DOE-GE CRADA for CCSI Modeling

Terri Grocela
Irina Spiry

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Imagination at work.

GE's CO_2 Solvent Separation Technology

Features

- Non-aqueous aminosilicone solvent, low water usage, low corrosivity
- Smaller footprint, simpler design, lower capital cost, lower operating cost
- Mature unit operations, robust system integration & heat management
- Low volatility (emissions),
- Successful bench scale demo completed

Bench scale CO_2 Capture Skid

Small Scale Pilot (0.5MW)

- Scope: Design, construct & test a pilot scale facility at the National Carbon Capture Center in Alabama
- 2014-2015 Design
- 2016: Operation

NCCC Infrastructure for 0.5 MW Pilot

Large Scale Pilot (10MW)

- Phase 1 Scope: Design facility for test at TCM, Mongstad, Norway
- TEA - Q1 2017

imagination at work

CCSI CRADA- GE/ WVU/ LANL

Problem: Limited solvent data & experience creates a risk for accelerating scale-up (viscosity, density)

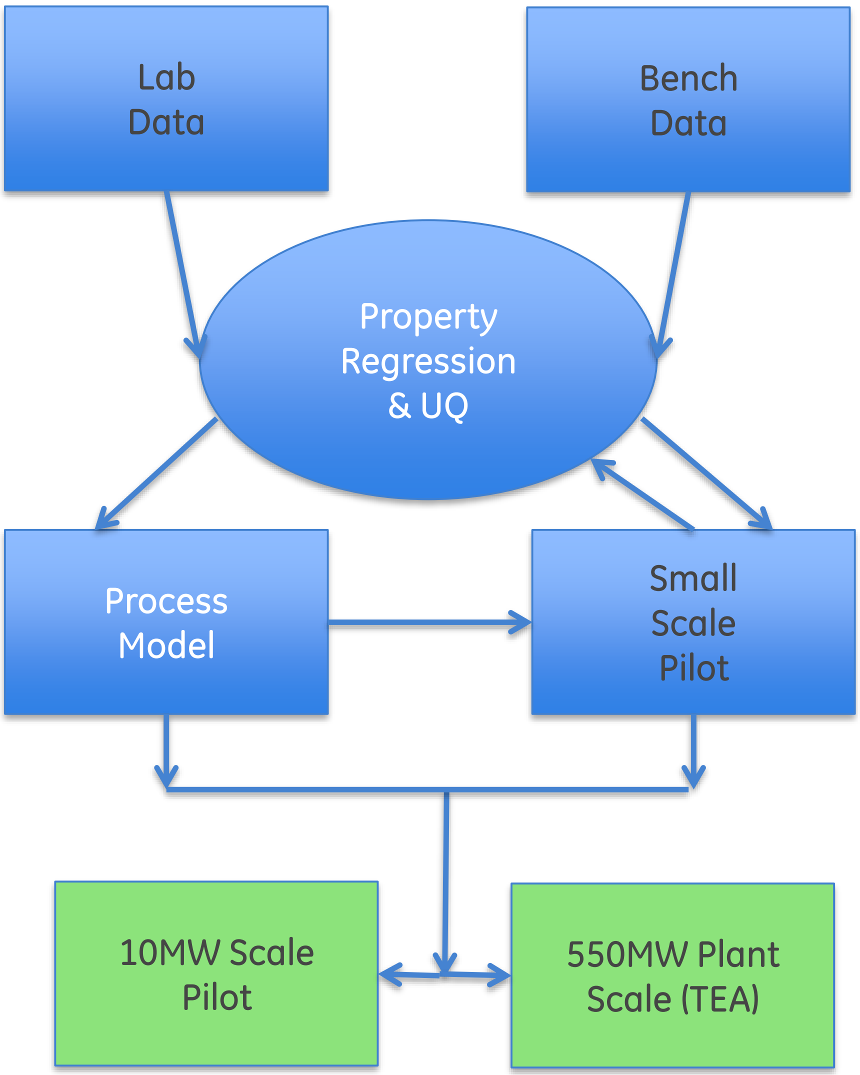
CRADA Scope: Use CCSI Tools to improve predictability of scale-up (physical properties, process model)

Critical Toolset: Process Systems (Solvents)
FOQUS: Physical & thermodynamic property regression and UQ

Advantages:

