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Process simulation based optimization of a commercial amine gas sweetening unit

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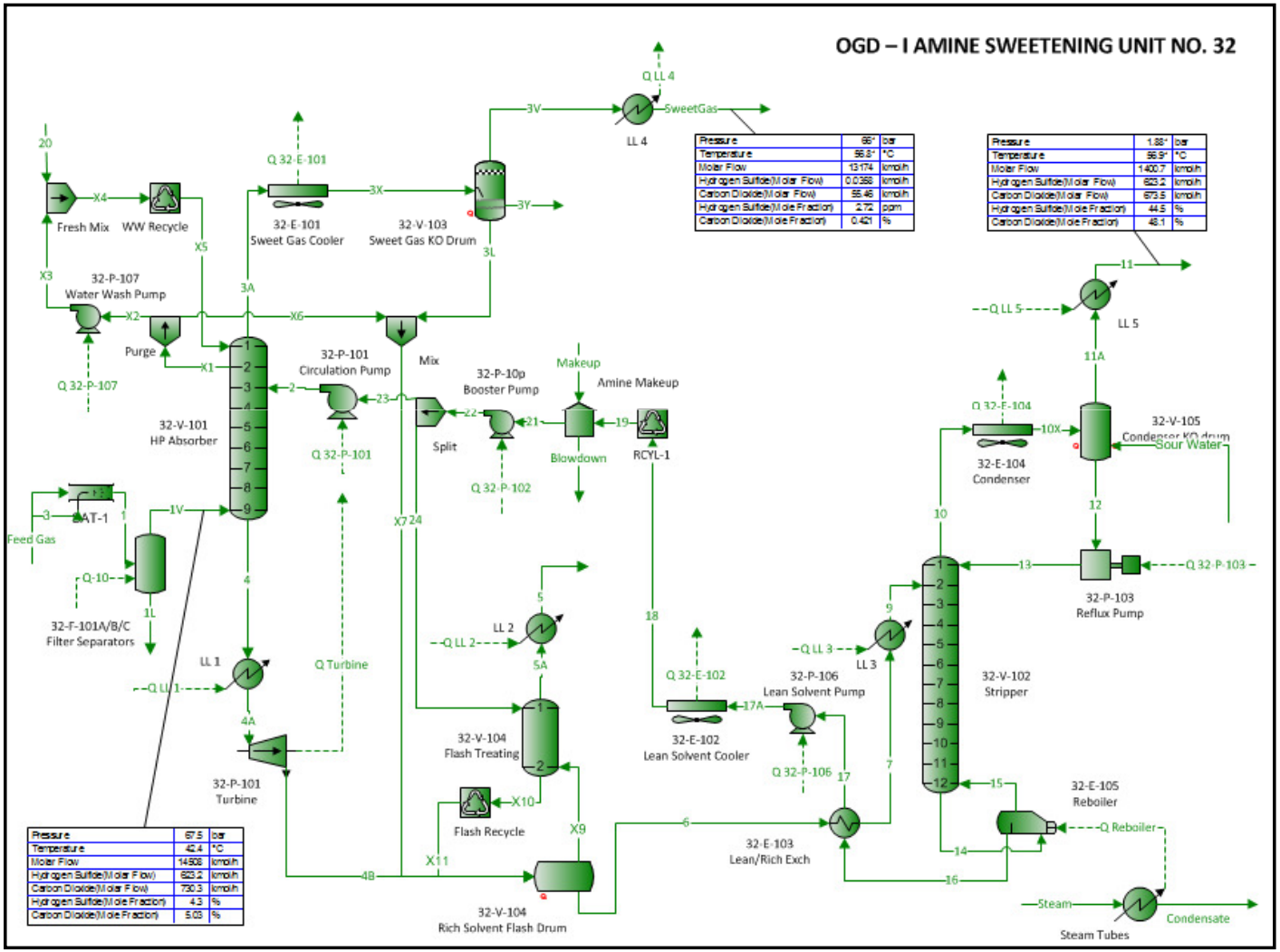
Outline

- Introduction
- Process simulation model
- Customization of the model
- Validation with plant data
- Optimization analysis

Introduction

- Amine sweetening unit #32, Habshan I, GASCO, Abu Dhabi, UAE
  - Sour gas: H_2S ~ 7% and CO_2 ~ 6%
  - Capacity – 400 MMSCFD
  - Generic MDEA
- Process simulation model development
  - ProMax V 3.2
  - TSWEET kinetics model
  - Amine sweetening SRK

Process simulation model



Customization of simulation model

- Reaction chemistry

$R_2NCH_3 + H_2S \leftrightarrow R_2NCH_4^+ + HS^-$ (Instantaneous)

$CO_2 + H_2O + R_2NCH_3 \leftrightarrow R_2NCH_4^+ + HCO_3^-$ (Slow)

