Ortloff NGL/LPG Recovery, CO2 Separation and Sulfur Recovery Technologies
CORE BUSINESS

NGL, LPG, AND LNG TECHNOLOGY

SULFUR RECOVERY TECHNOLOGY
HISTORY OF ORTLOFF

• The Ortloff Corporation (1960 - 1985)
  – Turnkey EPC Contractor in the gas processing industry
    ▪ Developed 5 U.S. Patents - Gas Processing Technology
      » MTP - Two Stage Expander Process
      » LSP - Liquid Subcooled Process
      » VEP - Vapor Enrichment Process
      » OHR - Overhead Recycle Process
      » **GSP - Gas Subcooled Process**
  – Withdrew from EPC contracting in 1985 and formed Ortloff Engineers, Ltd.

• Ortloff Engineers, Ltd. (1985 - Present)
  – Established Reputation as Technology Supplier/Developer
  – (21) Additional Patents
  – Established Cooperative Marketing Agreement with UOP in 2002
  – Sold to Management Group in 2005
Since 1985, Ortloff NGL/LPG Technology has been licensed to process over 50.0 BSCFD of natural gas in more than 120 plants ranging in size from 25 MSCFD to 1.4 BSCFD located in over 20 countries.
COOPERATIVE MARKETING AGREEMENT

• UOP MARKETS & LICENSES ORTLOFF TECHNOLOGY
  – NGL / LPG / LNG / SULFUR
  – Most countries outside of U.S.

• UOP / ORTLOFF SYNERGY
  – Development of process technology

• CLIENT BENEFITS
  – Single source for all major gas processing technology
  – Simplifies technology contract agreements
ETHANE RECOVERY

NOTE: ACTUAL PERFORMANCE MAY VARY DEPENDING ON ACTUAL FEED COMPOSITION AND CONDITIONS

MRX – MULTIPLE RECTIFICATION AND REFLUX
SRX – SUPPLEMENTAL RECTIFICATION WITH REFLUX
SRC – SUPPLEMENTAL RECTIFICATION WITH COMPRESSION
RSV – RECYCLE SPLIT VAPOR
RSVE – RECYCLE SPLIT VAPOR WITH ENRICHMENT
GSP – GAS SUBCOOLED PROCESS

RELATIVE COMPRESSION POWER (HP/MMSCFD)

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PROPANE RECOVERY

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RELATIVE COMPRESSION POWER
(HP/MMSCFD)

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CO2 TOLERANCE

NOTE: ACTUAL PERFORMANCE MAY VARY DEPENDING ON ACTUAL FEED COMPOSITION AND CONDITIONS
NGL / LPG RECOVERY TECHNOLOGY

Ortloff NGL / LPG recovery technology offers one or more of the following advantages:

- Ethane and propane recovery levels up to 99%
- Increased recovery with no increase in horsepower
- Increased capacity with no increase in horsepower
- Lower capital cost
- High CO2 tolerance
- Improved operational stability
- Improved operating flexibility (dual mode ethane / propane recovery)
- Maintain ultra-high C3 recovery throughout all C2 operating modes
- Easily retrofit into existing NGL/LPG Recovery Plants
TECHNOLOGY SELECTION

- Choose a process design which:
  - Meets all product specifications and recovery levels
  - Avoids CO2 freeze
  - Avoids unstable phase region
  - Requires the least heat and compression costs
  - Provides the required operating flexibility and upgrade potential
  - Minimizes inlet/product treating costs

*Iterations during early phase of project are critical!*
LNG
NGL / LPG RECOVERY TECHNOLOGY
LNG TECHNOLOGY

- INTEGRATED LNG TECHNOLOGY (SERIES)
LNG TECHNOLOGY

- INTEGRATED LNG TECHNOLOGY (ANGLE)
  Offers a 10% to 20% improvement in overall efficiency of the liquefaction process
LNG TECHNOLOGY

- LNG Fractionation Process (LFP) Technology
Ortloff’s LNG fractionation technology for the recovery of NGL / LPG at LNG receiving terminals offers the following advantages:

