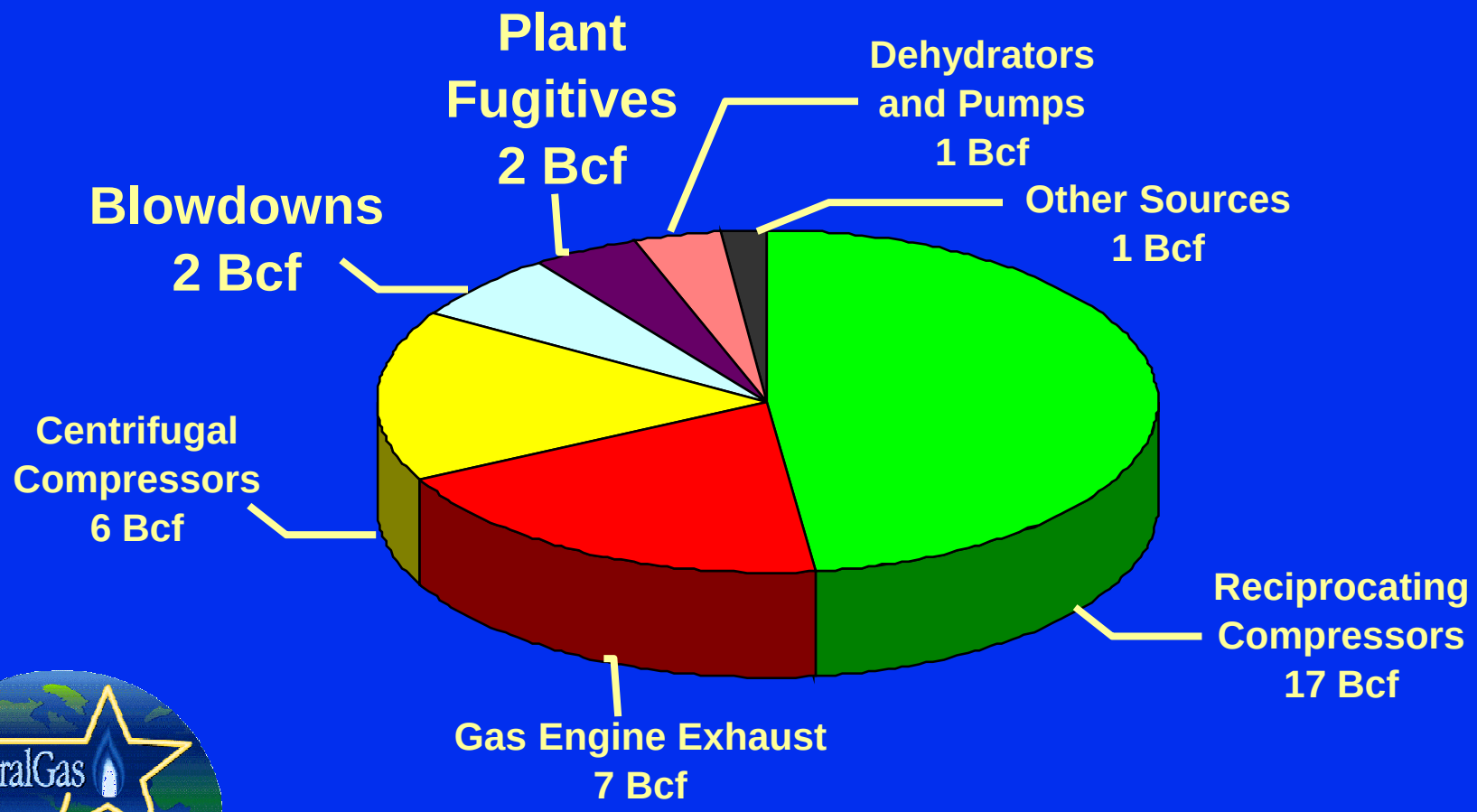
Nitrogen Contamination in Natural Gas

- 16% of US gas reserves contain large volumes of nitrogen*
  - **Gas with high nitrogen must be processed to meet heat content specifications (about 4% nitrogen by volume)**
- Wellhead gas can have well over 15% nitrogen, especially in associated gas production
  - **Nitrogen is sometimes injected for enhanced oil recovery operations and for pressure maintenance**
- Unacceptable levels of nitrogen can be removed with a Nitrogen Rejection Unit (NRU)

