Bench-Scale Silicone Process for Low-Cost CO_2 Capture

GE Global Research
GE Energy
Milliken/SiVance

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2012 NETL CO_2 Capture Technology Meeting
July 10, 2012

Overview

27 Month, $3.75M Program to Develop a Silicone Process for CO_2 Capture

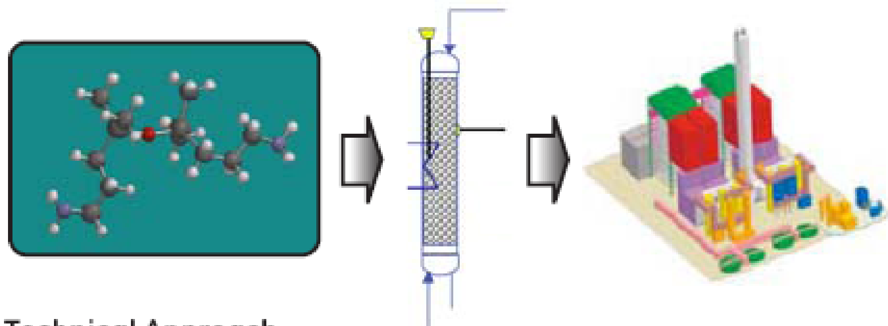
Program Team

GE Global Research
- *Bench-Scale Design and Testing of Absorption/ Desorption Process*
- *Materials of Construction*

GE Energy
- *Modeling and Design of Integrated Energy Systems*
- *Economic Analysis*
- *Technical and Economic Feasibility Study*

SiVance
Chemistry… for Precision Performance
- *Optimized Process for Solvent Synthesis*
- *Large Scale Manufacture of Silicone Solvent*
- *EH&S Risk Assessment*

Program Objective: *Design and optimize a new process for novel silicone CO_2 capture solvent and establish scalability and potential for commercialization of post-combustion capture of CO_2 from coal-fired power plants. A primary outcome will be a system capable of 90% capture efficiency with less than 35% increase in the cost of energy services (COE).*



Technical Approach
- Design and construct bench-scale unit and obtain parametric data to determine key scale-up parameters
- Perform an EH&S and technical and economic assessment to determine feasibility of commercial scale operation
- Develop material manufacturing plan
- Develop scale-up strategy

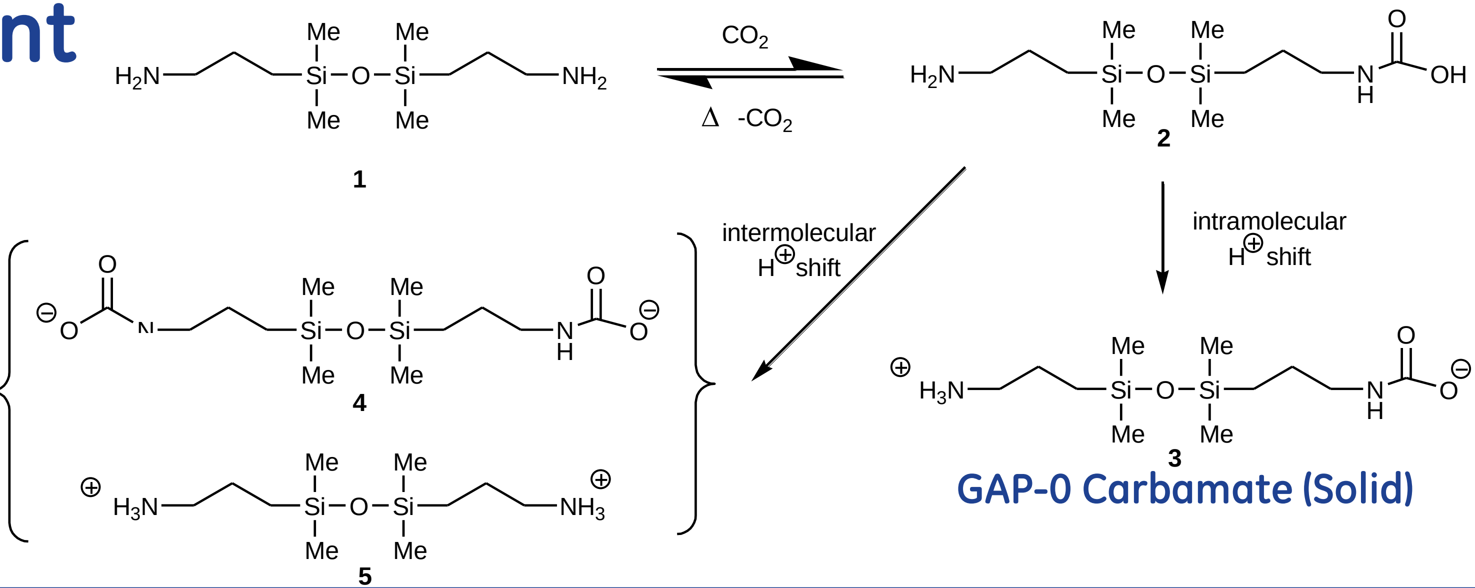
Outcomes
- Strategy for future scale-up
- Technical and economic feasibility determined
- Environmental assessment

Anticipated Benefits of the Proposed Technology
- 90% CO_2 capture with <35% COE increase

- Continuation of previous DOE/NETL funded project (DE-NT0005310)
- Current project has 2 phases
  - Phase 1: 10/1/2011 to 12/31/2012
  - Phase 2: 1/1/2013 to 12/31/2013

Absorbent

GAP-0 (Liquid)



