ProMax®

Process Simulation Predicts Corrosive Conditions in HF Alkylation Fractionators

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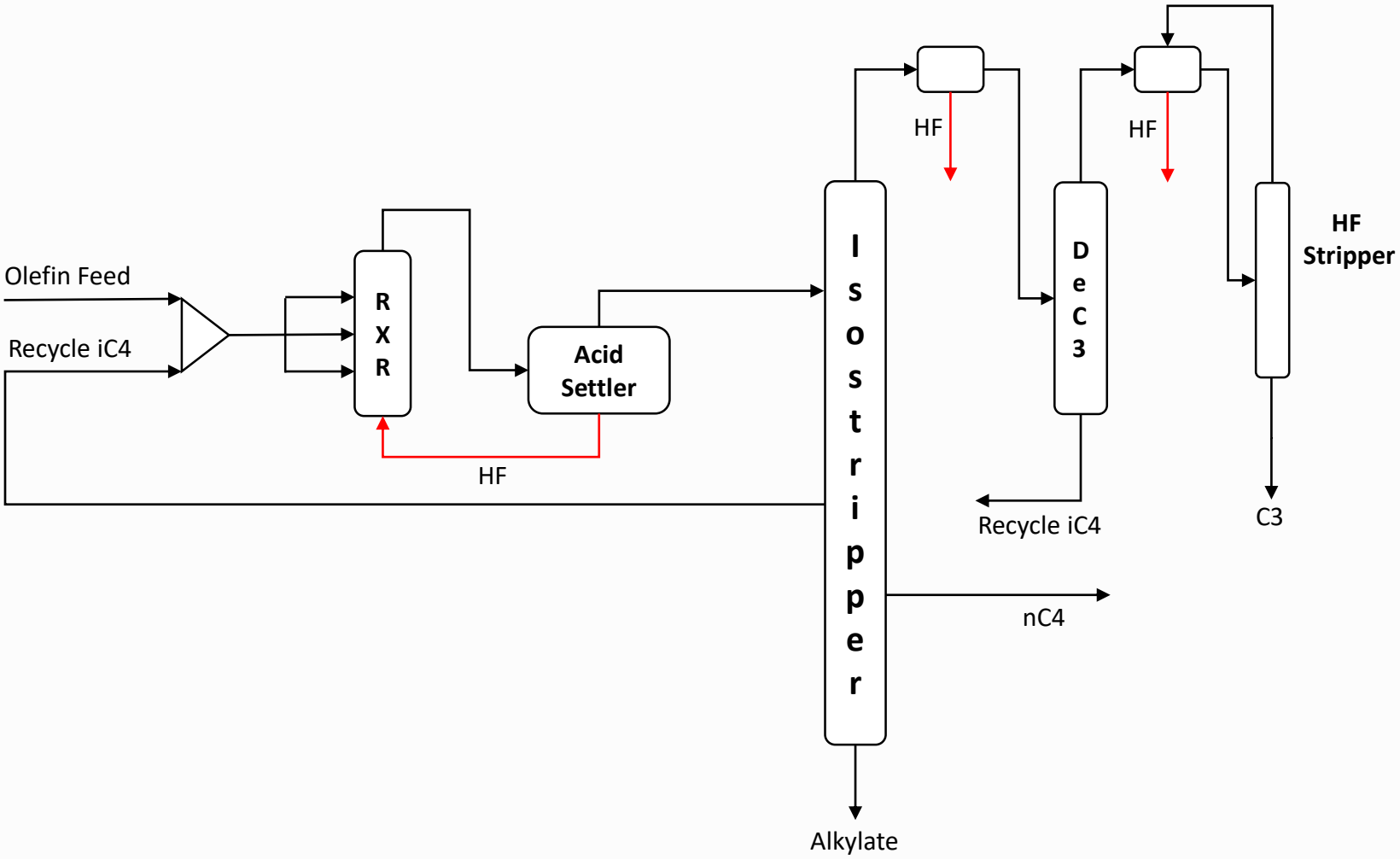
HF Alkylation Process



Overview

Issue:

Unexpected corrosion in Alkylation Unit Isostripper

- Rapid corrosion at iC4 (Vapor) Side Draw, as if free acid phase exists

Simulation Objective:

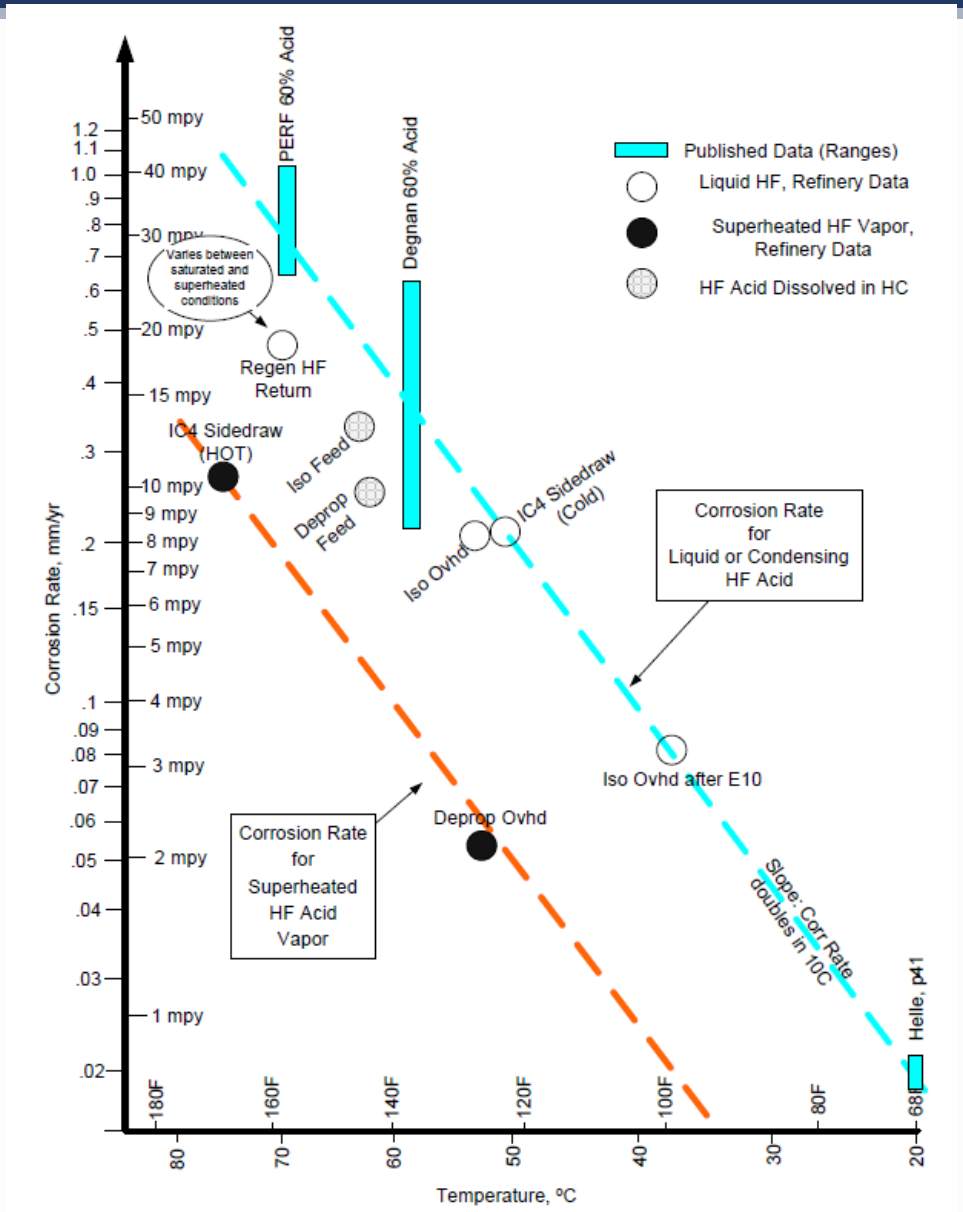
Test possible conditions that could form free acid near iC4 Side Draw