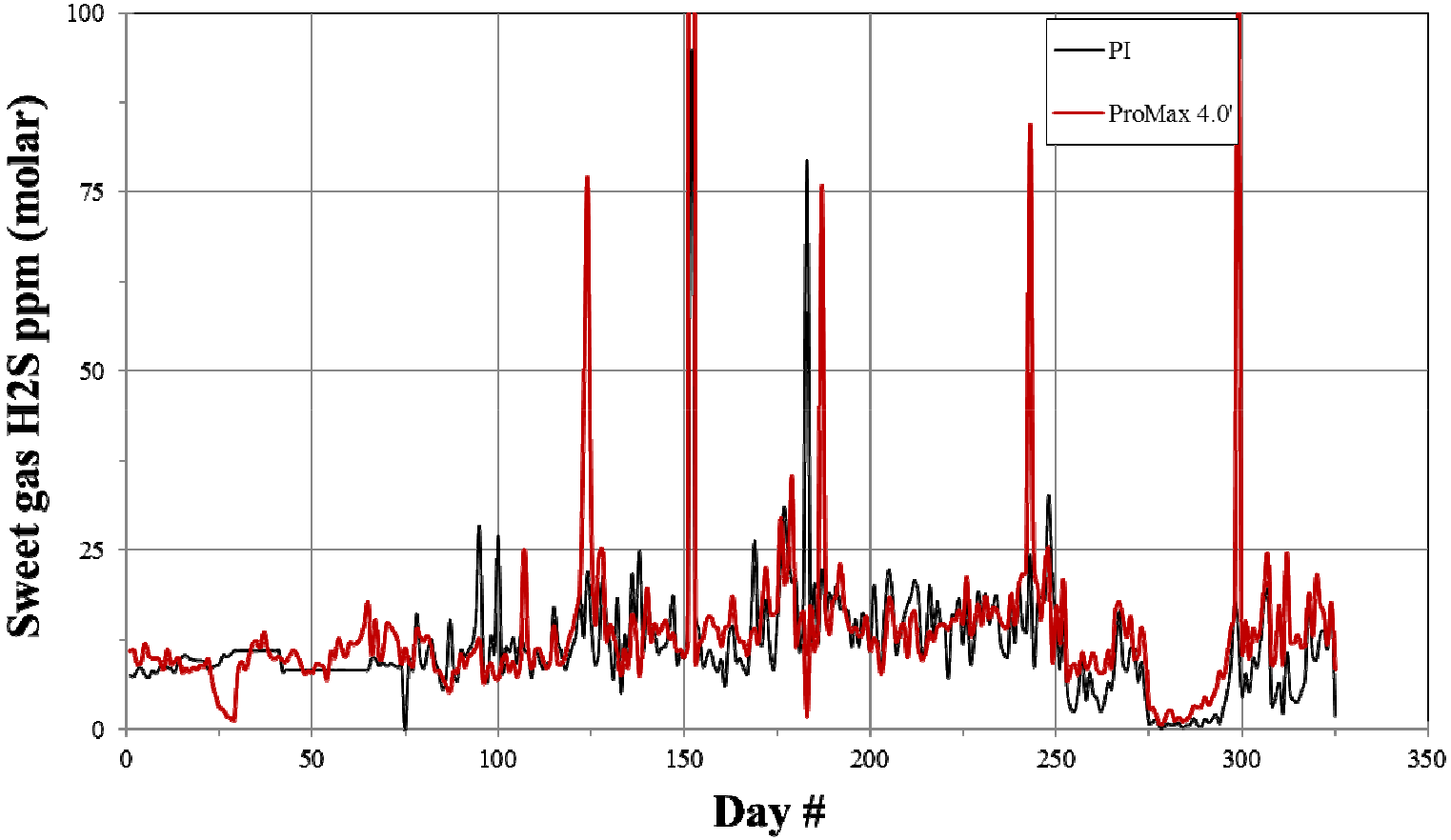
- TSWEET kinetics models
  - Sweet gas H_2S & CO_2 = f (Sour H_2S, CO_2, T, P, Residence time)
  - Developed using wide range of operating data of **various plants**

- Customized TSWEET kinetic models
  - Developed using operating data of a **specific plant**

