Controlled Freeze Zone™ Technology – An Integrated Solution for Processing Sour Natural Gas

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Outlook for Natural Gas

- Natural gas expected to be the fastest growing fuel source for the next 20 years
- Demand growth expected in power generation sector because of lower emissions and greater efficiency with natural gas fired units
- Domestic and imported supplies will be needed to meet regional gas demands via pipeline and LNG deliveries
Challenges with Sour Natural Gas Resources

• Increasingly sour global gas resources
  - As much as 1/3 of global conventional resources have significant amounts of CO₂ and H₂S
  - Fields with CO₂ contents greater than 30% and H₂S content greater than 10% are encountered more frequently

• Management of contaminants
  - Increased focus on CO₂ removal and disposition
  - Alternatives to sulfur production
  - Geosequestration of CO₂

• Challenging economics for developing sour gas reserves
  - Smaller amounts of valuable hydrocarbon
  - Remote gas developments
Simplified Flow Schematic – Gas Processing

Gas Treating
- Solvents: Chemical, Physical, Hybrid
- Cryogenic
- Membranes

Natural Gas from Separation & Compression

Sour Gas Treating
- H₂S & CO₂
- CO₂

Sulfur Recovery

Acid Gas Injection

CO₂ Pipeline

Sweet Gas

NGL Recovery
- Ethane
- Propane
- Butane
- Pentane+

Methane & Inerts

Miscible Injection

Methane

Gas to Feedstocks/Markets

N₂

Helium

ExxonMobil
Controlled Freeze Zone™:  
Comparison to Solvent Treating Process

Acid Gas Separation
• Normally CO₂ and H₂S are removed by a circulating solvent and are subsequently released as a low pressure gas during solvent regeneration, a process that requires multiple steps and vessels.

Controlled Freeze Zone™
• Cryogenic separation process without use of solvents.
• Acid gas byproduct stream is liquid.
• No produced gas emissions.

Typical Sour Gas Process

The CFZ™ Solution
Controlled Freeze Zone™ Technology Uses a Different Approach

Rather than avoiding solidification of CO₂, control it and confine it to specially designed section in distillation column.
Development of CFZ™ Technology

- Invented at Exxon Production Research Co. in 1983
  - Original U.S. patent granted in 1985

- Pilot plant design, construction and operation: 1984-1987
  - 15 – 65% CO₂; 200 – 600 kscfd

- Engineering studies and process improvements 1987+
  - Six additional U.S. patents (and associated world patents)

- Commercial Demonstration Plant under construction for operation in 2010
  - Test wide range of compositions
  - Integrated with acid gas injection
  - Provide design basis for world-scale plant
Case Study: Gas to Power Generation

- Comparing Gas Treating Processes on a Consistent Basis

Feed Gas: Sour Natural Gas
- Methane: 19%
- CO₂: 68%
- H₂S: 4%

Gas Treating Options
- Base – Selexol™
- Alt 1 – Bulk Fractionation + Selexol™
- Alt 2 – Ryan-Holmes
- Alt 3 – Controlled Freeze Zone™
CFZ™ Advantages:
Capital Costs and Process Efficiencies

- 10 - 27% lower overall capital costs
- 12 - 37% cost savings for treating

Simpler Process, Fewer Processing Steps – Less Equipment

- 5 - 16% less natural gas required
- 4 - 8% greater revenue from sales

Overall Greater Process Efficiency in Integrated Configuration
**CFZ™ Technology Incentives**

- **Significant capital and operating expense savings**
  - Fewer processing steps ➔ Less equipment for all applications
  - Reduction or elimination of solvents and additives
  - Lower acid gas injection costs
    + High pressure separation
    + Liquid acid gas stream can be pumped for reinjection vs. costly compression

- **Greater profitability ➔ Less costs, greater process efficiencies, greater revenue**

- **Environmental benefits:**
  - Allows economic CO₂ geosequestration or EOR
  - Provides alternative for sulfur plants

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*The Higher the Acid Gas Content, the Greater the Benefits*
ExxonMobil Acid Gas Injection Experience

- ExxonMobil leads the industry in designing and operating large-scale Acid Gas Injection (AGI) projects

- Sleipner CO₂ injection underway since 1998 (10 million tonnes CO₂)
Connecting Gas Treating to Carbon Capture

• Carbon capture and storage (CCS) could play a significant role in helping to reduce CO₂ emissions from the use of fossil fuels

• Technology components for CCS practiced in oil and gas industry
  – Removal of CO₂/H₂S from natural gas with processes like Controlled Freeze Zone™
  – Transportation via pipeline
  – Disposal via acid gas or sour gas injection
  – Use in Enhanced Oil Recovery

• Transfer experience of operating large recovery, treating, and injection facilities to facilitate technology advancements

• Challenge: Integrate these components into a single large scale system in a different industry while addressing costs and regulations
Taking on the World’s Toughest Energy Challenges.
Thermodynamics: Methane – CO₂ System

Thermodynamic Basis for Separation of CO₂ from Methane

Separation requires crossing the solidification zone for methane sales purity product