- Normal Operations
- Internal Regeneration
- Acid Regenerator Return
- Acid Settler Carry-Over

Corrosion in HF / H_2O

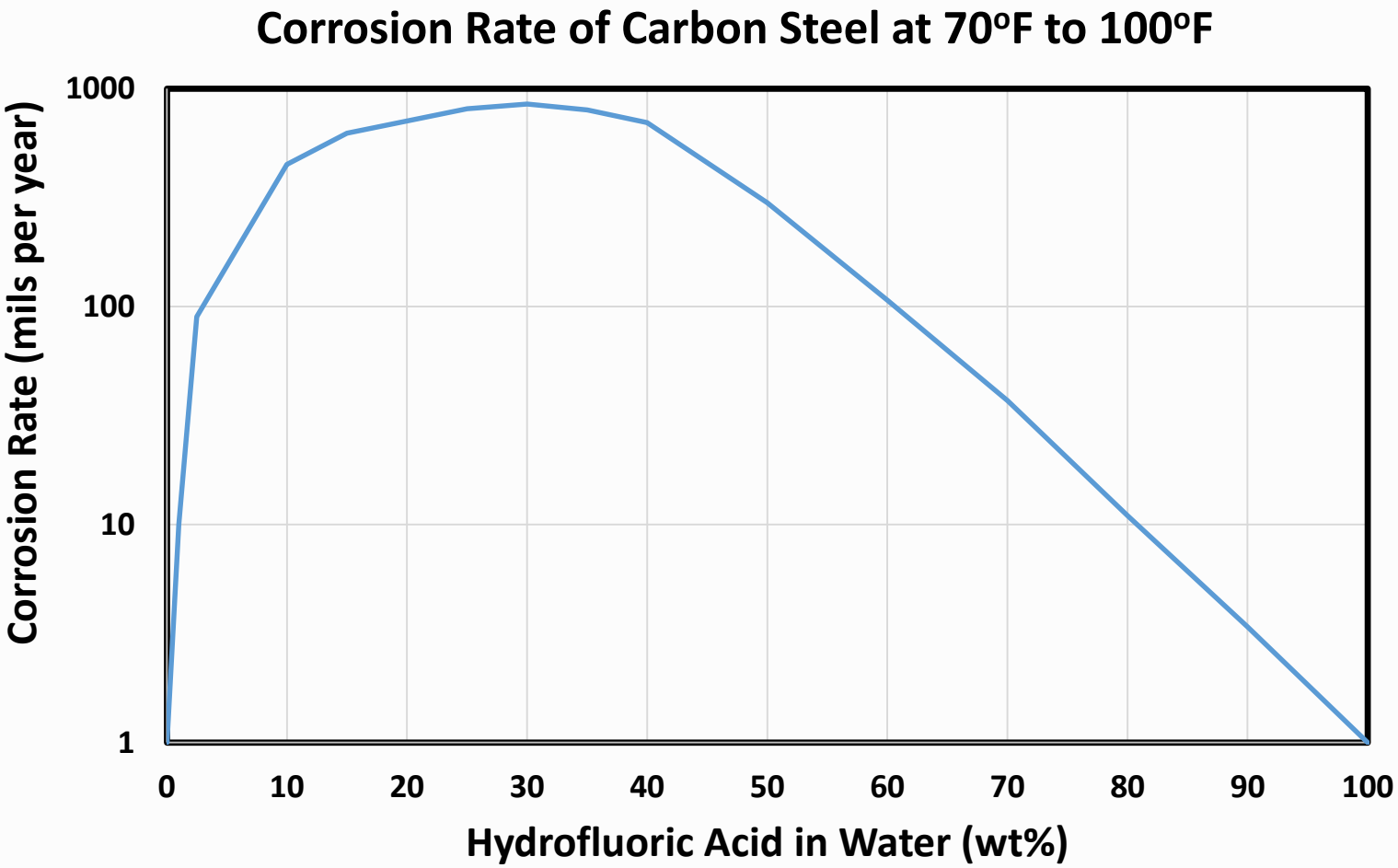
- Corrosion rates strongly affected by type of HF phase (superheated vapor, condensing HF)
- Corrosion rates rise exponentially with temperature
- Corrosion rates low for near-pure HF but rise with increasing H_2O content
- Simulation offers ability to predict HF/H_2O concentrations in liquid phases of streams and column stages

Corrosion vs Temperature and State



Corrosion Rates Of Carbon Steel in HF Alkylation Service, Schulz, C. J., CORROSION 2006, 12-16 March, San Diego, California