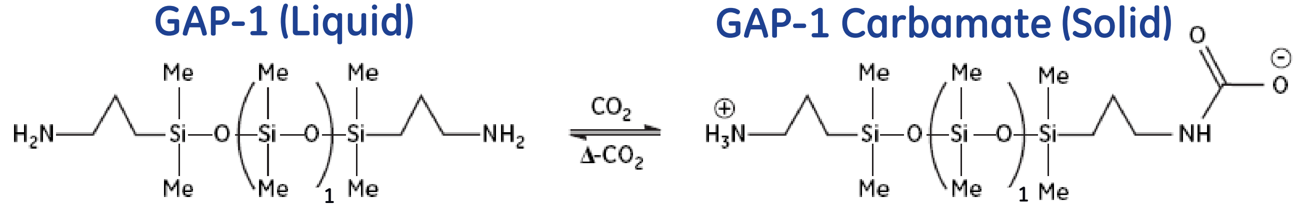
GAP-0 Carbamate (Solid)

- •GAP-0 demonstrates 17.7% wt gain of CO_2 (10.2% wt gain for 30% MEA/H_2O)
- •Co-solvent required to inhibit solidification (50 wt% triethylene glycol, TEG)
- •Even in a 50/50 (wt/wt) mixture of GAP-0/TEG, eventually carbamate precipitates

GAP-1_m Absorbent Composition

- •40% GAP-0
- •33% GAP-1
- •19% GAP-2
- •8% GAP-3

GAP-1 (Liquid) GAP-1 Carbamate (Solid)



Carbamate does not precipitate in a 60/40 (wt/wt) GAP-1_m/TEG mixture

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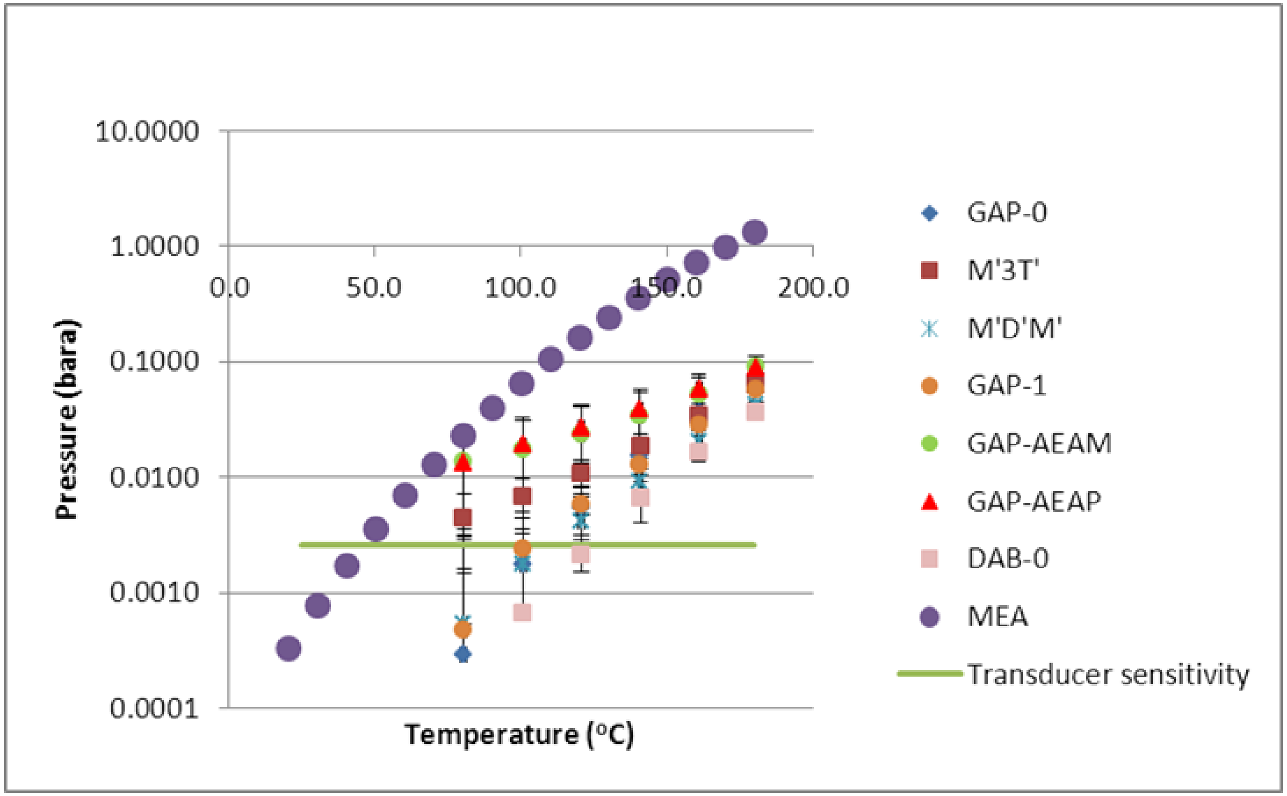
Vapor Pressure