*www.engelhard.com

Processing Sector Emissions

- Methane losses from NRUs are included in blowdown venting and plant fugitives



Methane Losses from Nitrogen Rejection

- NRU fugitives
  - Methane leaks occur at valves, piping connectors and open ended lines
  - Natural Gas STAR accounts for these leaks in processing plant fugitive emissions
- Nitrogen reject vent
  - Reject stream usually contains some methane, 1 to 5%
  - Natural Gas STAR accounts for these vents in processing plant blowdown/venting emissions

NRU Fugitives

- Clearstone study of 4 processing plants measured NRU fugitives

	Emission Factor (Mcf/yr/component)	Activity Factor (components/plant)	Emissions (Mcf/yr)
NRU Valves	11.37	101	1,148.70
NRU Connectors	2.50	242	604.04
NRU PRVs	0.00	2	0.00
NRU Comp Seals	0.00	1	0.00
NRU OELs	7.77	8	62.15
Total NRU Fugitive Emissions			1,815
Total Gas Plant Fugitive Emissions			41,116

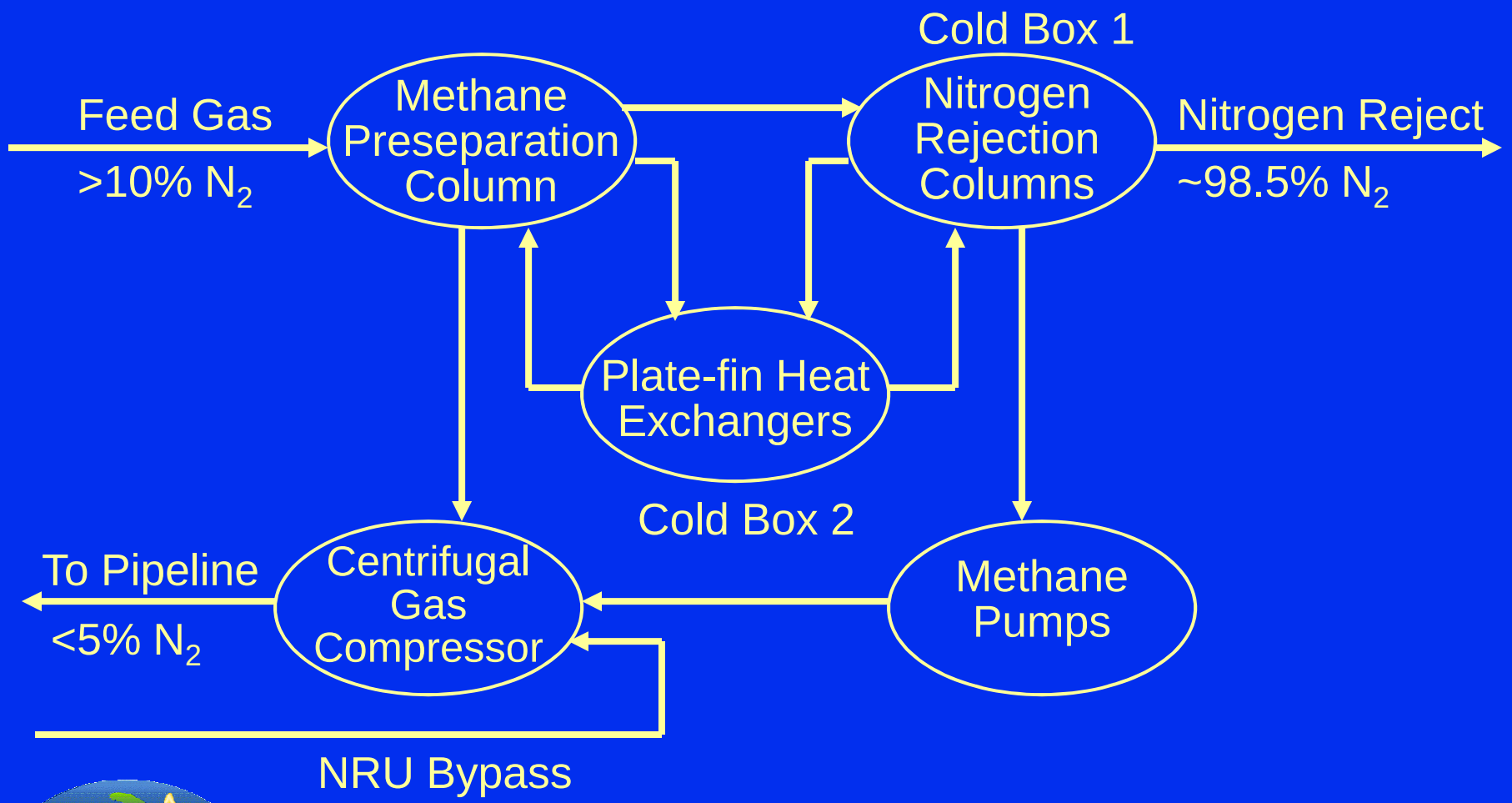
NRU Vented Methane

- Methane is lost in the nitrogen reject stream
  - On-line gas chromatograph can alert operators to the methane content of the reject stream
- Over a year, the small fraction of methane in the reject stream can add up to significant methane loss
- NRU optimization can reduce product loss in the reject stream, with a payback of <1 year

Nitrogen Rejection Unit

- Large gas feeds with nitrogen content of 10% or greater are best processed with cryogenic NRUs
  - **All sulfur, water, and mercury must be removed first to avoid corrosion**
  - **Dry gas then cooled to cryogenic temperatures where methane condenses**
  - **Non-condensable gases purged and vented to the atmosphere**

NRU Setup


Cold Box 1
Feed Gas
>10% N_2
Methane Preseparation Column
Nitrogen Rejection Columns
Nitrogen Reject
~98.5% N_2
Plate-fin Heat Exchangers
Cold Box 2
To Pipeline
<5% N_2
Centrifugal Gas Compressor
Methane Pumps
NRU Bypass

Methane Recovery: Optimizing NRU

- Building a process-specific model of your NRU is crucial to optimization
  - **Model all equipment in the process**
  - **Include all input material and energy streams and typical variations for those streams**
