Feedback on CAPE-OPEN use in implementing Gas Treatment components

S. Gonnard, L. Pigeon
Content

IFP Energies nouvelles in brief

Context and Objectives
- Gas Treatment
- Amine based process for gas sweetening
- Desulfo+ Project

Implemented components
- Unit Operations
- Thermo system and Physical Properties Package (PPP)
- Advanced development

Conclusion
IFP Energies nouvelles in brief

- Public-sector research, innovation and training center
- In the fields of energy, transport and the environment
- Five strategic priorities
  - Renewable energies
    - Producing fuels, chemical intermediates and energy from renewable sources
  - Eco-friendly production
    - Producing energy while mitigating the environmental footprint
  - Innovative transport
    - Developing fuel-efficient, environmentally-friendly transport
  - Eco-efficient processes
    - Producing environmentally-friendly fuels and chemical intermediates from fossil resources
  - Sustainable resources
    - Providing environmentally-friendly technologies and pushing back the current boundaries of oil and gas reserves
Content

- IFP Energies nouvelles in brief
- Context and Objectives
  - Gas Treatment
  - Amine based process for gas sweetening
  - Desulfo+ Project
- Implemented components
  - Unit Operations
  - Thermo system and Physical Properties Package (PPP)
  - Advanced development
- Conclusion
Natural Gas Processing

- **Gas treating**
- **Gas conditioning**
- **Sulfur recovery**

**Natural Gas** + Water, oil, solid ...

**First Separation**

**GOSP**

**Sweetening Process**
- Amines
  - Physical solvents
    - Dry beds, Redox, ...

**Dehydration unit**
- Physical Solvents: Glycols, Adsorption

**Sulfur Removal Unit**
- Claus unit
  - Tail gas treatment unit

**CO2** → **H2S**

**Natural Gas** → **Dry gas**

**Gas Liquids recovery**
- NGL extraction
  - NGL fractionation

**Gas Liquefaction**

**LNG**

**Sales gas**

- Ethane
- Propane
- Butane
- Gasoline

**Residual Water**

**Water, Oil, Solid**

**Sweet Gas**

- **Sales gas**
  - **Ethane**
  - **Propane**
  - **Butane**
  - **Gasoline**

- **Sweet Gas**
  - **Physical Solvents**: Glycols, Adsorption

- **Dry beds, Redox, ...**

- **Sour Gas**

- **CO2**

- **H2S**

- **Elemental Sulfur**
Amine based process for gas sweetening

- **Treated gas**
- **Fuel Gas**
- **Acid Gas**
- **Lean Amine**
- **Absorber Column**
- **Stripper Column**

Flow diagram shows the process sequence from raw gas to treated gas.
Desulfo+ Project: Advamine™

**Partnership**

- **TOTAL**
  - Engages in all aspects of the petroleum industry
    - Upstream operations (oil and gas exploration, development and production, LNG)
    - Downstream operations (refining, marketing and the trading and shipping of crude oil and petroleum products).
    - One of the world’s largest integrated chemical producers

- **PROSERNAT**
  - Subsidiary of HEURTEY PETROCHEM and IFP Energies Nouvelles
  - Supplies equipments and technologies to natural gas industry
    - Process Licensor of Acid Gas Removal units and Sulfur plants
    - Supplier of Modular Units in O&G Processing facilities
Desulfo+ Project: Advamine™

- **What is Desulfo+**
  - Amine based processes for gas sweetening simulator
  - Inclusive of mass transfer rate-based models for acid gas reactions with liquids
  - Upgraded version of in-house software “Desulfo”, initially developed by TOTAL
  - Models rated by more than 40 years experience of plant operation and process data from on-running Gas Sweetening Units

- **Existing Standalone software "Desulfo"**
  - Implemented in Fortran
  - No user interface (input and output as keywords file)
  - No interoperability with other process tools

- **Existing software needs:**
  - More user-friendly GUI
  - Advanced features (eg. controller / optimizer / reporting / ...)
Desulfo+ Project: Advamine™

Why CAPE-OPEN Standard?

