Process Optimization Using Simulation and Integrated Economics

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By
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Kuwait Oil Company
• Knowledge Management
• Define the Problem
• Root Cause Analysis and Why-Why Analysis of Functional Failure
• Define Revamp Scope
• Case Study Review
  – Revamp Scope
  – Gas Dehydration Package Replacement
• Techno-Economic Evaluation and Comparison
  – Revamp Project
  – Gas Dehydration Package Project
• Project Optimization through Best Process Selection
  – Value through Innovation
  – Value through Engineered Solutions by using Aspen Process Economic Analyzer
• Q&A
Knowledge Management

- Techno-Economic Evaluation of Process (Comparison of Different Methods at Conceptual Level)
- Identification of Different Process (Conceptual Level)
- Root Cause Analysis
- Why-Why analysis
- Define the Problem
- Selection of feasible project (Conceptual Level)
- Approval for Initiating CPP
Define the Problem

- **Defect**
  - Higher glycol consumption in Gas Dehydration unit due to functional failure of the system.

- **Opportunity**
  - To minimize the higher glycol consumption by revamping of the facilities.
Knowledge Management

• Techno-Economic Evaluation of Process (Comparison of Different Methods at Conceptual Level)

• Identification of Different Process (Conceptual Level)

• Root Cause Analysis
  • Why-Why analysis

• Selection of feasible project (Aspen HYSYS & Economic Evaluation) (Conceptual Level)

• Approval for Initiating CPP

• Define the Problem
Root Cause Analysis

GAS DEHYDRATION UNIT FUNCTIONAL FAILURE

Re-boiler Temperature/Glycol Cooler Duty
- Why higher glycol losses through Regeneration Section?
- Why Glycol Losses through Re-boiler Operation?

Losses through still column
- Why Re-boiler Temperature is High?
- Why reboiler temperature influencing the glycol losses

Losses through Regeneration flash drum
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Losses along with Gas as a Carryover & Higher Water content in the Dry Gas
- Why reboiler temperature influencing the glycol losses

Higher Gas inlet Temperature
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Constant Glycol circulation Rates
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

PCV operation Failure.
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Still column temperature maintained as per design conditions.
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Glycol losses noticed but unable to captured in After scrubber
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Losses through Regeneration flash drum
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Gas Cooler unable to cool to the required temperature as some tubes were plugged.
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Re-boiler Temperature/Glycol Cooler Duty
- Why higher glycol losses through Regeneration Section?
- Why Glycol Losses through Re-boiler Operation?

Why higher glycol losses through Regeneration Section?
- Why higher glycol losses through Regeneration Section?
- Why Glycol Losses through Re-boiler Operation?

Why Glycol Losses through Re-boiler Operation?
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Why reboiler temperature influencing the glycol losses
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Higher reboiler operating temperature.
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Inefficient Differential temperature
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature

Higher Gas Inlet temperature
- Why reboiler temperature influencing the glycol losses
- Inefficient Differential temperature
- Higher Gas Inlet temperature
Knowledge Management

- Identification of Different Process (Conceptual Level)
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- Define the Problem
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Conceptual Simulation
Gas Dehydration for Case -A

Glycol Re-generation
Revamp Project Scope

- **Cause #1**: Replacement of existing bubble cap trays of glycol contactors with structured packing along with associated packing supports
- **Cause #2**: Installation of new liquid distributor in the absorber
- **Cause #3**: Replacement of stripping column and still column internals
- **Cause #4**: Replacement of sock filters with cartridge filters
- **Cause #5**: Replacement of mist eliminators for glycol contactor, flash drum & replacement of vanes for after scrubbers
- **Cause #6**: Additional scope like NACE MR O175 material compliance

Note: These scope items arose from root cause analysis
Conceptual Simulation
Gas Dehydration for Case -B

Gas Dehydration Unit package complete replacement
New Gas Dehydration Unit Replacement Project Scope

Cause #1
- Installation of new Gas dehydration Unit package

Cause #2
- To ensure highest reliability

Cause #3
- To have only the Tie-in Shutdown period (Minimize loss of production)
Knowledge Management