Corrosion Rate vs HF/H_2O Content

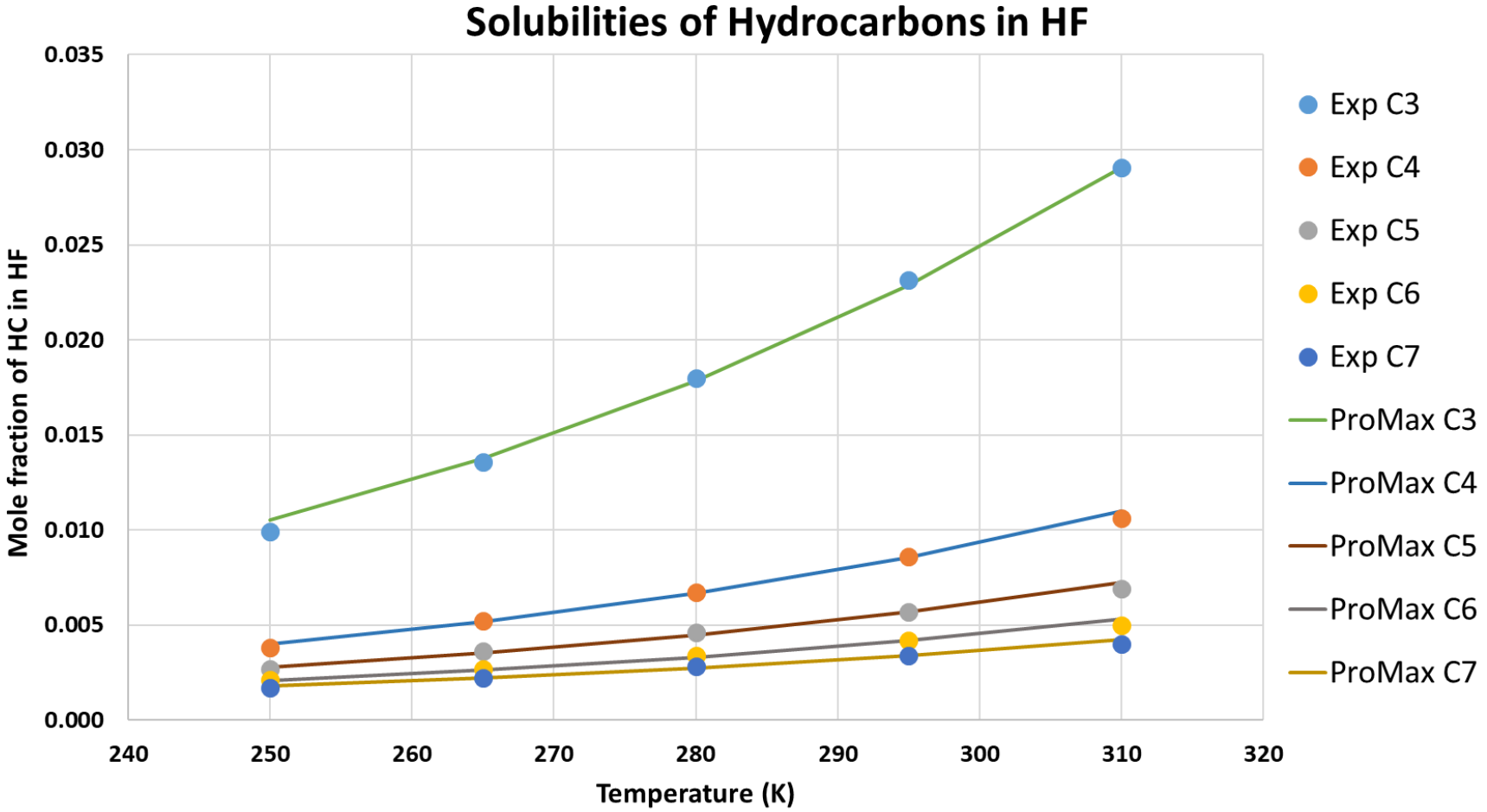


The Effect of Operating Conditions on Corrosion in HF Alkylation Units: Part I, Dobis, J.D., Williams, D.G., and Bryan Jr., D. L., Inspectioneering Journal, May/June 2004

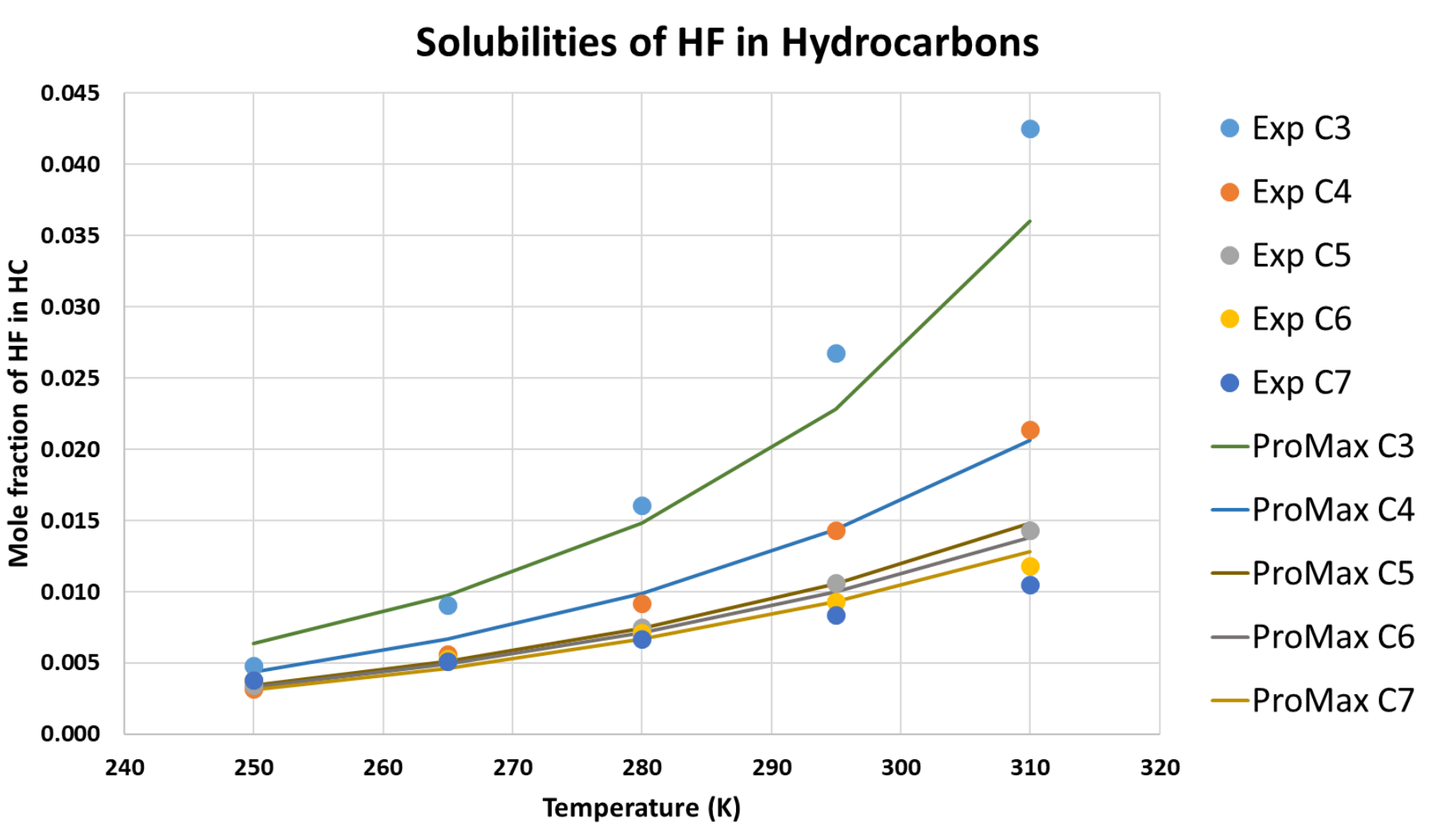
HF Alkylation in ProMax

- Peng-Robinson Polar thermodynamics tuned to predict:
  - 3-phase HF/HC flash
  - HF/H_2O azeotrope
- Plug Flow Reactor with 14 molecular, kinetic reactions
- Ghosh RON Prediction model
- Calibrated against 100 weekly data sets from a single stage contactor (Phillips)
- Can converge Acid Circulation, HF Stripper Overhead, iC4 Recycle, and Acid Regeneration recycles
- Simulated 17 of ~50 HF Alkylation Units in USA