- Sensitivity calculations can help to develop recommendations for maintenance and process modification
- Prioritize recommendations and develop a maintenance schedule

Optimization Activities

- Depends on the process model results
  - **Adjust temperature/pressure in nitrogen reject columns**
  - **Inspect and clean heat exchangers**
  - **Re-tray nitrogen reject columns**
- Prioritize activities
  - **Temperature/pressure adjustments can be made by control systems**
  - **Replacing column trays requires unit to be taken out of service**

Partner Experience

- One Gas STAR partner operating an older NRU took steps to optimize their process
  - **NRU was 20+ years old**
  - **High nitrogen composition gas (60% N_2)**
  - **On-line chromatograph showed 5% methane in reject stream**
- Contractor hired to develop a process model and provide process optimization recommendations

Optimization Recommendations

- Change control settings
  - **Adjust nitrogen reject column reflux**
- Perform maintenance
  - **Fix leaking valve that had iced over**
- Change process equipment
  - **Re-tray columns with higher efficiency trays**
    - **Scheduled at a later date**

Methane Savings

- After performing recommended activities (aside from replacing column trays) methane in the reject stream was reduced from 5% to 2%
- 50 MMcf/day NRU with 60% inlet nitrogen saved over 200,000 Mcf/yr
- Additional savings are anticipated from replacing column trays

Is Recovery Profitable?

- Gas savings of 200,000 Mcf/yr
- Optimization costs
  - **$35,000 for process model development on existing software**
  - **$15,000/yr for plant maintenance**

Gas Price ($/Mcf)	$ 2.00	$ 3.00	$ 4.00
Gas Saved (Mcf/yr)	200,000	200,000	200,000
Annual Savings ($/yr)	$ 400,000	$ 600,000	$ 800,000
Installed Cost	$ 35,000	$ 35,000	$ 35,000
Operating Cost	$ 15,000	$ 15,000	$ 15,000
Payback Period (months)	1.1	0.7	0.5

Discussion Questions

- Is the methane content of the nitrogen reject stream continuously monitored in your NRU?
- How can this presentation be improved to help you determine your opportunities for NRU methane savings?
- What other activities have you undertaken to increase the efficiency of your NRU?