Customization of simulation model

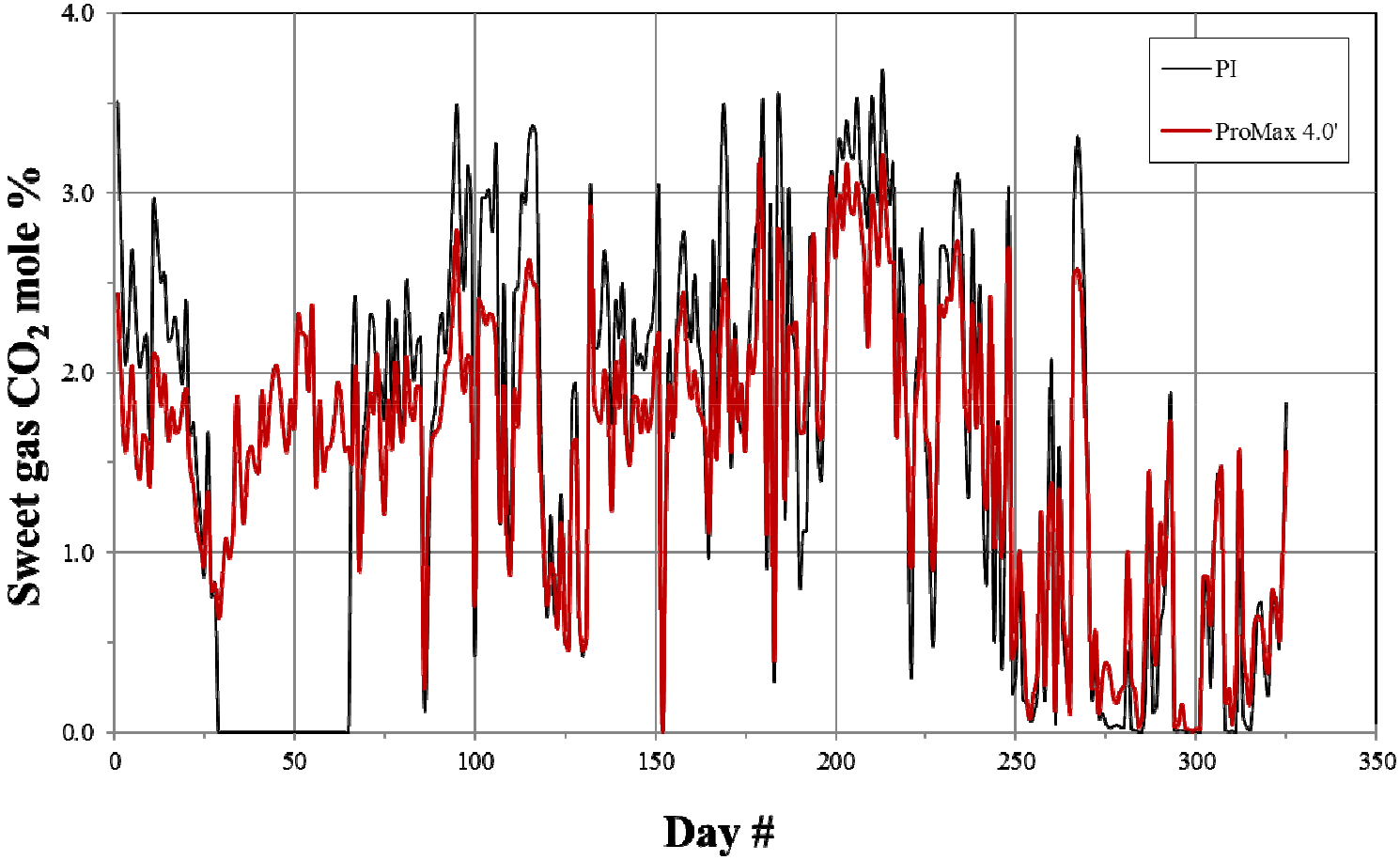
- Assign data to ProMax existing model
- Identify properties of data that differs from plant data
- Provide constraint to the kinetic model in accordance with the trend
- Run new ProMax model
- Verify new data against plant data