Peng-Robinson Polar

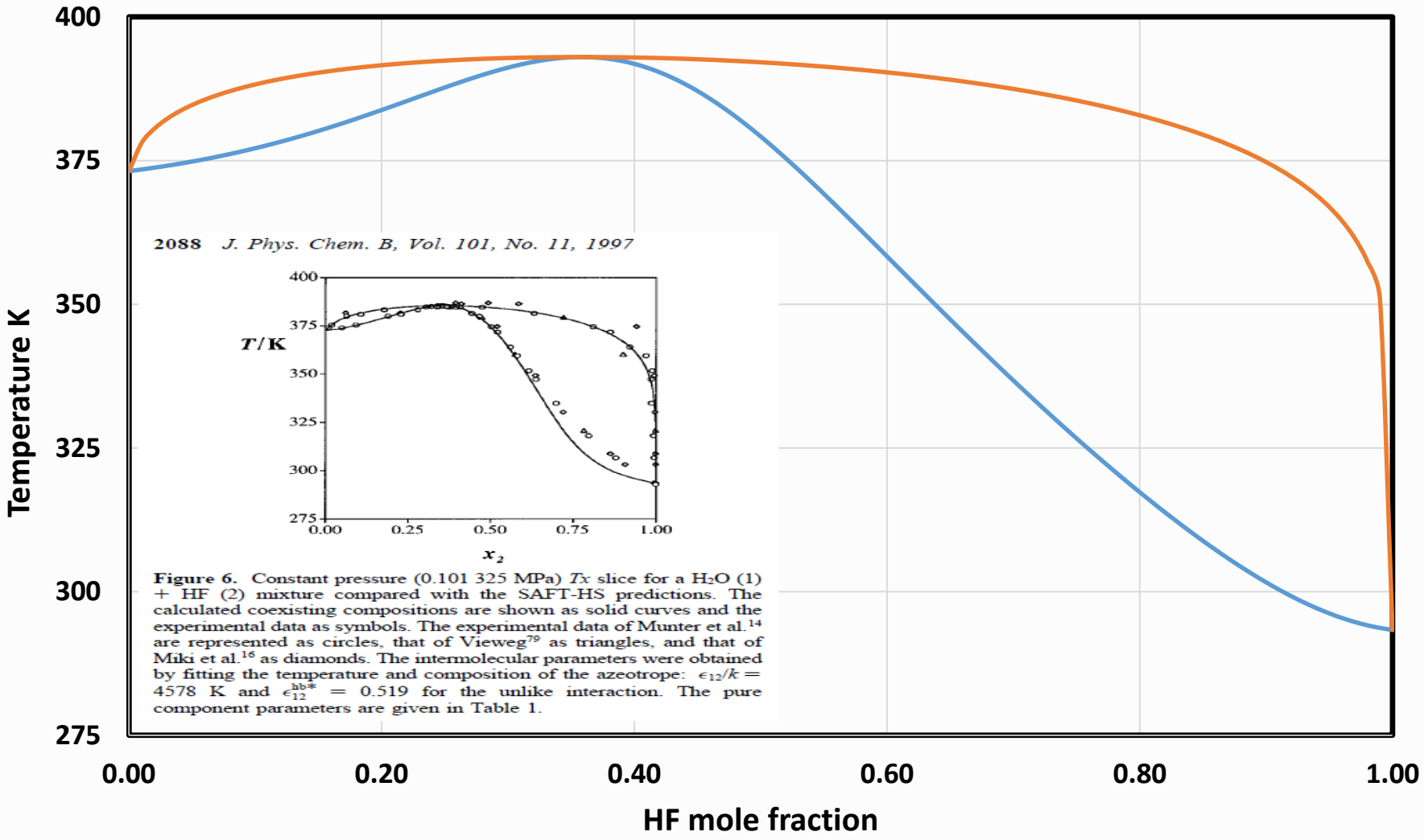


Peng-Robinson Polar



Peng-Robinson Polar

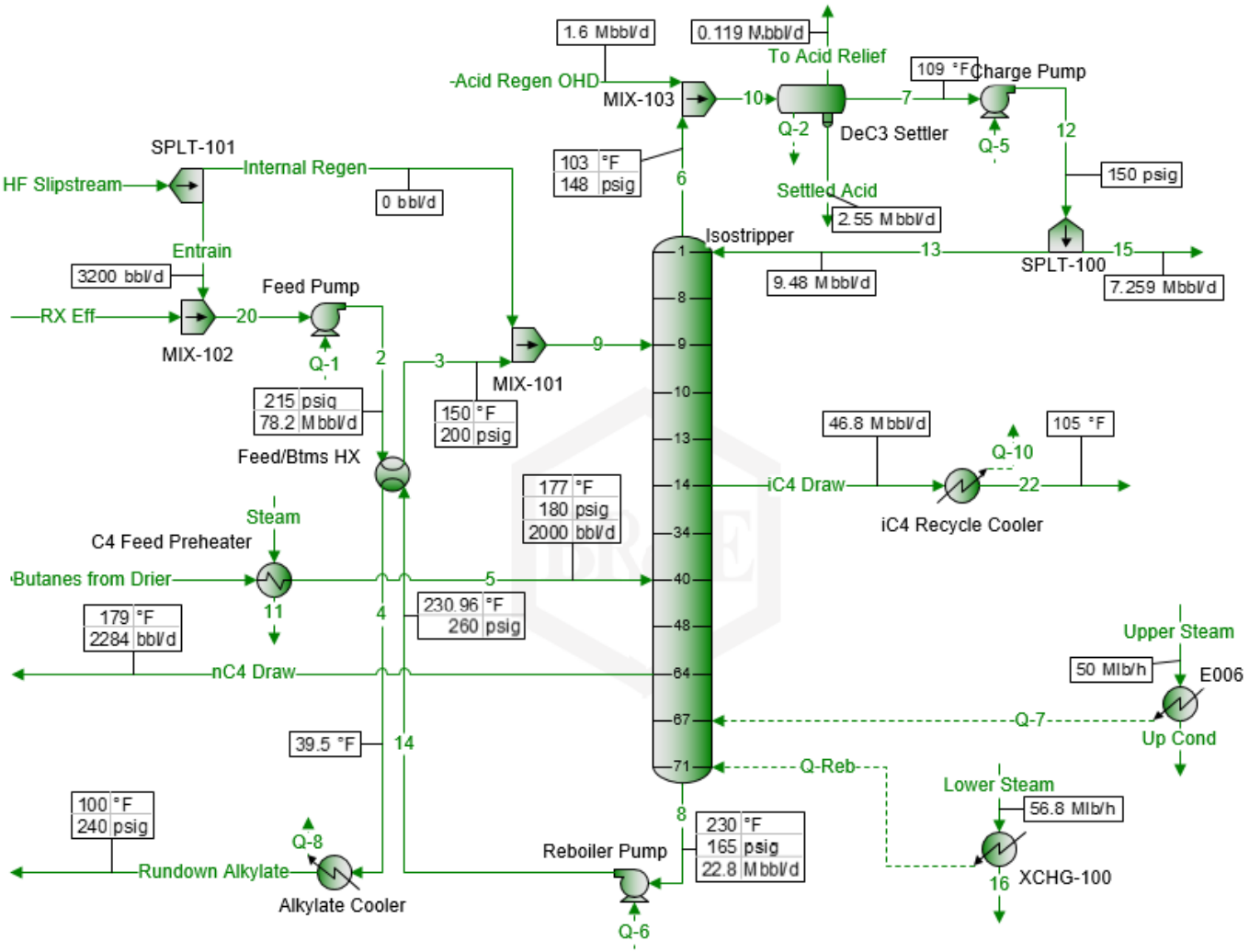
HF-H_2O Txy @ 1.01325 bar



2088 *J. Phys. Chem. B, Vol. 101, No. 11, 1997*

Figure 6. Constant pressure (0.101 325 MPa) *Tx* slice for a H_2O (1) + HF (2) mixture compared with the SAFT-HS predictions. The calculated coexisting compositions are shown as solid curves and the experimental data as symbols. The experimental data of Munter et al.[14] are represented as circles, that of Vieweg[79] as triangles, and that of Miki et al.[16] as diamonds. The intermolecular parameters were obtained by fitting the temperature and composition of the azeotrope: $\epsilon_{12}/k = 4578$ K and $\epsilon_{12}^{hb*} = 0.519$ for the unlike interaction. The pure component parameters are given in Table 1.