All aminosilicone materials tested exhibited vapor pressures < MEA



Lower absorbent vapor pressure simplifies CO_2 desorption process

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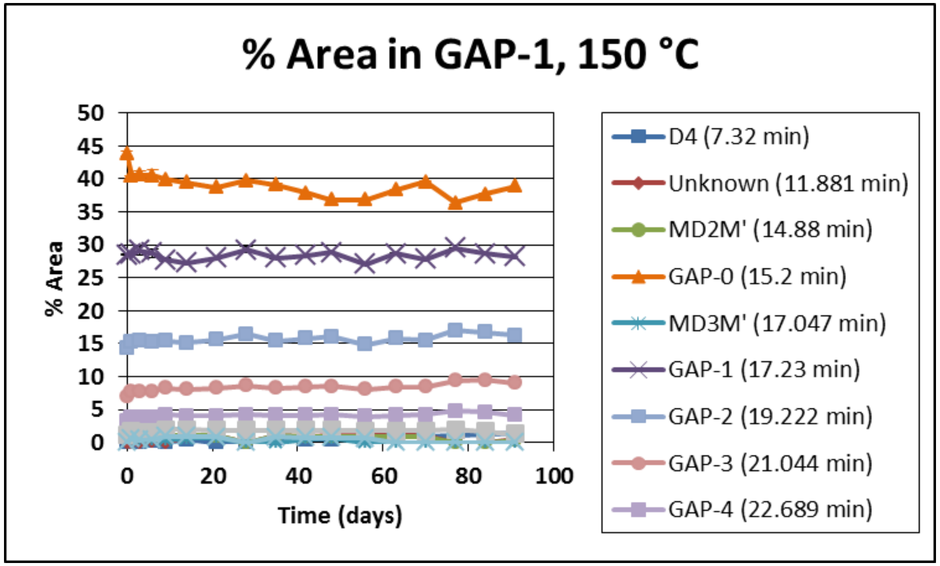
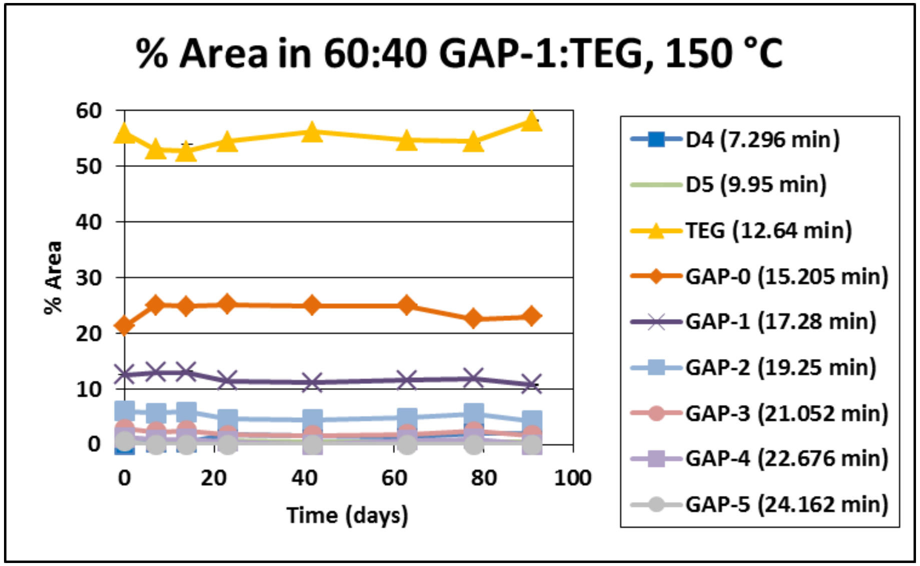
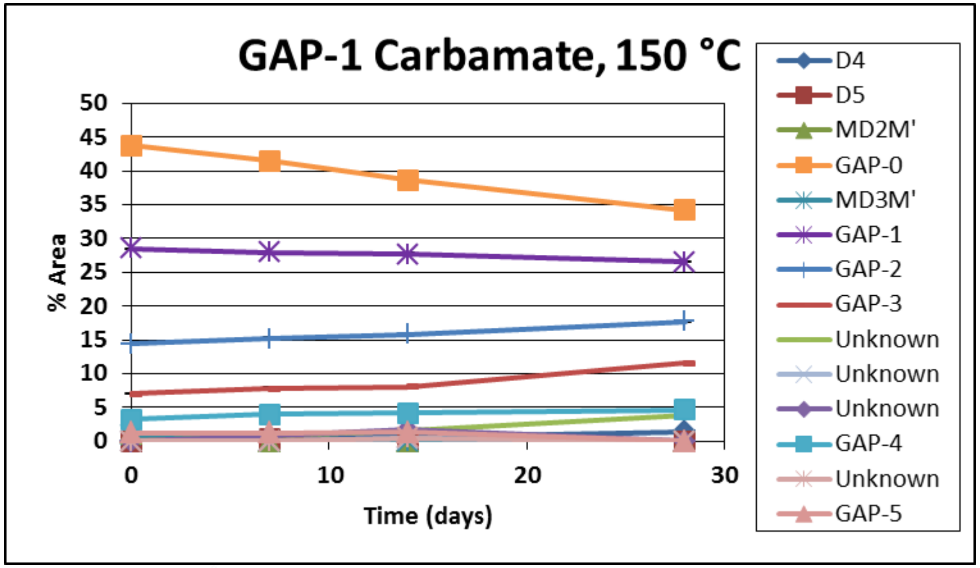
Thermal Stability Measured by GC