Validation of customized simulation model



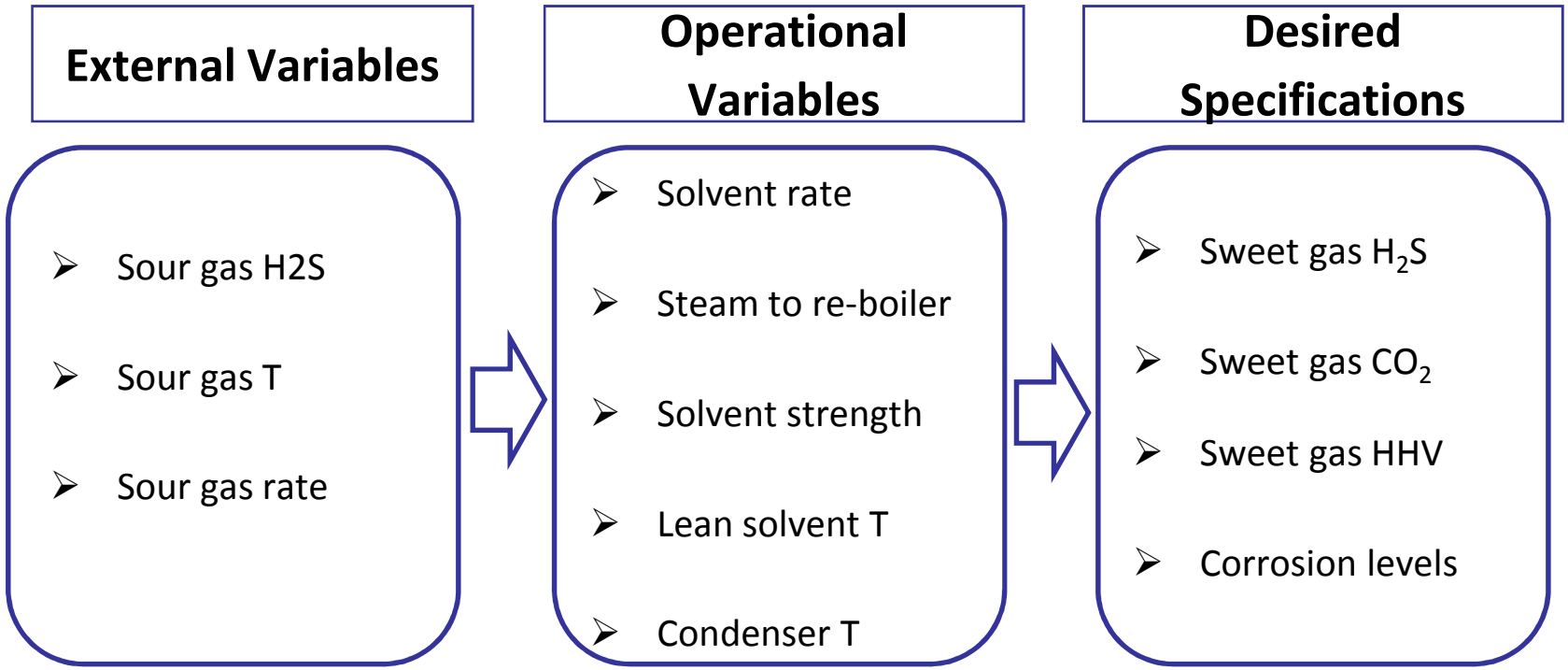
Average sweet gas H_2S prediction error – 2.8 ppm

Validation of customized simulation model



Average sweet gas CO_2 prediction error – 0.17%

Optimization - Operational changes



Optimum set of 'operational variables' is the key for efficient plant performance

Operating conditions' significance

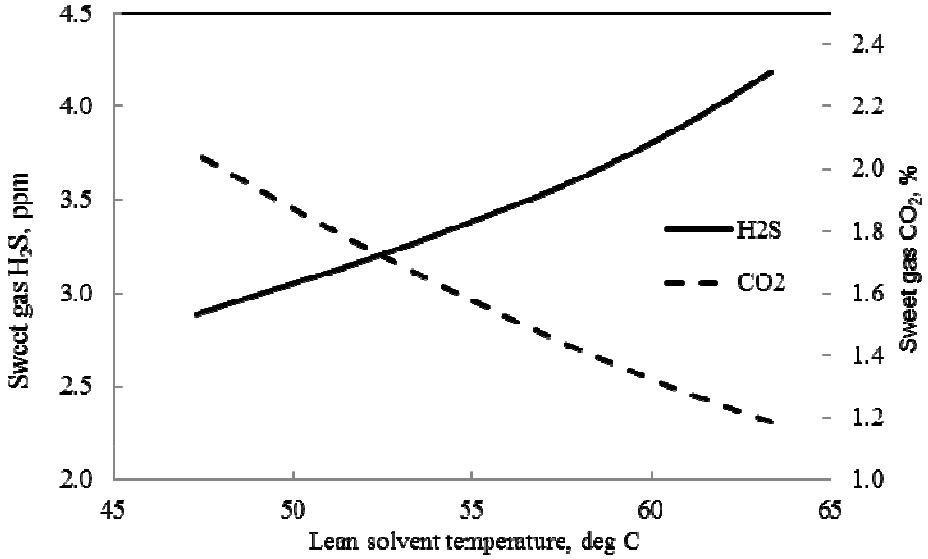
- Solvent circulation rate
  - Sweet gas specs
  - Rich amine loading (Corrosion on absorber-flash drum piping)
  - Pumping energy

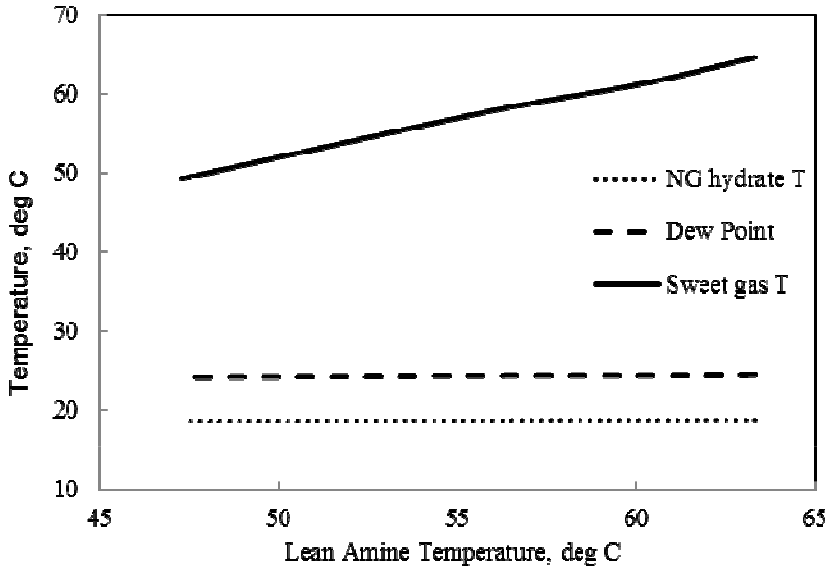
- Steam rate
  - Sweet gas specs
  - Lean amine loading (Corrosion in re-boiler and piping)