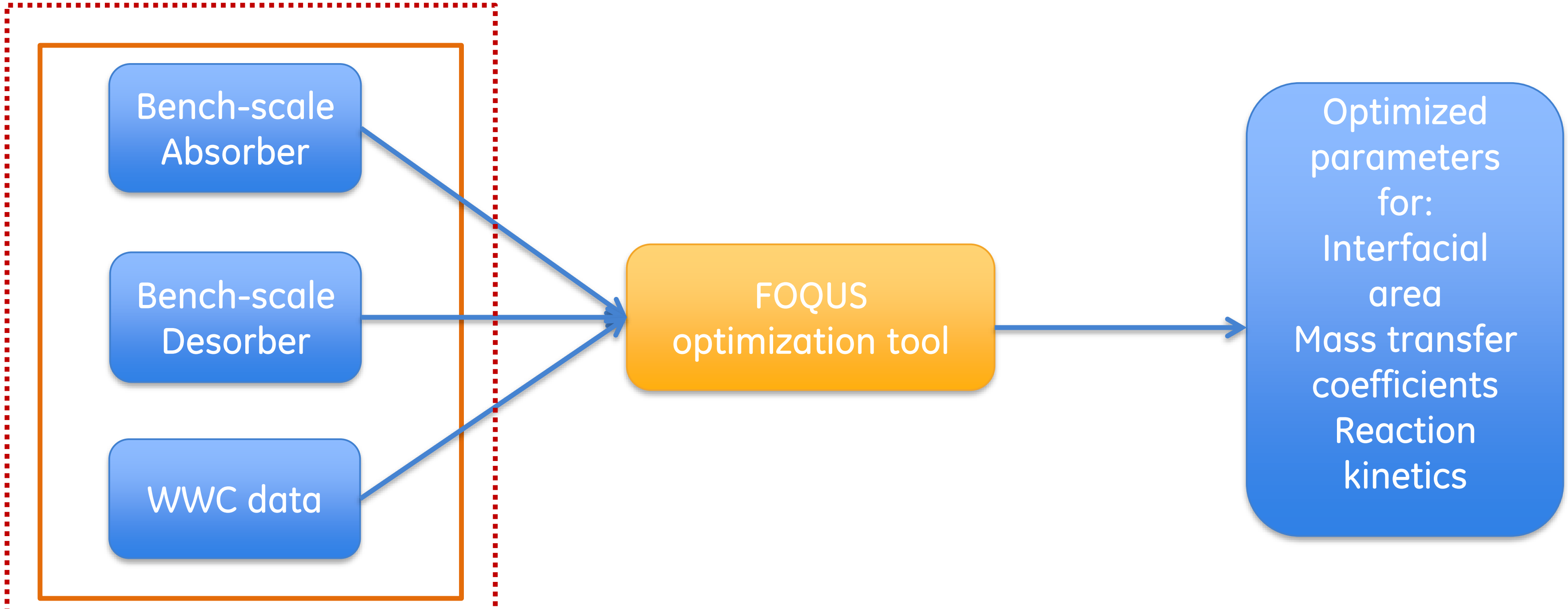
- Ability to utilize real solvent properties in a USER model fed to ASPEN Plus process model
- Uses all of the limited data available by calibrating to the bench scale data

Property Regression & Process Model



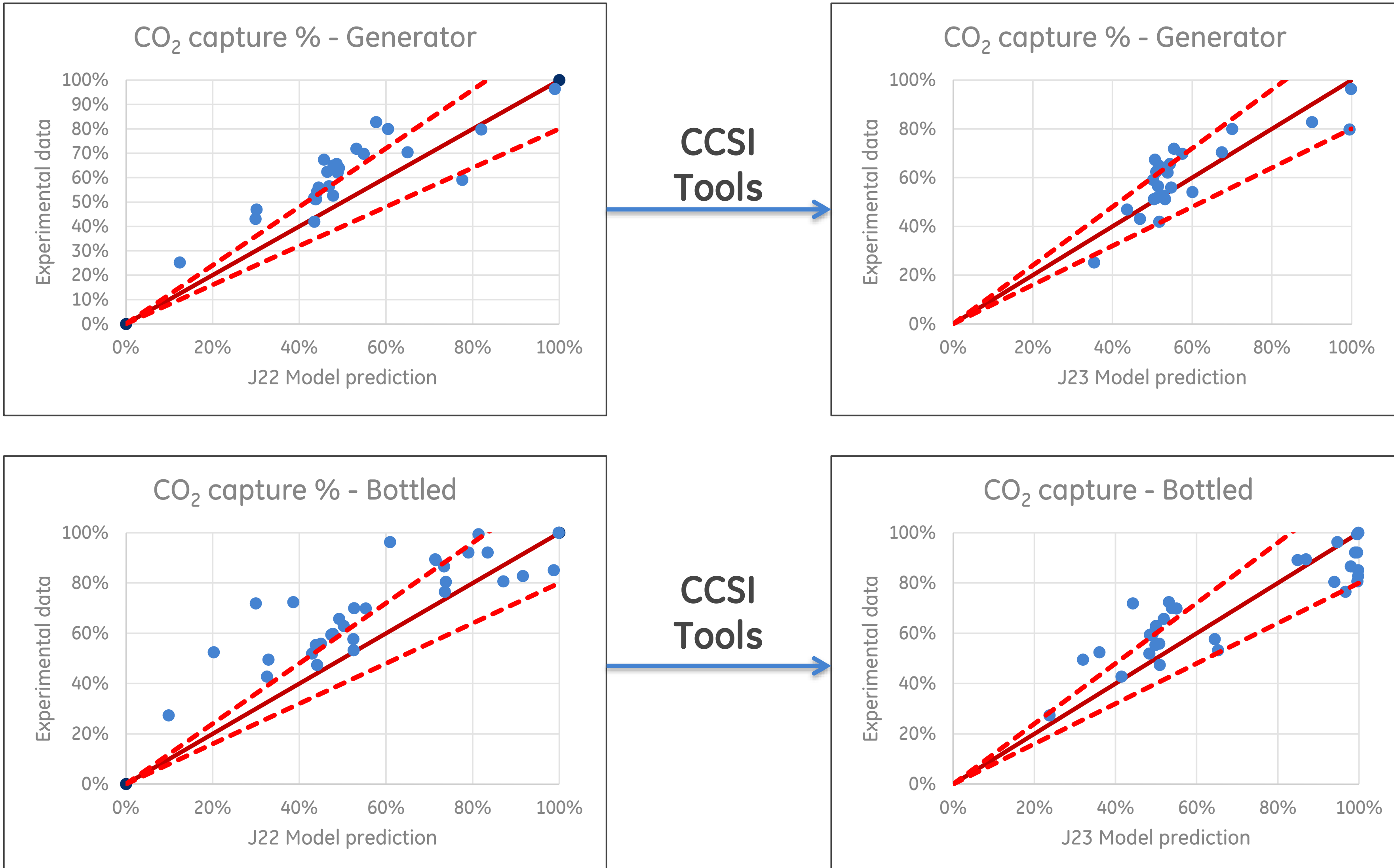
- Property regression & UQ first necessary step in scale-up
- Regression functions to inform the pilot and assimilate data for the process model
- Robust process model key to large scale pilot and plant scale economics