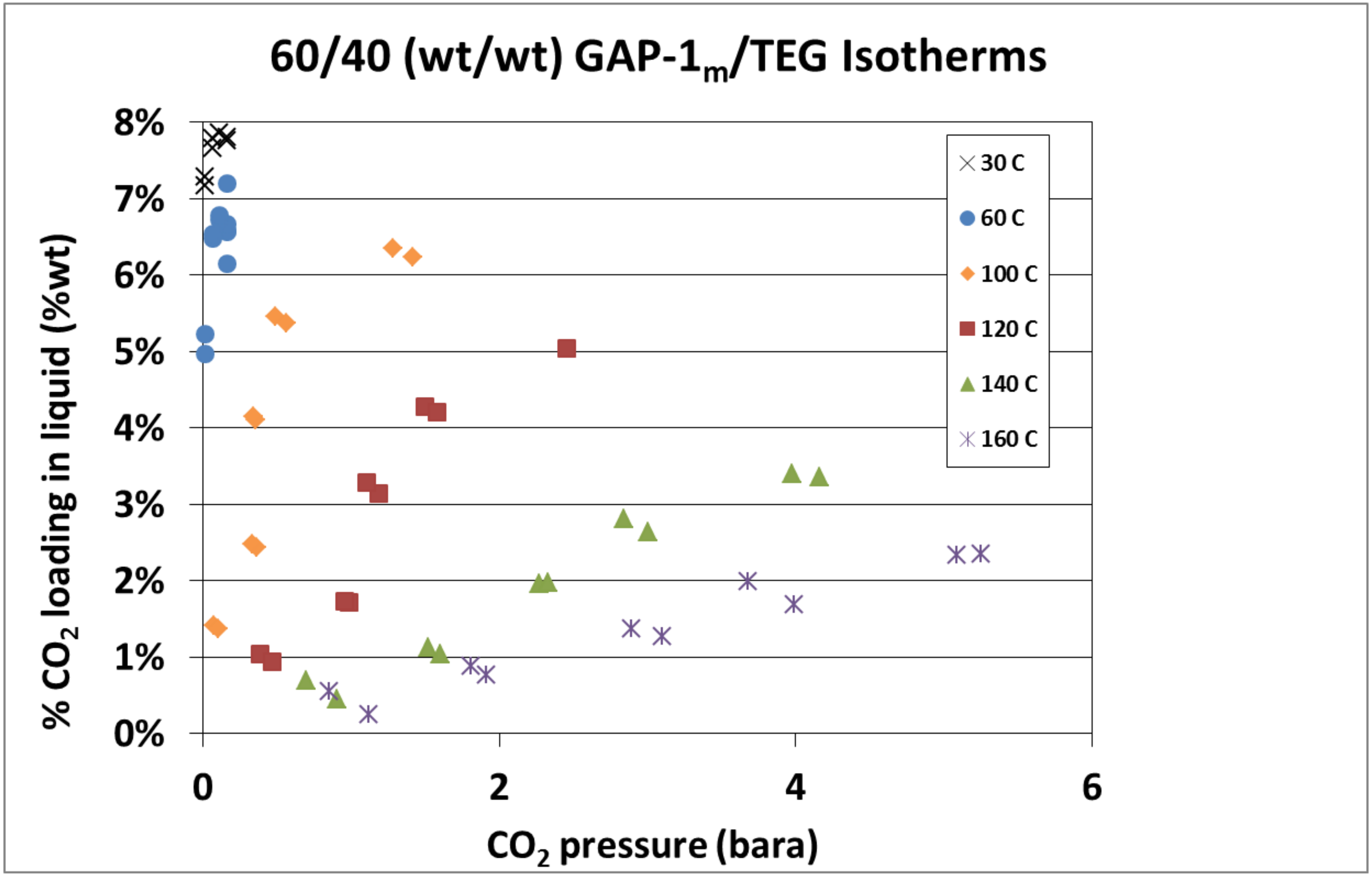






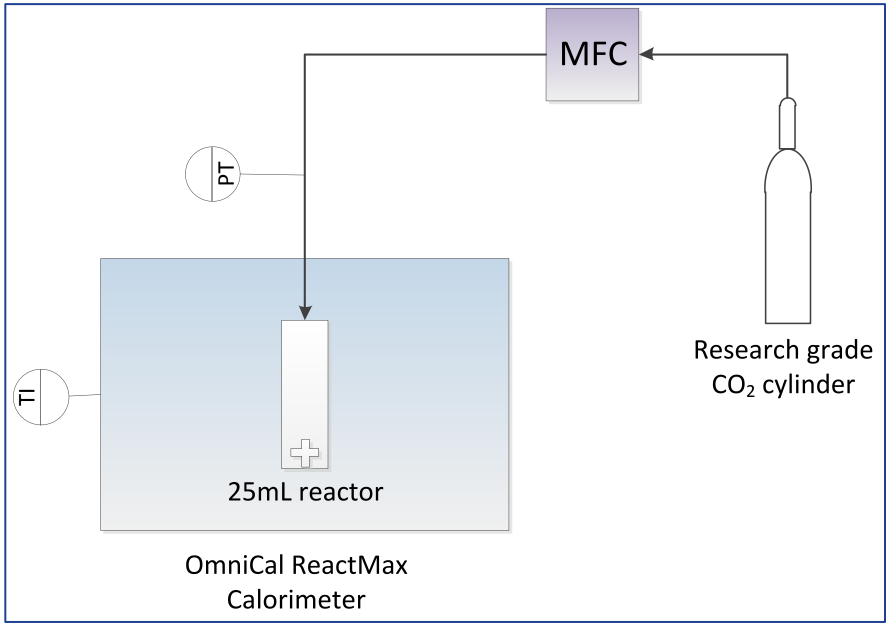
- Thermal stability of GAP materials is high
- Carbamate materials have lower thermal stability
  - GAP-0 converts to higher MW GAP materials
  - Have discovered additives that greatly improve thermal stability