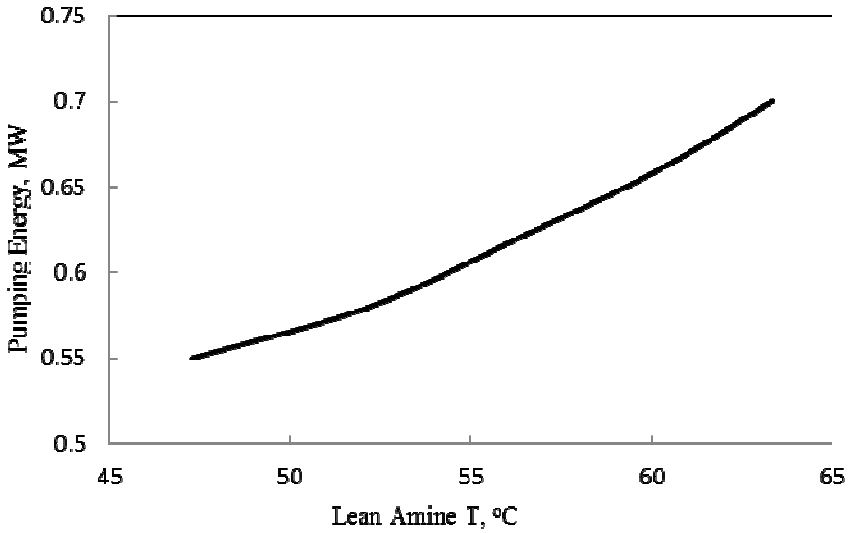
- Lean amine temperature
  - Increased H_2S absorption with CO_2 slip
  - Reduced load on dehydration
  - Foaming and hydrate risks

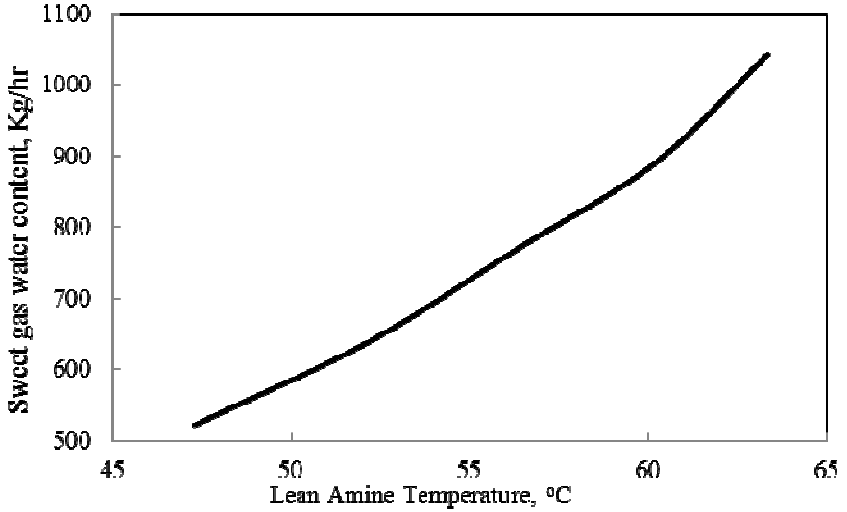
- Solvent concentration
  - Decreases solvent circulation rate
  - Corrosion effects

