Advanced Equipment Manufacturing

Fangzhou Hu
UOP LLC, A Honeywell Company

US-China Oil & Gas Industry Forum
September 16-18, 2015 | Chongqing, China
UOP creates knowledge through invention and innovation and applies it to the energy industry

- **800+** R&D employees
- **3,000+** Active patents
- **2,500** Engineers and scientists
- **200** with PhDs
- **100** Years of Experience

- Process Technology
- Catalysts and Adsorbents
- Equipment
- Services

- Refining
- Petrochemicals
- Natural Gas
- Renewables

More Than 60 Percent of the World’s Gasoline and 90 Percent of Biodegradable Detergents Use UOP Technology
Gas Processing & Hydrogen Technology

Processing for single-unit to large integrated technology facilities

Broad portfolio of technologies

• Wellhead treating
• Sulfur & liquids recovery
• Upgrade of natural gas liquids to olefins, aromatics & more…
• Hydrogen purification from steam reforming
• Hydrogen recovery from many processes

Key Processes

• Polybed™ PSA – hydrogen purification & recovery
• Polysep™ Membranes - hydrogen purification & recovery
• UOP Separex™ – bulk CO₂ removal
• UOP Selexol™ – acid gas removal
• UOP Amine Guard™ Process – acid gas removal
• UOP Merox™ – mercaptan sulfur removal
Fabricated Plants
- UOP Gas Processing Plants
- Polybed™ PSA Systems
- Separex™ Membrane Systems
- Modular Refining Units
- Sinco SSP Technology

Process Equipment
- Separations & Heat Transfer
- Key Mechanical Equipment
- Process Information & Controls

Callidus
- Burners
- Flares
- Thermal Oxidizers
- Selective Catalytic Reduction Units (SCRs)
Challenges in Natural Gas Value Chain

- **Gas Impurities in the Feed**
  - High level of H2S, CO2, N2 and sulfur in some major field, e.g. Tarim and Sichuan Basin

- Remote and difficult onsite condition for unconventional gas

- Specific treatment requirement for SNG with additional elements like ammonia, phenol, naphthalene

- Scattered and small volume treatment on well head

Gas Processing Challenges Exist but Can Be Overcome with the Right Packaged Technology Solutions
Why Modularize?

The advantages of skid-mounting are many:

- More assembly work is done in the shop at a lower hourly rate and not subject to weather.
- Equipment and parts are more readily available at the shop location, closer to supplies.
- Much assembly work can be completed prior to field move in, while waiting on permits and weather.
- Equipment, piping, and instrumentation can be checked out prior to shipment to field.

Train Sizes up to 10 MCM/D can be easily Modularized.
## What to Modularize?

### Process Plants

<table>
<thead>
<tr>
<th>Component</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensate Stabilizer</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Acid Gas Removal</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>NGL Recovery with Refrigeration Loop(s)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Dehydration</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>NGL Fractionation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>LPG Fractionation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Heating Medium Oil System</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Sulfur Recovery</td>
<td>✓</td>
<td>✓*</td>
</tr>
</tbody>
</table>

### Balance of Plant

<table>
<thead>
<tr>
<th>Component</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Separation</td>
<td>✓</td>
<td>✓*</td>
</tr>
<tr>
<td>Inlet Compression</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Pipe Racks and associated structures</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Residue Gas Compression</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Produced Water Treatment</td>
<td>✓</td>
<td>✓*</td>
</tr>
<tr>
<td>Flare</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Thermal Oxidizer</td>
<td>✓</td>
<td>✓*</td>
</tr>
<tr>
<td>Heating Medium Oil System</td>
<td>✓</td>
<td>✓*</td>
</tr>
<tr>
<td>Motor Control Center (MCC)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gas Metering</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Instrument Air System</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>N2 System</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Fuel Gas Network</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Cooling Water System</td>
<td>✓</td>
<td>✓*</td>
</tr>
<tr>
<td>Chemical Injection Systems</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Lube Oil System(s)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Plant Control System</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fire &amp; Gas Detection</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Process drains</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

### Infrastructure

<table>
<thead>
<tr>
<th>Component</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Buildings</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Power Generation / Power Supply</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Area Lighting</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Security Systems</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Plant water systems</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fire water systems</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Storm water system</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Storage tanks</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Pipeline infrastructure</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

**M = Suited for Modular**  
**F = Field Fabrication more appropriate**  
* Suitable for Multi-Train Facilities
How We Modularize

LPG Recovery Unit Inlet Filter Skids
How We Modularize

LPG Recovery Process Skids
LPG Recovery Major Offskid Items

Turbo Expander/Compressor
Rearview

Mafi Turbo-Expander/Compressor

Front view

Demethanizer Tower
Modular process technology as skid-mounted, shop-fabricated packages for:

- Lower cost fabrication versus on-site construction
- Faster installation
- Trusted process and mechanical performance
- High on-stream efficiency
- Lower risk of safety incidents due to less in field fabrication

Ideal candidates for packaged units:

- Individual units sized for 1.2 – 10 MCM/D each
- Remote locations
- Plants with multiple trains for up to 25 MCM/D
UOP Natural Gas Modular Products