Isotherms



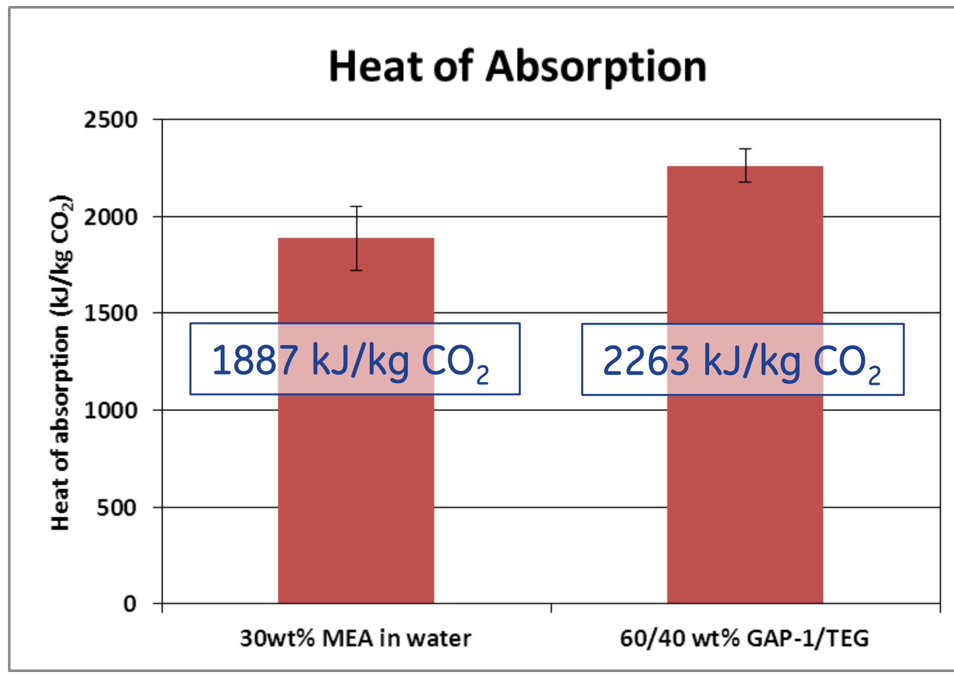
- The maximum possible working CO_2 capacity can be determined

Heat of Absorption of CO_2



Conditions:

- T = 40 °C
- 14 doses of 20 SCC CO_2
- Magnetically stirred



Error bars - 95% CI

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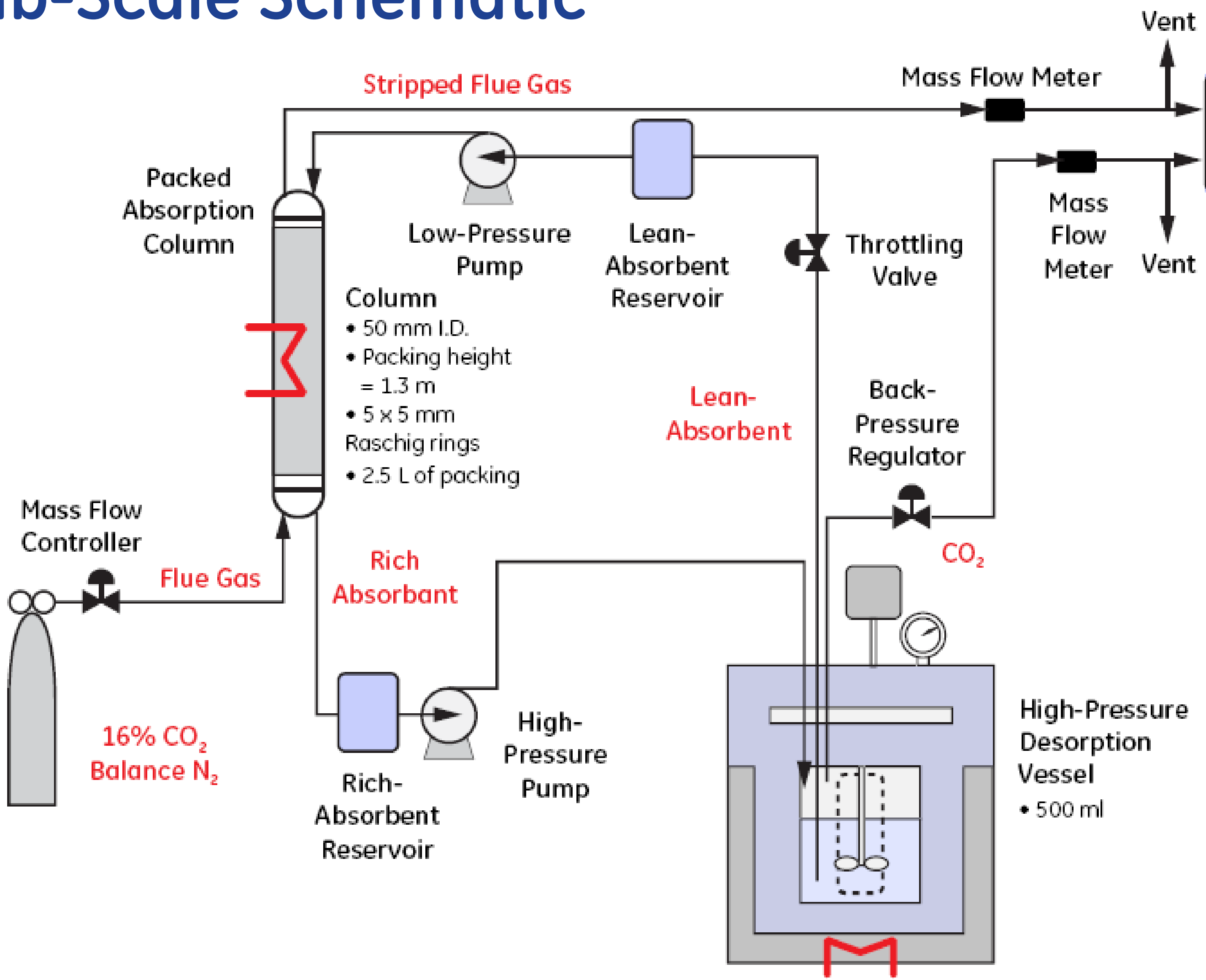
Lab-Scale Schematic