- Flexibility to handle wide range of LNG composition
- Improved plant efficiency by utilizing inherent refrigeration available in LNG
- No increase in heat load on vaporization
- Minimizes plant capital and operating costs over traditional straddle plant design
- Recovery of liquids easily adjusted to meet natural gas pipeline heating value specifications
- Requires no compression
- Easily retrofitted into an existing facility
CO2 / METHANE SEPARATION IN PRODUCED GAS WITH HIGH CO2 CONTENT
Integrated DRCF / SELEXOL™ Process

• Two stage process for separation of CO2 and Methane
  – Stage 1: DRCF for bulk removal and purification of CO2
  – Stage 2: UOP SELEXOL™ for final separation and purification of natural gas

DRCF - Dual Refrigerant CO2 Fractionation
Integrated DRCF / SELEXOL™ Process

SandRidge Century Plant

- Dehy: 400 MMSCFD, 65% CO2, 1120 psig
- DRCF: 38 MMSCFD, 90% CO2, 585 PSIG
- DeC1 Comp.: 21% CO2
- Flash Comp.: 1200 PSIG
- UOP SELEXOL™: 140 MMSCFD, CO2 Product: 260 MMSCFD, 2,000 PSIG
- Sales Gas: 90% CO2, 21% CO2
## CO2 Removed

<table>
<thead>
<tr>
<th>Process</th>
<th>CO₂ Removed (MMSCFD)</th>
<th>Single Refg CO₂ Frac</th>
<th>Dual Refg CO₂ Frac</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Selexol™</strong></td>
<td><strong>Single Refg CO₂ Frac</strong></td>
<td><strong>Dual Refg CO₂ Frac</strong></td>
</tr>
<tr>
<td>UOP Selexol™</td>
<td>260</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Single Refg CO₂ Frac + UOP Selexol™</td>
<td>69</td>
<td>191</td>
<td>--</td>
</tr>
<tr>
<td>Dual Refg CO₂ Frac + UOP Selexol™</td>
<td>38</td>
<td>--</td>
<td>222</td>
</tr>
</tbody>
</table>

Based upon 400 mmscfd of 65% CO2 inlet gas
## Power Comparison

<table>
<thead>
<tr>
<th>Process</th>
<th>Power Required (MW)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compression</td>
<td>Pumping</td>
<td>Total</td>
</tr>
<tr>
<td>UOP Selexol™</td>
<td>71.3</td>
<td>10.6</td>
<td>81.9</td>
</tr>
<tr>
<td>Single Refg CO₂ Frac + UOP Selexol™</td>
<td>44.1</td>
<td>9.3</td>
<td>53.4</td>
</tr>
<tr>
<td>Dual Refg CO₂ Frac + UOP Selexol™</td>
<td>37.6</td>
<td>7.9</td>
<td>45.5</td>
</tr>
</tbody>
</table>

Note: UOP Selexol™ pumping HP is for solvent circulation
Fractionation pumping HP is for CO₂ delivery
Summary of Potential Savings

- **CAPEX** - $30 – 40 MM
- **OPEX** - $39 MM / year

(U.S. cost basis)
SULFUR RECOVERY TECHNOLOGY
Early SRU Experience

• Designed / built 7 SRUs for sister company in 1960s
  − Little design information available
  − SRUs suffered typical reliability problems
  − Sulfur plant reliability affects profitability

• Began analyzing reliability problems in 1969
  − Developed design concepts to improve reliability
  − Further improvements have been on-going
  − Concepts used in all Ortloff plants since 1970

• The Ortloff Corporation (1960 – 1985)
  − Designed / constructed 53 SRUs

• Ortloff Engineers, Ltd. (1986 – Present)
  − Designed 30 SRUs constructed by others
Ortloff Designed SRUs
LICENSING/CONSULTING SUPPORT SERVICES
CONSULTING SERVICES

- PROCESS DESIGN PACKAGES FOR LICENSED TECHNOLOGY
- TECHNOLOGY SELECTION STUDIES
- GENERAL OPERATING MANUALS
- OPERATOR TRAINING
- PLANT STARTUP
- PLANT PERFORMANCE TESTING
- PLANT TROUBLESHOOTING & DEBOTTLENECKING