**GAS PRETREATMENT**
- Dehydration
  - Mol Sieve Adsorption
  - Glycol (TEG) Absorption
- Acid Gas Treatment
  - Amine Units (100-1000 gpm\(^1\))
  - Membrane Units (1+ BCFD)
- Sulfur Recovery
  - Modular Claus (10-100+ LTPD)
  - Sulfur Scavengers
- Hg Removal Units

\(^1\)gpm = gallons of amine per minute

**NGL RECOVERY**
- Rich Gas Conditioner
- Mechanical Refrigeration
- Cryogenic Turboexpander

**NGL SEPARATION**
- Fractionation
  - Deethanizer / Depropanizer / Debutanizer

**SEGMENT**
- NGL Recovery
  - NGL Upgrading
  - Gas NGL Content (GPM\(^2\))
  - Mechanical Refrigeration
  - Cryogenic Turboexpander

\(^2\)GPM = gallons of NGL per thousand SCF of natural gas

**OFFERING**
- Complete Modular Equipment Solutions: Pre-engineered or Custom
UOP Global Equipment Experience

<table>
<thead>
<tr>
<th>Technology</th>
<th># of Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSA Units</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Gas Processing/NGL Units</td>
<td>230</td>
</tr>
<tr>
<td>Membrane Systems</td>
<td>200</td>
</tr>
<tr>
<td>CCR Regenerator Sections</td>
<td>65</td>
</tr>
<tr>
<td>Merox Units</td>
<td>55</td>
</tr>
<tr>
<td>Recovery Plus Units</td>
<td>37</td>
</tr>
<tr>
<td>Isomerization Units</td>
<td>17</td>
</tr>
<tr>
<td>Naphtha Block Units</td>
<td>3</td>
</tr>
</tbody>
</table>

A Global Modular Leader with Experience dating back 50 years

Advanced Technology, Faster, Better Total Installed Costs
Pre-Engineered Cryo Plant

Inlet Gas ➔ MOLSIV™ ➔ Cryo Plant ➔ Residue Gas

Y-grade

2 to 4 GPM C2+
• Unsaturated Feed
• “Low” CO₂ in Feed

Pre-Engineered Cryo Plants
1.2 – 6+ MCM/D
Pre-Engineered Cryo + Supplemental Refrigeration (SR)

- Inlet Gas
- MOLSIV™ (saturated feed)
- Cryo Plant
- Refrig Loop
- Y-grade
- Residue Gas

6 GPM C2+
- Unsaturated Feed
- “Low” CO₂ in Feed

Supplemental Refrigeration Units
1000 – 6000 HP
Cryo + SR + Pre-Engineered Amine

- Inlet Gas
- Amine Treater
  - MOLSIV™ (saturated feed)
  - Cryo Plant
  - Refrig Loop
  - Residue Gas
  - Y-grade
  - Water Unsaturated Feed
  - “High” CO₂ in Feed

Pre-Engineered Amine Units
100 – 1000+ gpm
Cryo + SR + Amine + Fractionation
Type of Membranes and Membrane Assembly

**Membrane Type**

- **Asymmetric membrane:**
  - Same polymer materials for selective layer (top) and supporting layer

- **Composite membrane:**
  - Different polymer materials for selective layer (top) and supporting layer

**Type of Membrane Assembly**

- **Spiral-Wound Membrane Element**

- **Hollow Fiber Membrane Element**
UOP Separex Membrane System

From Membrane to Modular Equipment
Fundamentals of Membrane Process

- Simple One-Stage Membrane Process
  - Feed
  - Residue (Low CO₂)
  - Permeate (High CO₂)

- Two-Stage Membrane Process
  - Feed
  - 1st-stage Permeate
  - 2nd-stage Permeate
  - Residue

Comparison of Membrane Processes

Hydrocarbon recovery from membrane separation can be improved from multi-stage membrane processes.
# UOP Separex Membrane

## UOP Separex™ Membrane Technology

<table>
<thead>
<tr>
<th>Installation Type</th>
<th>No. of Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>52</td>
</tr>
<tr>
<td>Enhanced Oil Recovery (EOR)</td>
<td>5</td>
</tr>
<tr>
<td>Hybrids</td>
<td>5</td>
</tr>
<tr>
<td>Offshore</td>
<td>7+12</td>
</tr>
<tr>
<td>Landfill Gas</td>
<td>7</td>
</tr>
<tr>
<td>Digester Gas</td>
<td>1</td>
</tr>
<tr>
<td>H₂ Purification</td>
<td>94</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>&gt;170</strong></td>
</tr>
</tbody>
</table>
What is the UOP SeparALL Process?

Next generation solution of UOP Selexol™ process
Selective removal of H₂S, COS, & CO₂ via absorption/ regeneration process
Offered as licensed technology

- Uses a “next generation” physical solvent (SELEXOL™ MAX Solvent) from DOW Chemicals
- Uses a typical solvent-extraction flow-scheme
- Loading directly proportional to partial pressure

Product Quality

- Can be essentially sulfur free
- Project specific CO2 capture and quality
- Project specific acid gas H2S concentration

Physical vs Chemical

Typical Gasification Application

High Pressure is advantageous
Contact

Michael Hu
430 Li Bing Road, Zhang Jiang Hi-Tech Park, Pudong New Area, Shanghai 201203
Tel: +86-21-28945454
Fax: +86-21-58557390
Mobile: +86-15002176491
fangzhou.hu@honeywell.com