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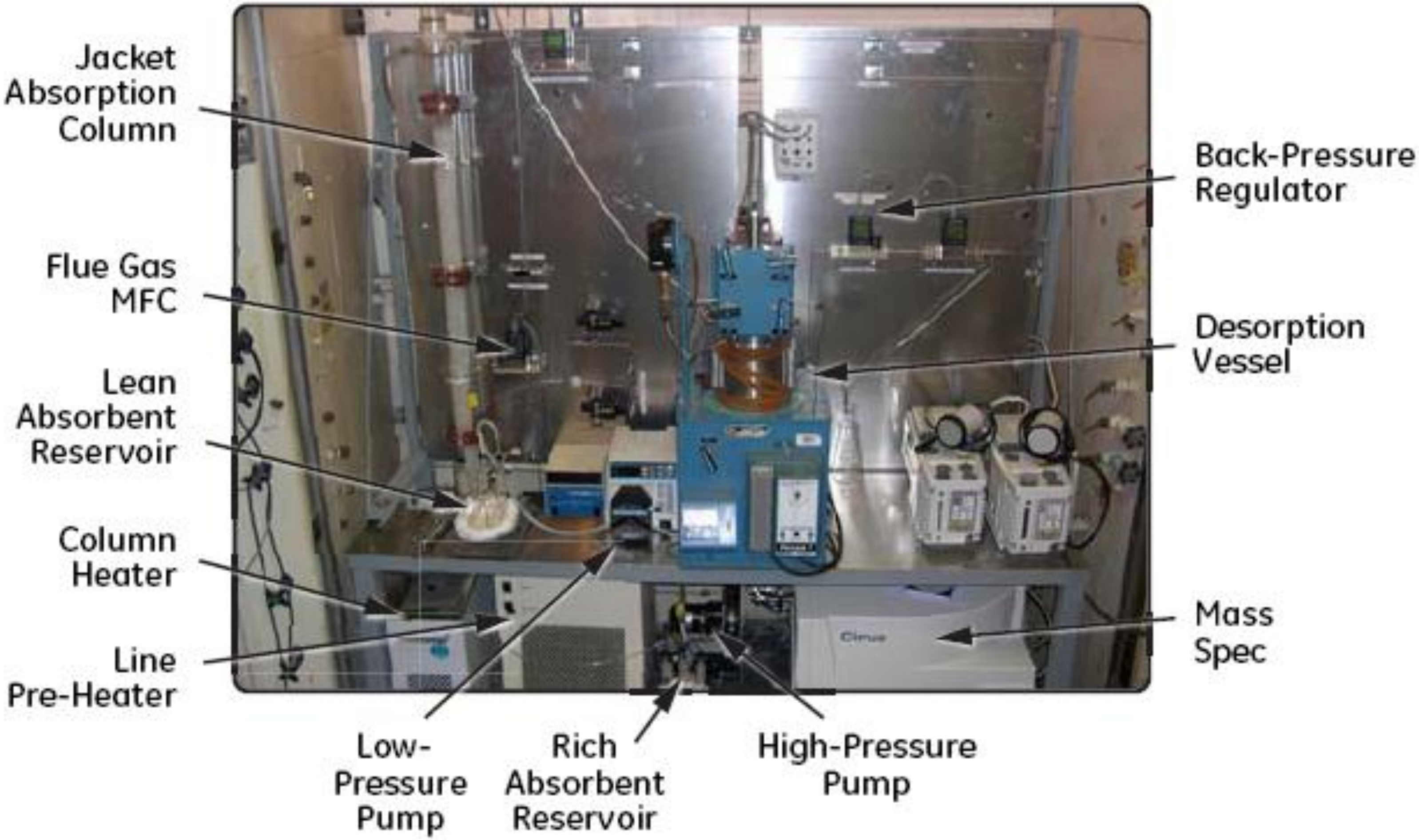
Lab-Scale System



- Successfully ran numerous multi-hour experiments where solvent was cycled continuously between the absorber and desorber
- Was able to achieve >90% CO_2 capture