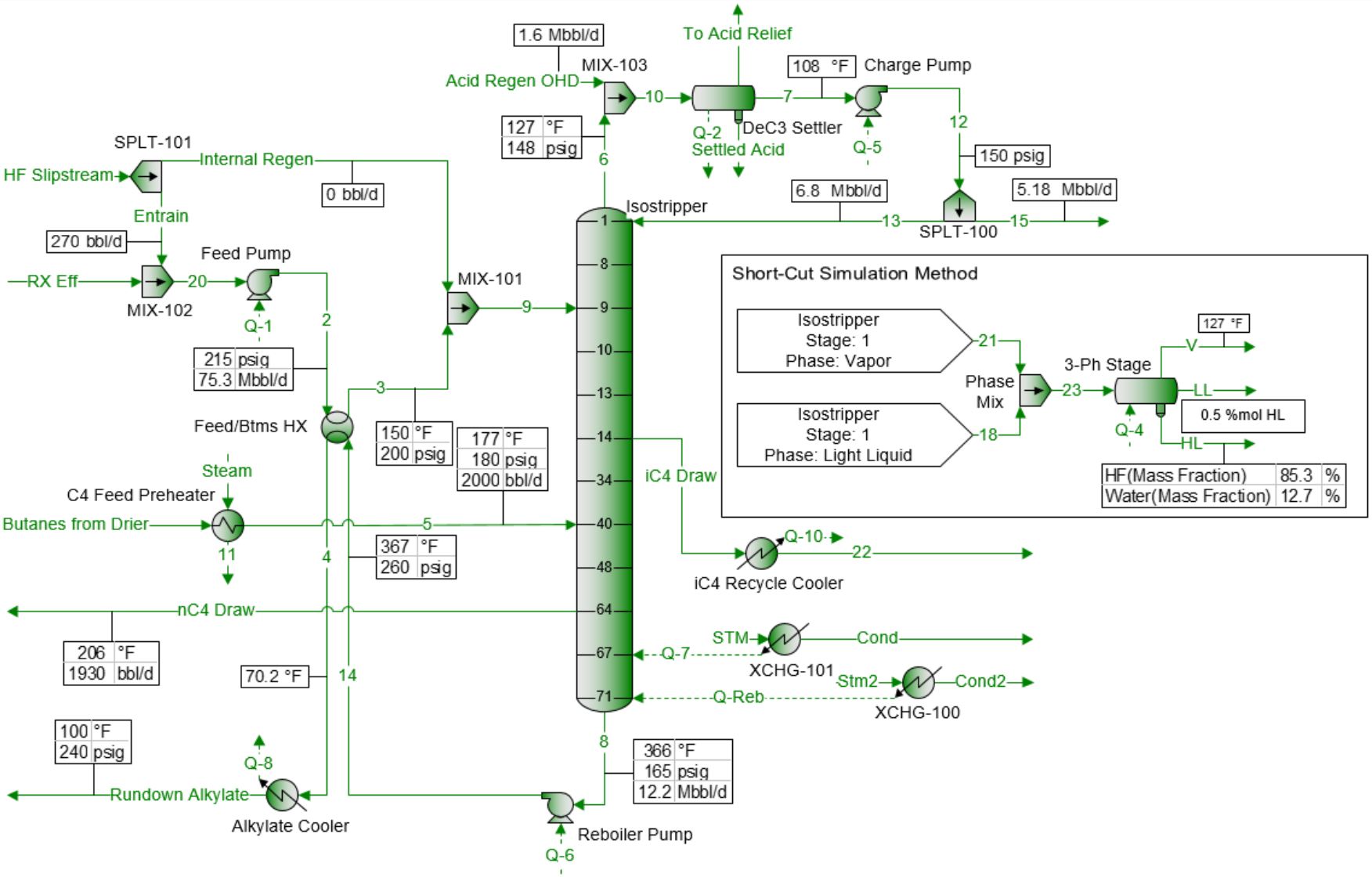
ProMax Isostripper



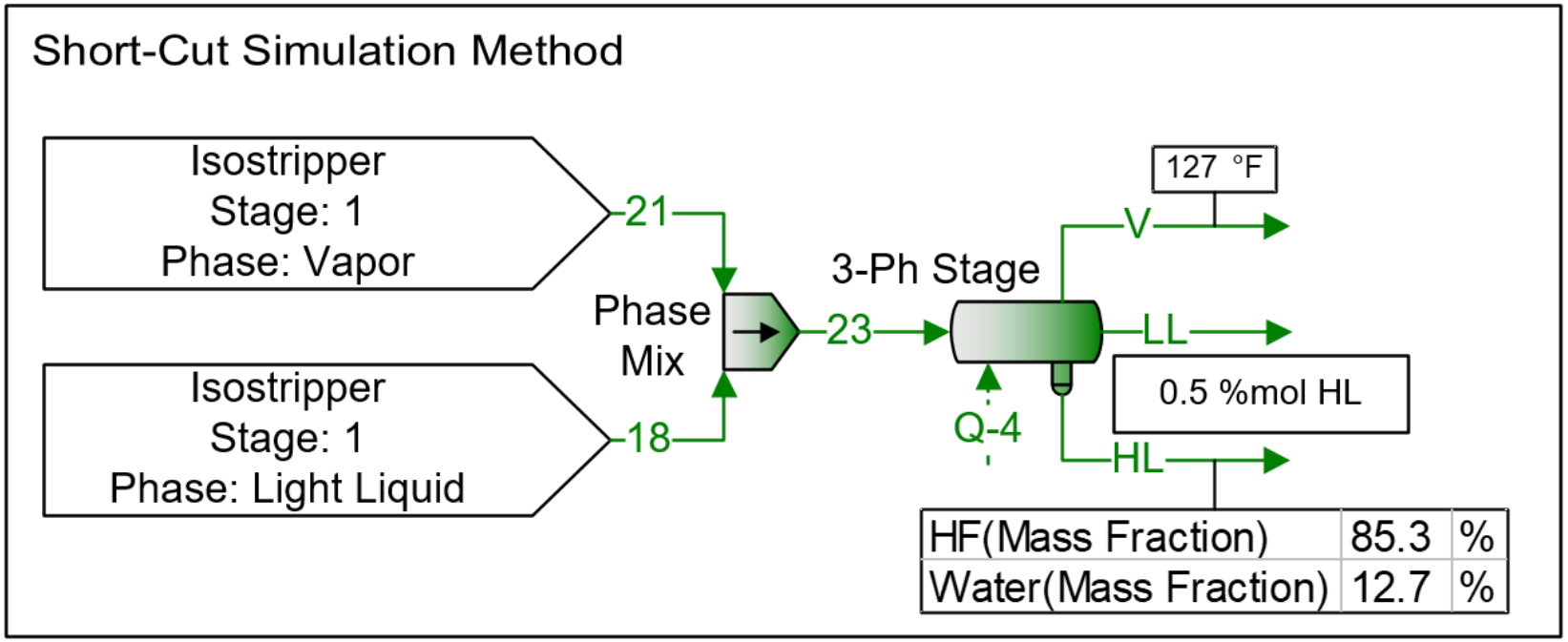
3-Phases on Stage Warnings

Solve ended: Wednesday, January 24, 2018 10:47:51 AM
Block Warnings:
ProMax:ProMax!Project!Flowsheets!Isostripper!Blocks!Isostripper!Stages!1
Warning: Stage 1 has 3-phases
ProMax:ProMax!Project!Flowsheets!Isostripper!Blocks!Isostripper!Stages!2
Warning: Stage 2 has 3-phases
ProMax:ProMax!Project!Flowsheets!Isostripper!Blocks!Isostripper!Stages!3
Warning: Stage 3 has 3-phases
ProMax:ProMax!Project!Flowsheets!Isostripper!Blocks!Isostripper!Stages!4
Warning: Stage 4 has 3-phases