FOQUS Optimization



Equation	Model form		Name
Gas-side mass transfer coefficient	$k_G = D_G \boldsymbol{C_G} \left(\frac{a}{d_H}\right)^{0.5} Sc_G^{\ 0.333} \left(\frac{u_G \rho_G}{a \mu_G}\right)^{0.75} \sqrt{\frac{1}{\varepsilon - h_L}}$	3	Billet and Schultes (1993)
Liquid-side mass transfer coefficient	$k_L = \boldsymbol{C_L} \left(\frac{1}{\mu_L}\right)^{\boldsymbol{p}} (\rho_L g)^{0.167} \left(\frac{D_L}{d_H}\right)^{0.5} \left(\frac{u_L}{a}\right)^{0.333}$	4	Billet and Schultes (1993)
Interfacial area	$a_e = \boldsymbol{A_1} \left[\frac{\rho_L}{\sigma} g^{1/3} \left(\frac{u_L A}{L_P}\right)^{4/3}\right]^{\boldsymbol{A_2}}$	5	Tsai (2010)
Reaction rate	$r_{CO2} = \boldsymbol{k_F} e^{-\frac{\boldsymbol{E}}{R}\left(\frac{1}{T} - \frac{1}{298.15}\right)} \left(x_{GAP} x_{CO_2} - \frac{x_{GAPCO_2}}{K_{EQ1}}\right)$	6	

Preliminary results



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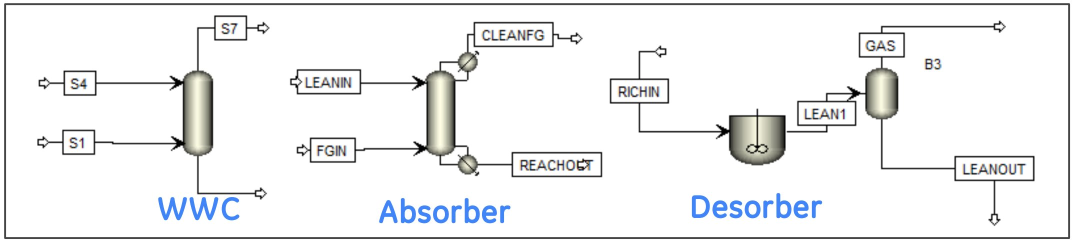
- **Existing data**: Used to create preliminary models
- **Update Model:** Additional data is obtained from the bench scale testing and WWC – by August 1st
- **Calibrate Model**: Incorporate additional data for further model calibration August – September 2016
- **Validate:** Use the model during pilot testing to inform the pilot test and understand additional data needed at the bench scale - Q3 2016
- **Robust Process Model:** Team will create a more robust process model - by end of 2016



Benefits of this collaboration

- Reduces the risk for scale up by advancing a rigorous and scalable model for 550MW scale
- Identified entirely new areas where additional work would accelerate scale-up and reduce risk.
- Improves understanding of uncertainty of model prediction
- Ability to compare the current GE model of the bench scale system to a model with additional robustness
- FOQUS tool allowed a more efficient way to determine parameter sensitivity
- GE and CCSI team improved FOQUS software through testing and feedback
- Common platform for analysis can be used for comparison of multiple technologies

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