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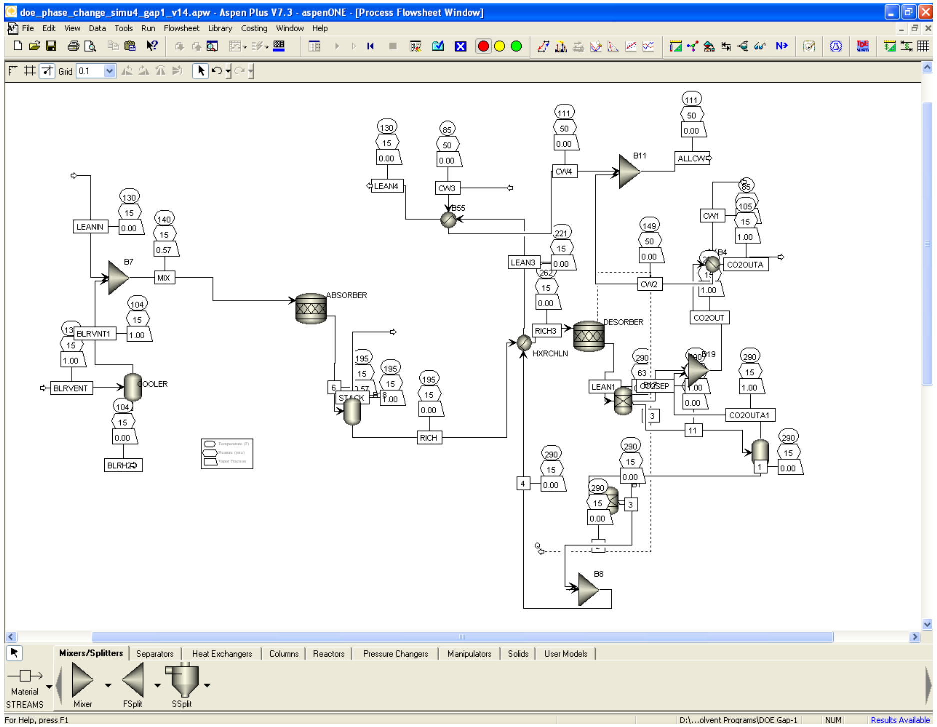
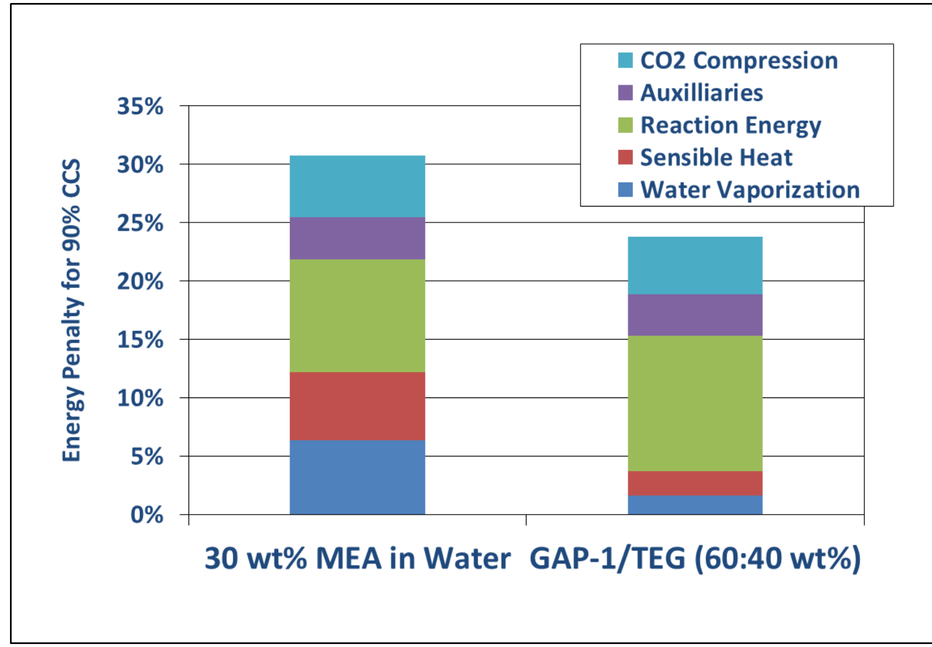
Energy Penalty





- ASPEN Plus model built for CO_2 separation using GAP-1/TEG; Updated with experimental results
- GAP-1/TEG energy penalty for the overall system ~24% vs. ~30% for MEA

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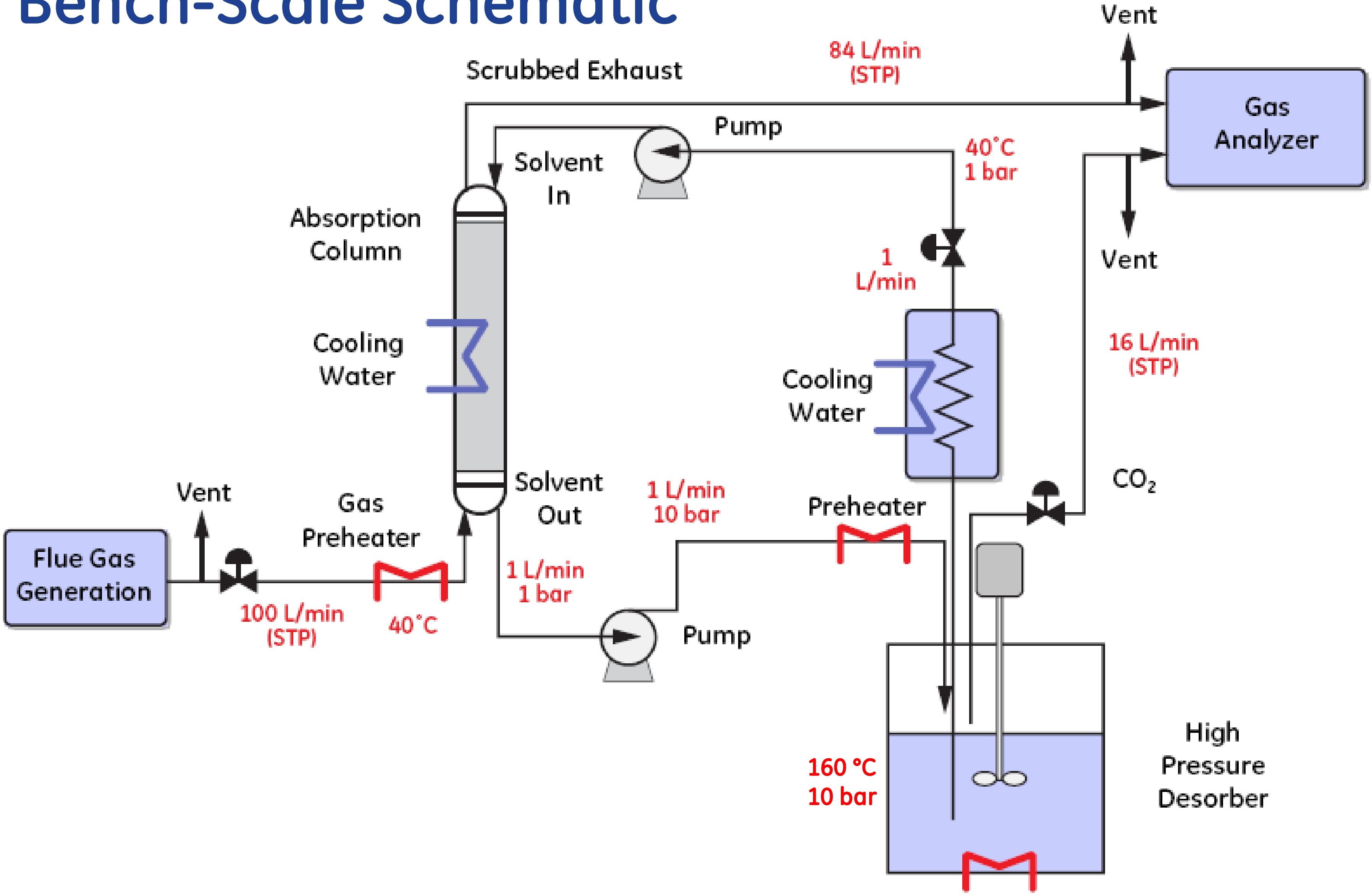
Bench-Scale Schematic