Lean solvent temperature





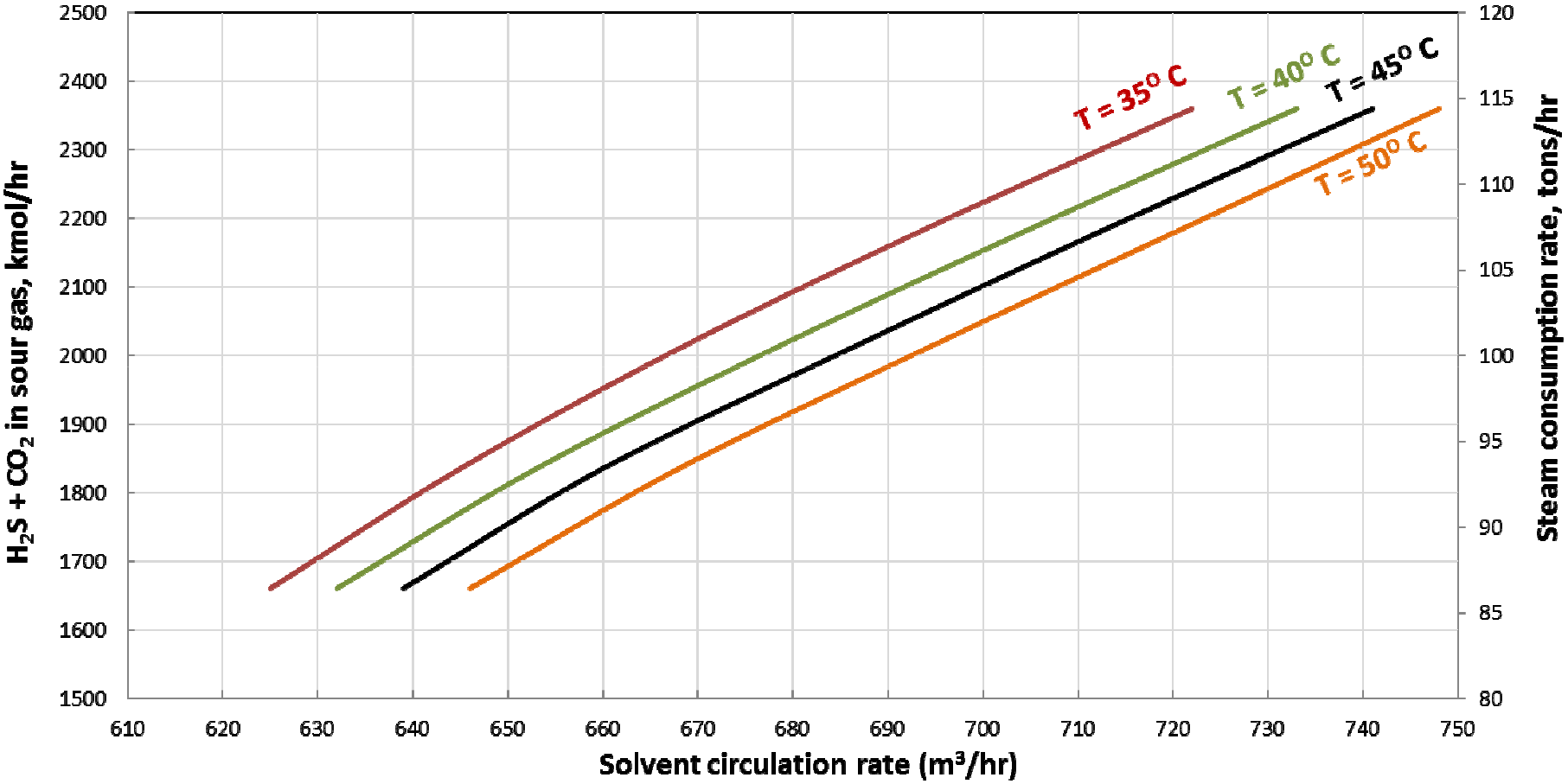




Optimized operating conditions

Parameter	Operating case	Proposed case
Lean solvent temperature, °C	59	47.3
Solvent circulation rate, m^3/hr	785	630
Steam consumption rate, tons/hr	117	91
Lean solvent concentration, %	42.4	50
Condenser temperature, °C	32	55
Sweet gas H_2S, ppm	4	4
Sweet gas CO_2, %	1.4	2.0
Lean solvent cooler load, MW	44	39
Pumping load, MW	0.70	0.55
Hydrate formation temperature, °C	18.7	18.6
Hydrocarbon dew point, °C	24.4	24.1
Sweet gas temperature, °C	60.4	49.3
Sweet gas H_2O content, kg/hr	858	522