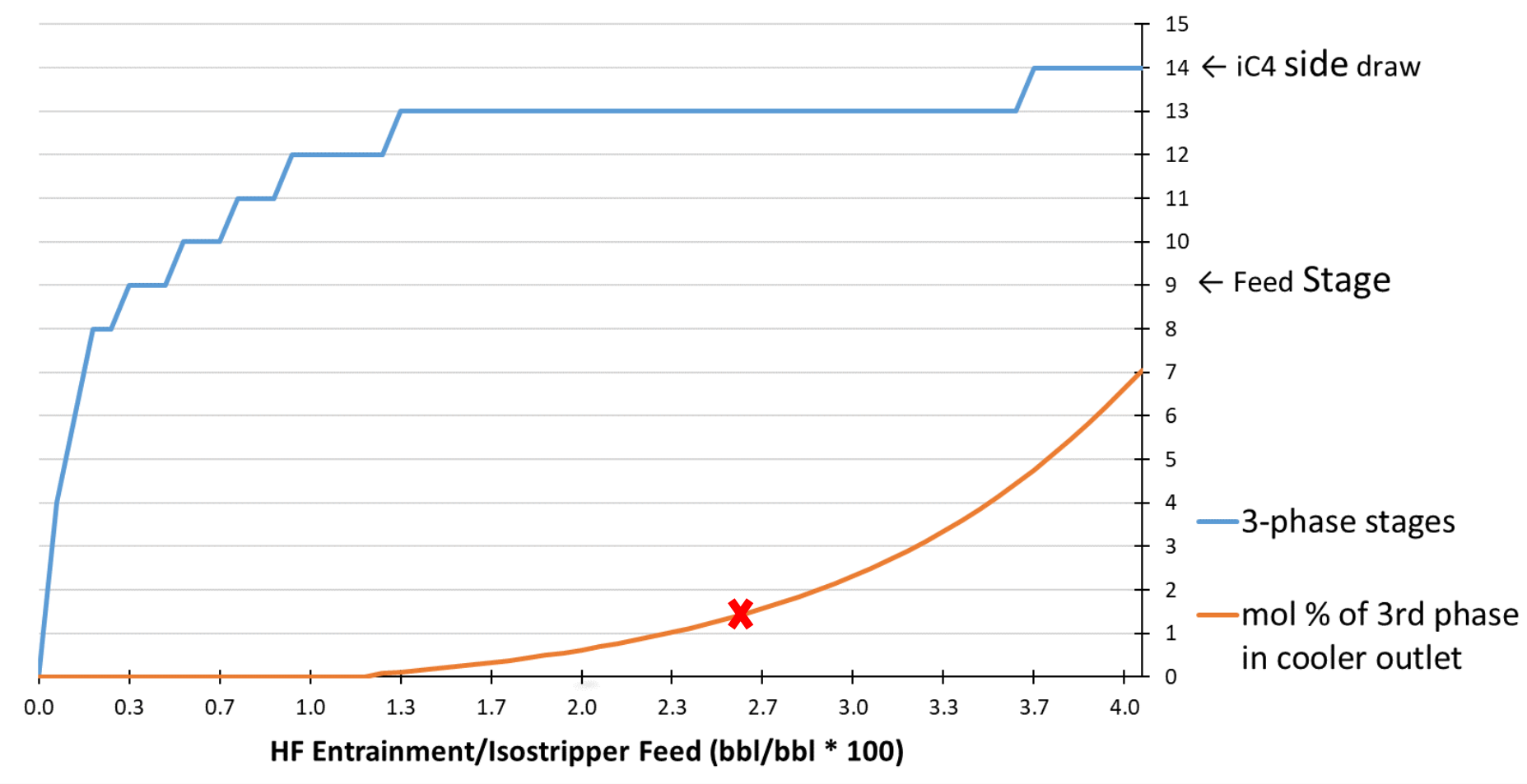
Determine HF phase Composition



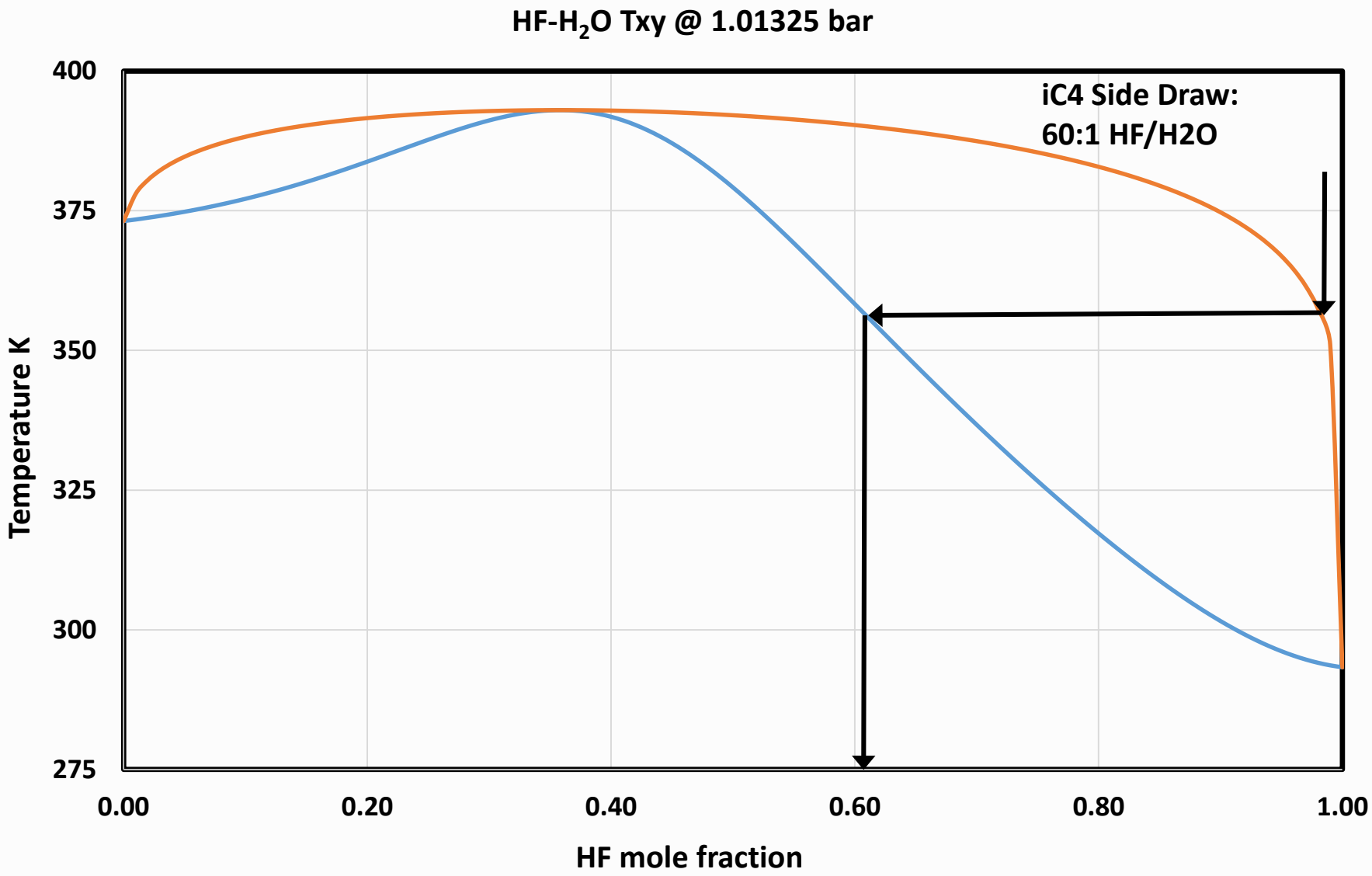
Short-Cut Method



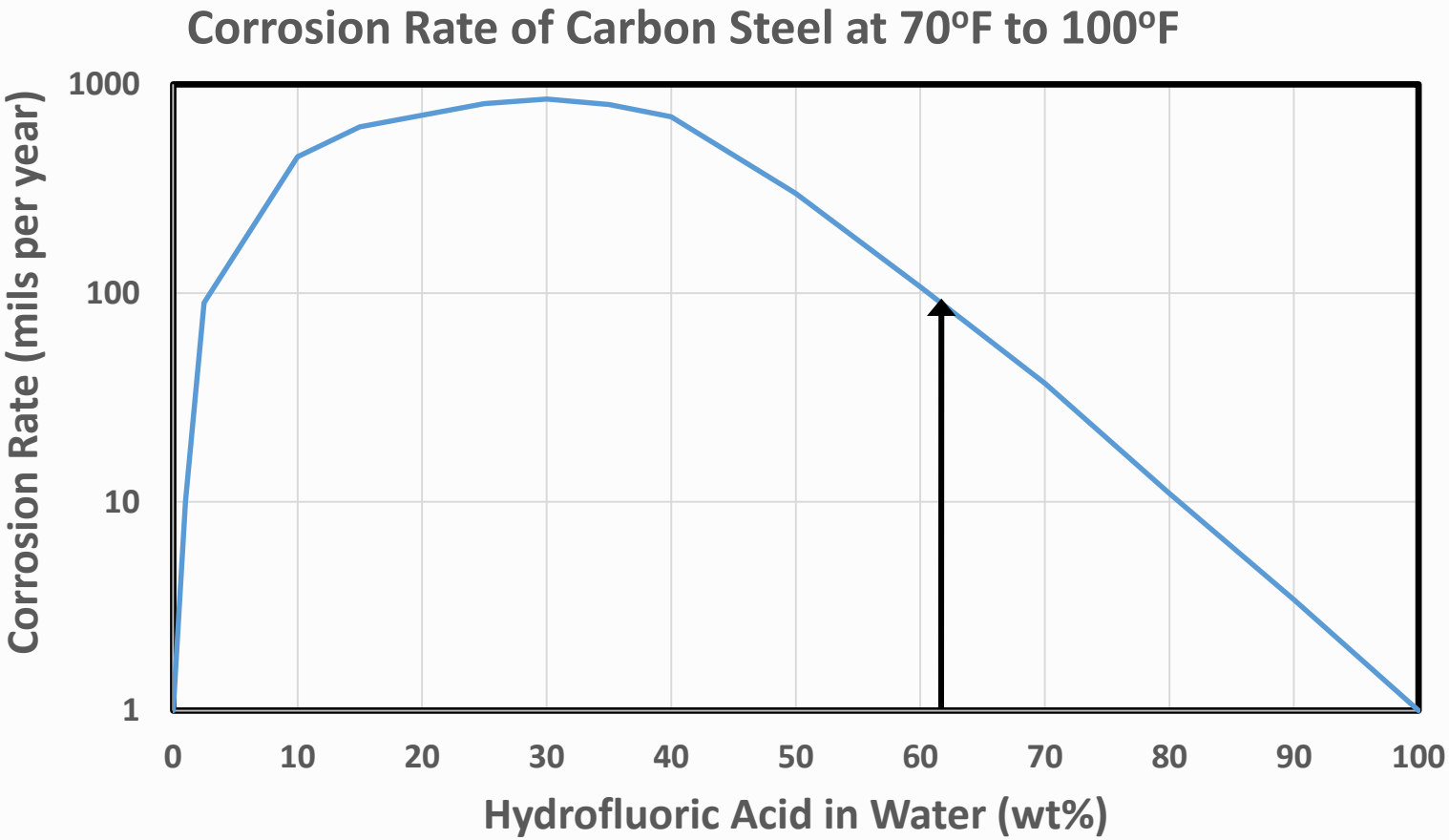
Varying HF Entrainment



iC4 Side Draw Condensation



Corrosion Rate at Acid Dew Point



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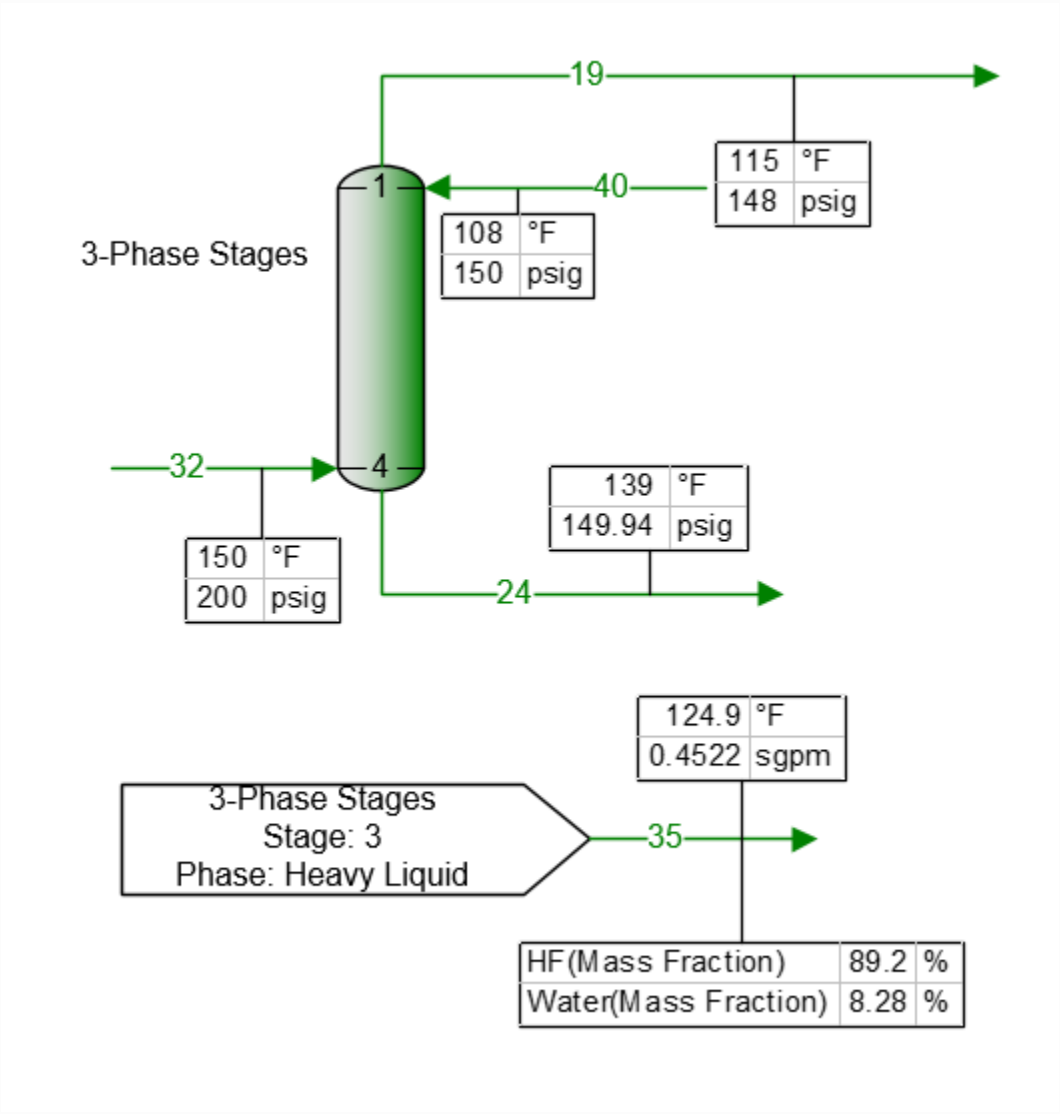
Conclusions and Recommendations

- Acid Carryover from Acid Settler to Isostripper produces 3rd phases on column stages.
- Stage HF/H_2O compositions in 3^{rd} phases predict high corrosion rates in Cooled iC4 Side Draw.
- Should validate model by performing a similar study on an Isostripper having flow measurement off acid boots.