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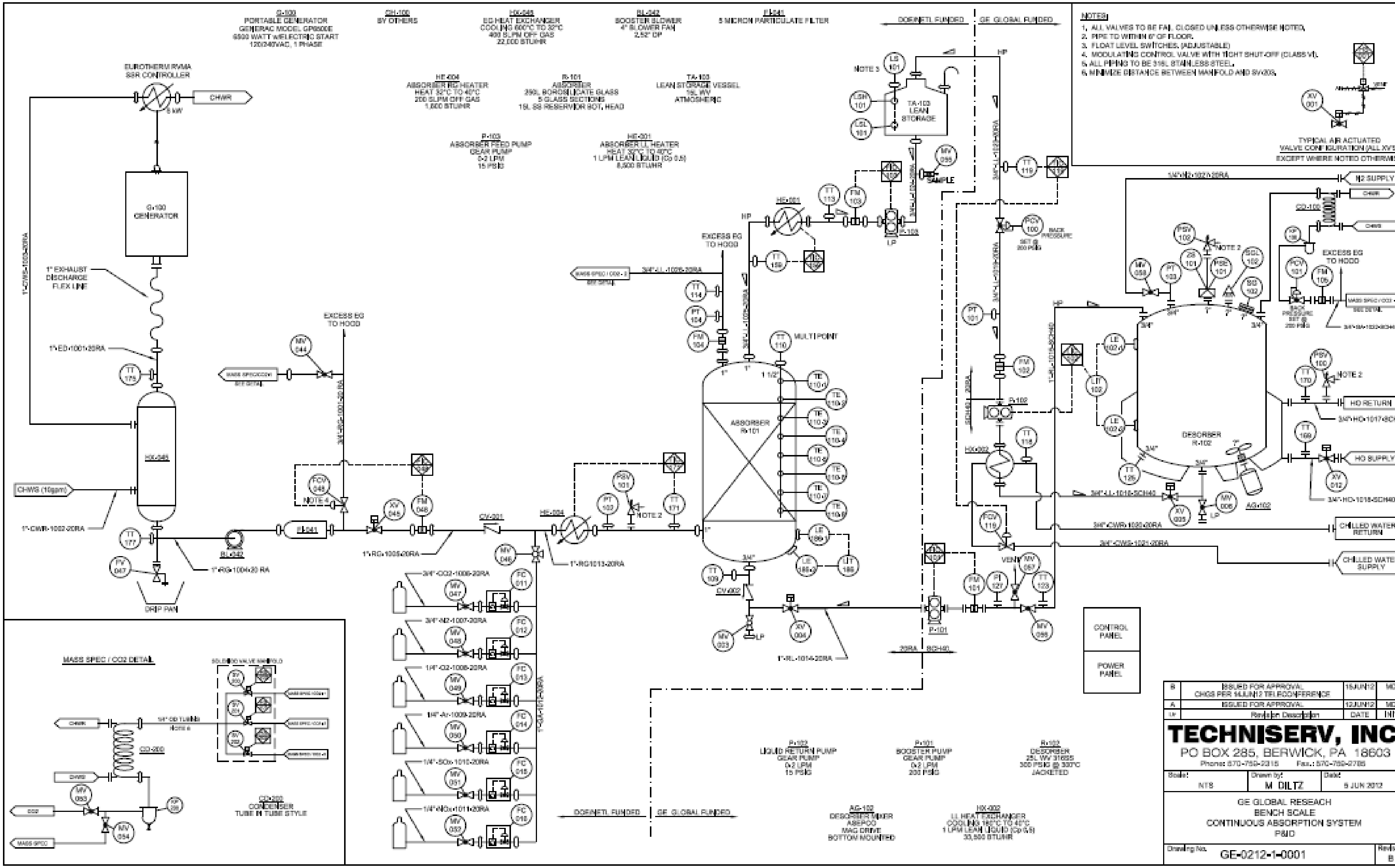
Bench-Scale P&ID



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