DCS look up tables

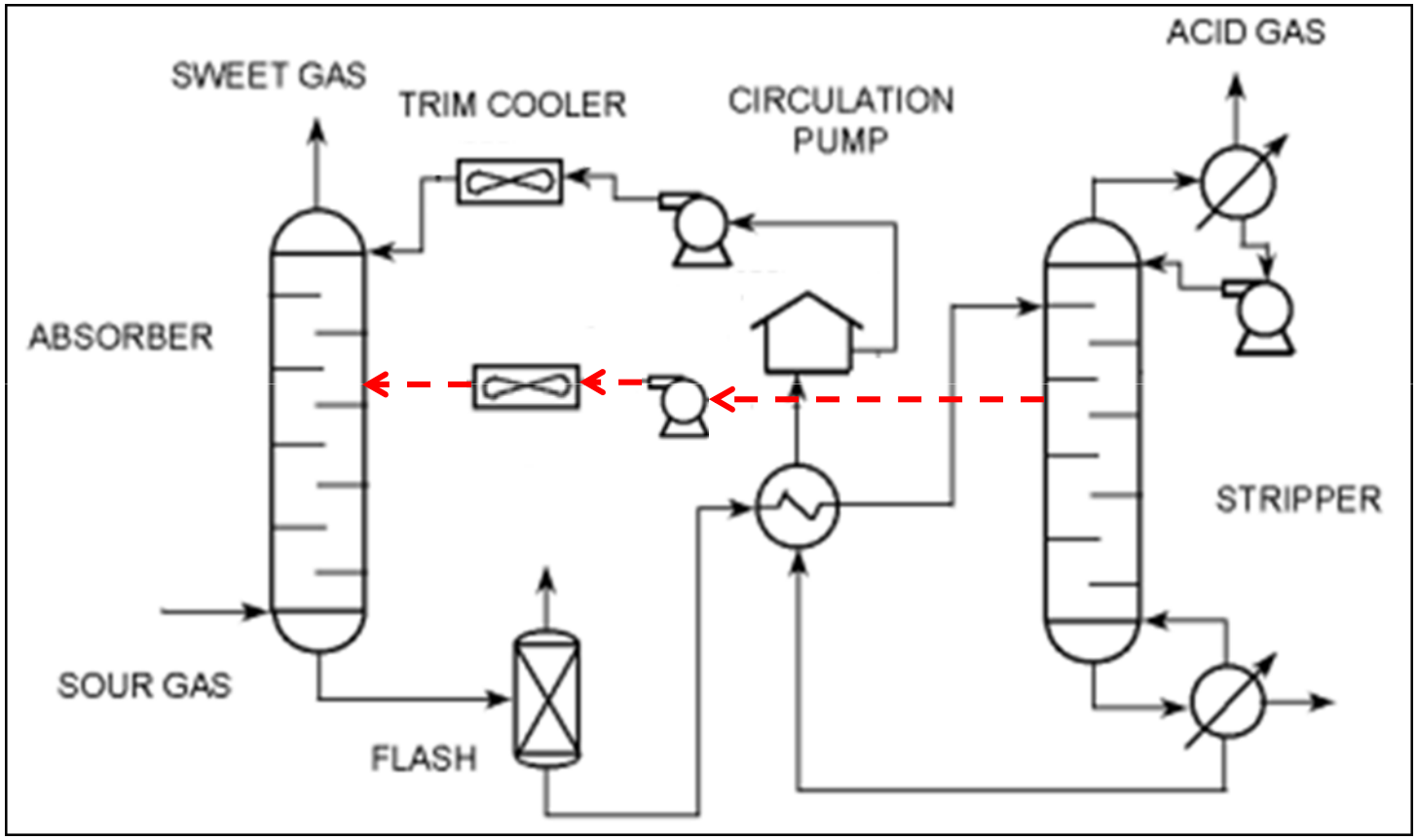


Solvent rate and steam rate as function of sour gas H_2S+CO_2 contents and sour gas temperature