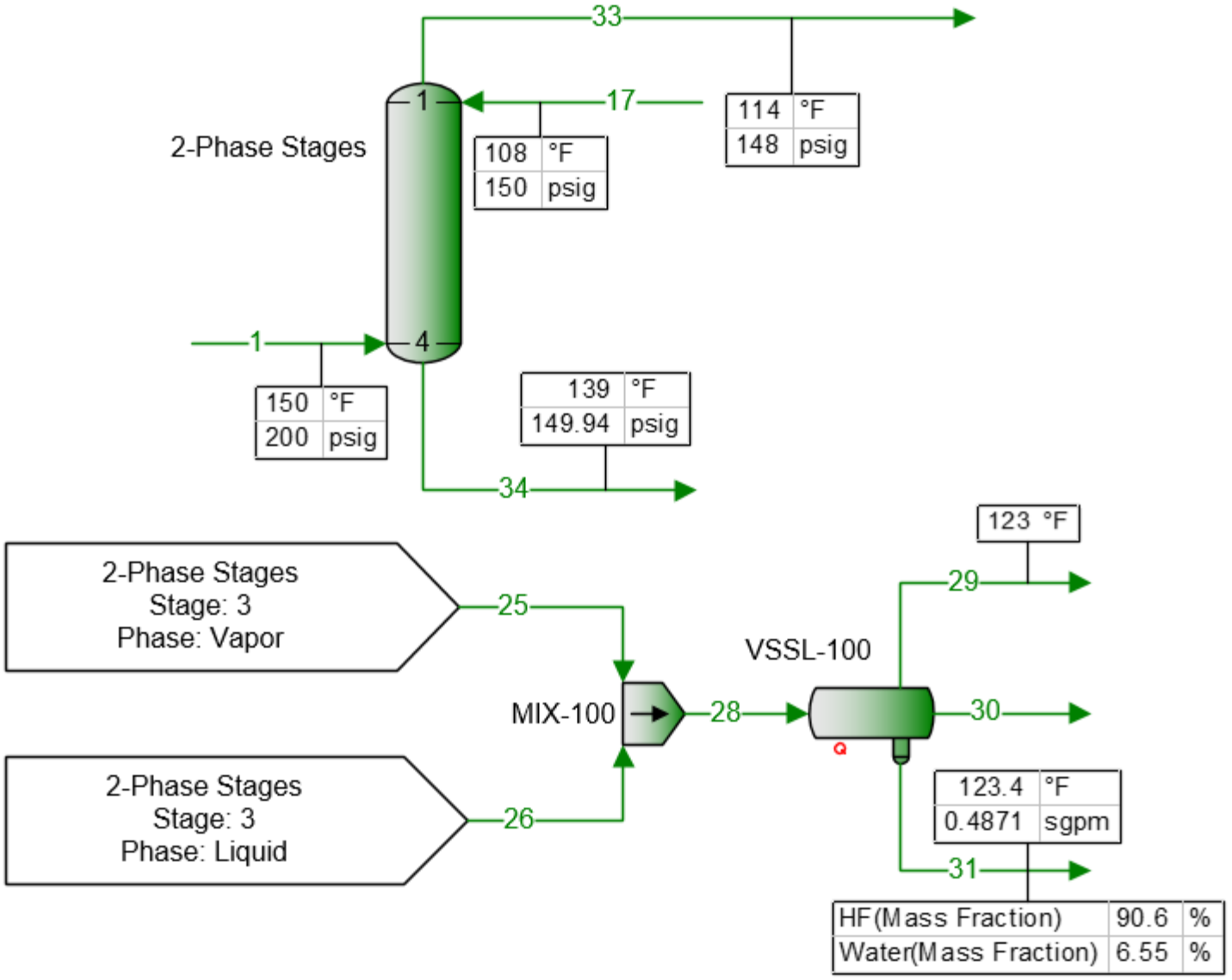
Thank You!

Questions?

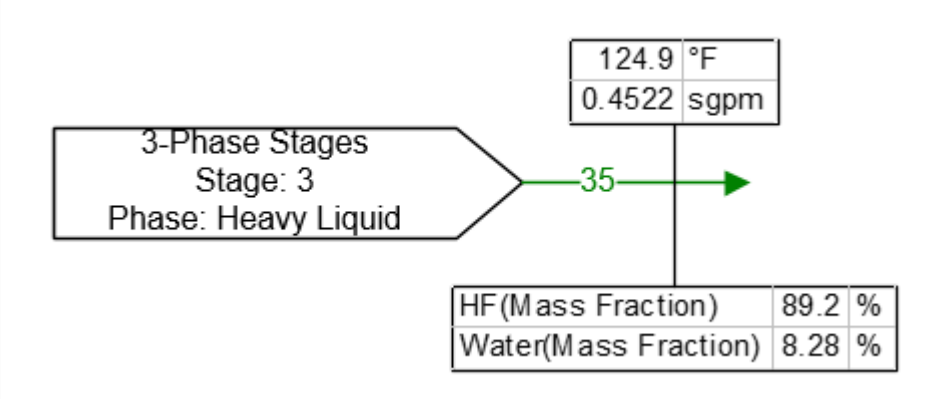
3-Phase Stages

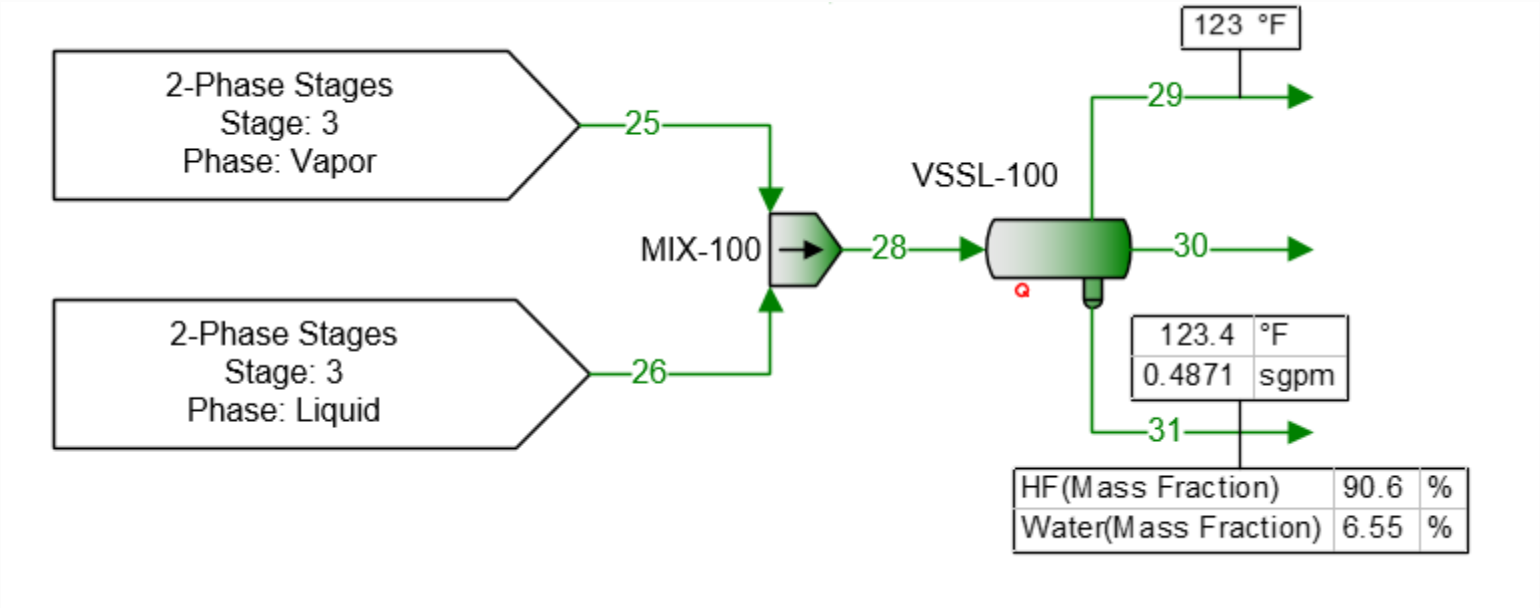


2-Phase Stages



Comparison


124.9 °F
0.4522 sgpm
3-Phase Stages
Stage: 3
Phase: Heavy Liquid
35
HF(Mass Fraction) 89.2 %
Water(Mass Fraction) 8.28 %


123 °F
2-Phase Stages
Stage: 3
Phase: Vapor
25
29
VSSL-100
MIX-100
28
30
2-Phase Stages
Stage: 3
Phase: Liquid
26
123.4 °F
0.4871 sgpm
31
HF(Mass Fraction) 90.6 %
Water(Mass Fraction) 6.55 %