- Interoperability with process tools
- Portability in most of process simulation environment
- Modularity / Maintainability

New software "Desulfo+"

- Keeps the proprietary models from Desulfo
- Uses the PME Interfaces for input (GUI) and outputs (reporting facilities)
- Uses some native UO from PME (Flash drum, HX, Pumps, ...)
- Offers more interoperability with other process tools
Desulfo+ in simulation of amine based process

Mass transfer model interfaced with thermodynamics:
- Consider thermal transfer models
- Consider rated calculations of hydraulics on various types of tower internals
Desulfo+ Project – Integration in PROII

Absorber

Regenerator

Reboiler Computation

Water Make up Computation
Content

- IFP Energies Nouvelles in brief
- Context and Objectives
  - Gas Treatment
  - Amine based process for gas sweetening
  - Desulfo+ Project

- Implemented components
  - Unit Operations
  - Thermo system and Physical Properties Package (PPP)
  - Advanced development

- Conclusion
Implemented Components

- **Unit Operations**
  - Regenerator
  - Absorber

- **Thermo System / Physical Property Package (PPP)**
  - Extended in-house thermodynamic server (CARNOT)
  - Delegate equilibrium computation to PME built-in thermo using properties computed by our PPP
  - CAPE-OPEN thermodynamics v1.0
Unit Operations

Absorber

- **3 input ports**
  - Raw Gas (mandatory)
  - Lean Amine (mandatory)
  - Other Amine (optional)

- **3 output ports**
  - Treated Gas (mandatory)
  - Rich Amine (mandatory)
  - Draw off (optional)
Unit Operations

Regenerator

- **3 input ports**
  - Rich Amine Gas phase (mandatory)
  - Rich Amine Liq. phase (mandatory)
  - Reflux (mandatory)

- **3 output ports**
  - Acid Gas (mandatory)
  - Lean Amine (mandatory)
  - Draw off (optional)
Interoperability within PME

- **PRO/II (Invensys)**
  - Begin project with v8.x
    - Some CAPE-OPEN defects
  - Currently, using Pro/II v9.1.1
    - Better CAPE-OPEN compliance

- **Aspen HYSYS (AspenTech)**
  - Tests in progress with v7.3
Advanced Development

- **Performance**
  - Cached computation in calcProp from PPP
    - No computation if input thermodynamics conditions are the same

- **Dynamic ports**
  - Pro/II allows dynamic ports management on editing UO GUI

- **Future developments**
  - Multithreading
Feedback

- Not so difficult
  - Business approach (Modular in terms of business entities)
  - Only few methods to implement
  - Some tools to spy on what happen (eg, COLTT)

- Not so easy
  - Integration into black box software
    - Where is the bug?
  - How to implement specifications?
  - Management of supporting industrial simulator, itself under upgrade and delivery of new releases of CAPE-OPEN compliant simulator
  - Delay to fix bugs if from third-party supplier
    - Not same delay from owner company (few days) to third-party (few months)
Content

- IFP Energies nouvelles in brief
- Context and Objectives
  - Gas Treatment
  - Amine based process for gas sweetening
  - Desulfo+ Project
- Implemented components
  - Unit Operations
  - Thermo system and Physical Properties Package (PPP)
  - Advanced development
- Conclusions and perspectives
Conclusions and perspectives

- IFPEN and its partners have developed models and tools for Amine based processes for Gas Sweetening simulation
  - Based on CAPE-OPEN Standard
  - Gain
    - User Friendly software
    - Improved flexibility to implement adds
  - Difficulties
    - Interface with third party supplier and management of support software
    - Need lot of time
      - Development / Testing (compare to monolithic codes)
Conclusions and perspectives

■ Perspectives
  ■ Use in design of gas sweetening plants & analysis of industrial logs
  ■ New developments
    ▪ New Unit Operations models
    ▪ New Thermodynamic models
    ▪ Multithreaded computation
  ■ Portability studies (Aspen Plus, ProSimPlus, ...)

© 2012 - IFP Energies nouvelles
Innovating for energy

www.ifpenergiesnouvelles.com