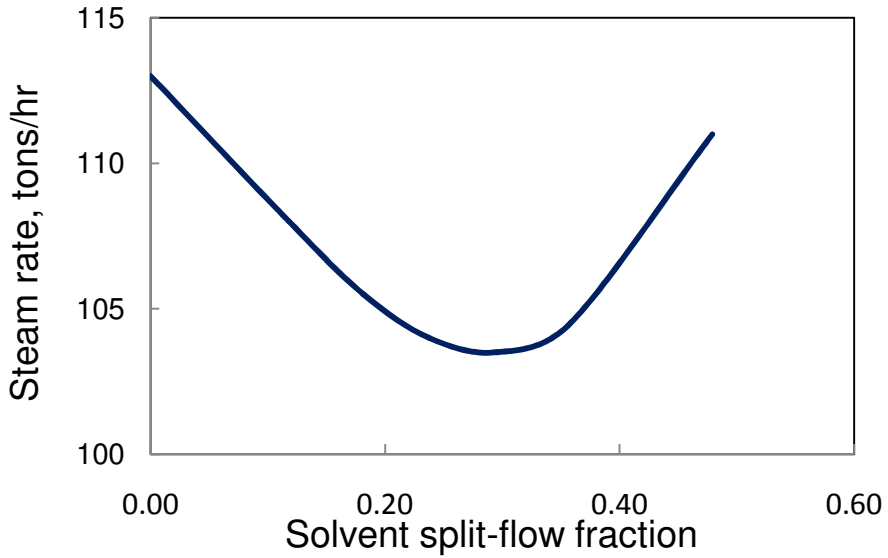
Optimization - Structural changes

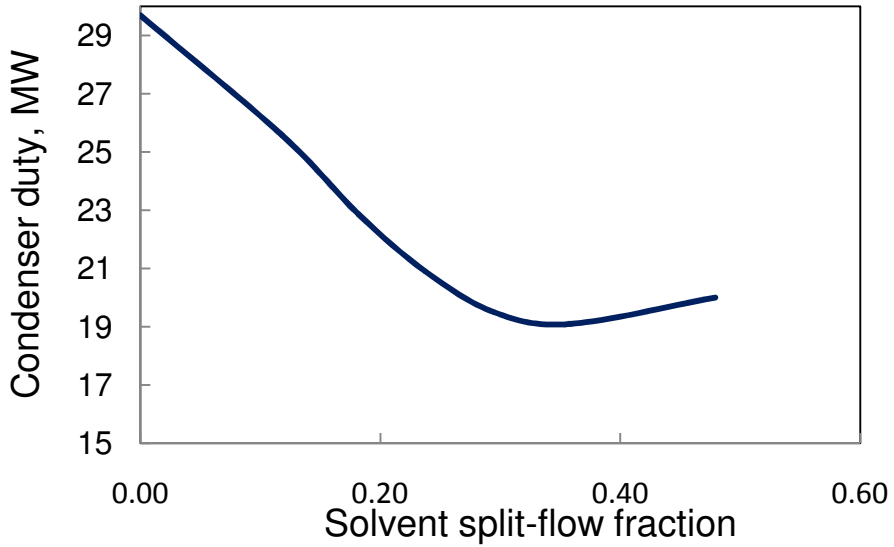
- Split-flow configuration
- Multiple absorber feeds
- Semi lean solvent recycle
- Heat integration (Rich Lean HX – Condenser loop)
- Mixed solvents

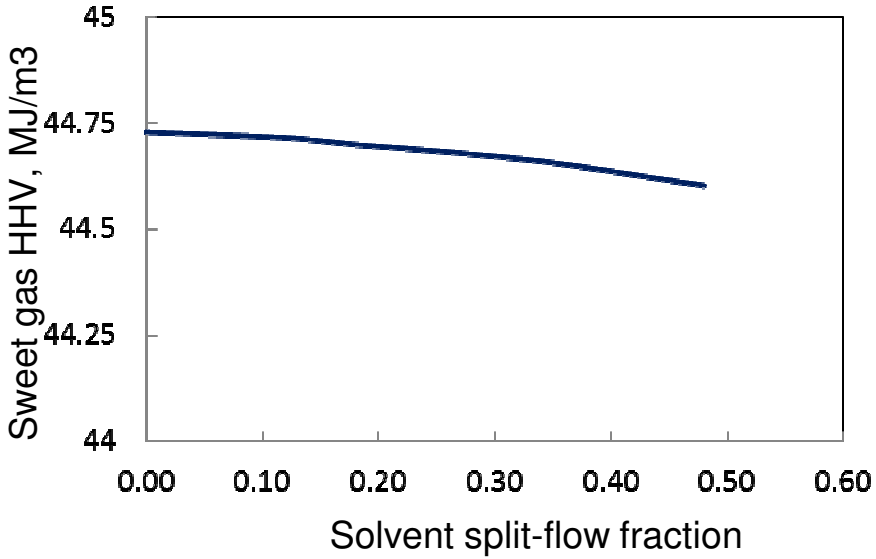
Split-flow configuration

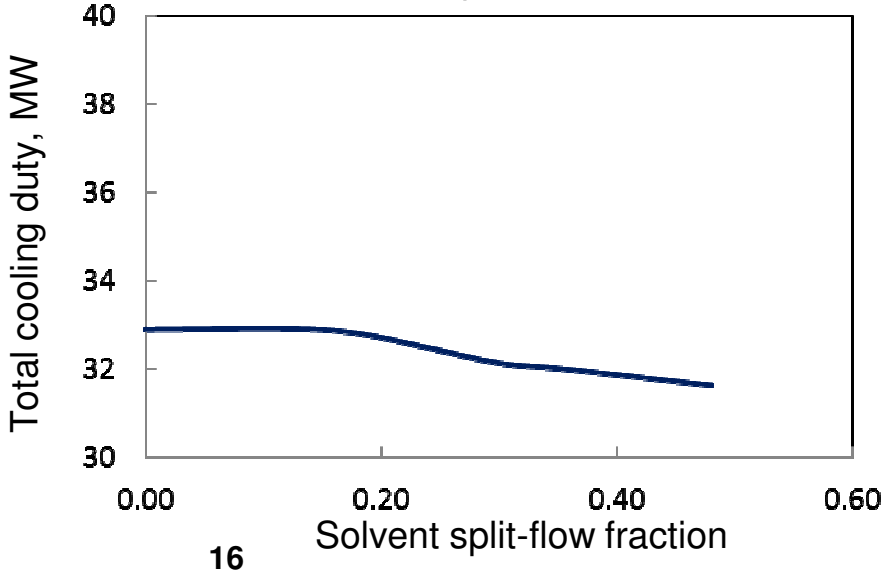


Split-flow configuration - Results









Summary

- Process simulation analysis of a commercial amine sweetening unit was performed
- Customized simulation model was developed with tailor-made kinetics correlations and property packages
- Model was validated with operating data over a period of one year
- DCS look up tables were developed to provide guidelines on optimum operating conditions
- Optimization analysis was performed by investigating various operational and structural changes

THANK YOU