2019 Summer Internship
Department of Energy Supply and Conversion

Emily Sebastian
Agenda

• Personal Background
• Carbon Capture Projects
  – ROTA-CAP
  – GO-PEEK membrane system
• Lessons Learned
• Summer Fun
• Future Plans
• Acknowledgements
Personal Background
Extracurricular Activities

• Research In Department of Chemistry and Biochemistry
  – CRISPR
• Research In Department of Biomedical Engineering
  – Targeted cancer treatment
• Volunteering Organizations
• Mentor
Carbon Capture

- Minimize carbon footprint by fossil fuels
  - More environmentally friendly
  - Halt climate change caused by carbon emissions
ROTA-CAP: Intensified Carbon Capture

- Rotating Packed Bed Reactors
  - Smaller, uses less solvent, water, and electricity
  - Capture CO2 for $30/tonne
ROTA-CAP Design
Process and Instrumentation Diagrams (P&IDs)
Safety - HAZOP

- Risk Ranking Matrix
  - Based on severity and likelihood
  - Severity: Major, Serious, Minor, or Incidental
  - Likelihood: Frequent, Occasional, Seldom, Unlikely
  - Risk Ranking: Severity x Likelihood

<table>
<thead>
<tr>
<th>Severity of Incident</th>
<th>Frequent (4)</th>
<th>Occasional (3)</th>
<th>Seldom (2)</th>
<th>Unlikely (1)</th>
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<tbody>
<tr>
<td>Major (4)</td>
<td>16</td>
<td>12</td>
<td>8</td>
<td>4</td>
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<tr>
<td>Serious (3)</td>
<td>12</td>
<td>9</td>
<td>6</td>
<td>3</td>
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<tr>
<td>Minor (2)</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Incidental (1)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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Future Work

• Design Completed and Parts Ordered
• Build Skid
  – September 2019– October 2019
• GTI Testing
  – November 2109- January 2020
• Ship to NCCC and begin testing
  – July 2020
Variables

1. Rotating packed bed rotational speed 500–2000 RPM
2. Absorber Liquid/Gas ratio 0.5–5.0 kg/m³
3. Solvent circulation rate 30–150 kg/h,
4. Solvent concentration/viscosity 40–80 wt.% (5–100 cP)
5. Regenerator operating pressure/temperature 0.0–1.0 bar(g) (100–130°C)
GO-PEEK Membranes

• Combines Polyether ether ketone (PEEK) and Graphene Oxide (GO) membrane
  – GO membranes are pressure driven
  – PEEK membranes are solvent driven
• Combination leads to greater efficiency
PEEK Membranes

- Polyether ether ketone membranes
  - superior thermo-mechanical properties and chemical resistance from semi-crystalline nature
  - “best” plastic
  - Previous success

![PEEK Membrane Structure](image)

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Tensile modulus (GPa)</th>
<th>Tensile strength (MPa/kpsi)</th>
<th>Max service temperature (°C/°F)</th>
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<tr>
<td>Teflon™</td>
<td>0.4-0.5</td>
<td>17-21/2.5-3.0</td>
<td>250/480</td>
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<td>PVDF</td>
<td>0.8</td>
<td>48/7.0</td>
<td>150/302</td>
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<tr>
<td>Polysulfone</td>
<td>2.6</td>
<td>70/10.2</td>
<td>160/320</td>
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<tr>
<td>PEEK</td>
<td>4</td>
<td>97/14.1</td>
<td>271/520</td>
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</table>
GO Membranes

- Graphene derivative
- Ideal material for membranes
  - good mechanical strength, chemical inertness and thermal stability
- Highly selective of carbon dioxide
- Requires Humidity
Testing
Future Work

• GO membrane issues halted progress
  – Troubleshooting
• Complete testing GO membrane
• Test GO-PEEK membrane system
• Determine efficiency/ operational success
Lessons Learned

• Technical Writing and Presentation skills
• Networking
• Importance of Safety
• Design/ Engineering Process
  – P&ID / PFD
• Unit Operations
Summer Fun

• Networking with weekly intern breakfast
• Various Events
  – Young Professionals in Energy Events
  – Ice Cream Social
  – Chicago Dogs Baseball Game
  – Summer Family Event
• Exploring Chicago
Future Plans

• Complete Bachelors degree in Chemical Engineering
• Grad School
  – Chemical or Bioengineering PhD
• Interest
  – Fuel development
  – Vaccine/ Antibiotic development and
Acknowledgements

• Thank You!
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    • Osman Akpolat, Andrew Kramer, Travis Pyrzynski, and Riley Silber
• Southwestern Research Institute