- Identification of Different Process (Conceptual Level)
- Root Cause Analysis
- Why-Why analysis
- Define the Problem
- Selection of feasible project (Aspen HYSYS & Economic Evaluation) (Conceptual Level)
- Approval for Initiating CPP
- Techno-Economic Evaluation of Process (Comparison of Different Methods at Conceptual Level)
Case Study “A” – Revamp

Scope:
• Revamp of Gas Dehydration Unit
• Capital cost estimation (conceptual stage)

Revamp Objectives:
• Objectives arrived at through a Root Cause Analysis process
• Reduce water content of the dry export gas
  – Current design level of 15 deg C Dew Point
  – Target as low as 4 deg C Dew Point
• Reduce combined glycol losses from the glycol contactor and glycol regeneration unit to 0.1 gallon (US) / MMSCF
Methodology and Results:

• Revamp life assumed for a period of 20 years
• Capital cost of the revamp project estimated at US $4.23 MM/Train
• OPEX estimated at US $2.18 MM/yr (chemicals & spare parts only)
• Aspen Process Economic Analyzer and Weibull++ applications used to identify the CAPEX, OPEX (includes spare parts, reliability and probability for the upcoming 20 year life period and failure rates)
• Revamp project requires further added maintenance costs to meet required reliability of 98% +
• Initial reliability will be higher.
• However, during its life span (20 years) the asset will need additional maintenance support to counter the reliability trend.
Probability vs. Time (20 Years)

Top Confidence Limit

Failure Probability

Bottom confidence Limit
Scope:
• Gas Dehydration Unit total new package replacement
• Package capital cost estimation (conceptual stage)

Methodology:
• Use Aspen HYSYS and its integrated costing capabilities with Aspen Economic Evaluation
• Aspen Process Economic Analyzer used to estimate CAPEX and OPEX
• Process engineers to evaluate the economic impact by selecting the appropriate converged Aspen HYSYS designs
Case Study “B” – Replacement Aspen Economic Analysis

Gas Dehydration Unit Total New Package Replacement Cost Estimation (Conceptual Stage)
Aspen Process Economic Analyzer (APEA)

• **Features**
  – Interactive equipment sizing to determine operating costs and investment analysis.
  – Automatic generation of block and process flow diagrams from the process stream information.
  – Integrated with Aspen HYSYS.

• **Benefits**
  – Evaluate lifecycle business impact of design alternatives in the early phases of conceptual design
  – Generate operating costs to quantify a plant’s business contribution
## EXECUTIVE SUMMARY

<table>
<thead>
<tr>
<th>PROJECT NAME:</th>
<th>09_TEGDEHYDRATION -relative economics</th>
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<tbody>
<tr>
<td>CAPACITY:</td>
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<td>PLANT LOCATION:</td>
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### SCHEDULE:
- Start Date for Engineering: 1-Jan-12
- Duration of EPC Phase: 20
- Completion Date for Construction: Friday, May 22, 2012
- Length of Start-up Period: 20

### INVESTMENT: (USD)

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<td>Total Operating Cost</td>
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<td>Total Raw Materials Cost</td>
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<td>P.O. Period</td>
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### PROJECT INFORMATION:

- Simulator Type: Aspen HYSYS
- Version: Aspen HYSYS Version 7.2 (24.0.0.7263)
- Report File: C:\KOC\09_TEGDEHYDRATION -relative economics.hsc
- Report Date: Tuesday, March 22, 2011
- Economic Analysis Type: IPE
- Version: 18.0.1
- System Cost Base Date: 1Q 09
- Project Directory: C:\INCIDENTS\k\KOC\09_TEGDEHYDRATION -relative economics\Scenario1
- Analysis Date: Tue Mar 22 11:39:47 2011
- Country Base: US
- Project Type: Grass roots/Clear field
- Design code: ASME

### NOTES:

Source: Aspen HYSYS V7.2 and Aspen Process Economic application
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**1.5 MM US $/ Day**

**Case Study Conditions**

1. BS-140 Running machine shutdown and non-availability of standby train for 12 hrs
2. Gas Export loss observed at 110 MMSCFD
3. BS-140 gas export composition used
4. Gas price considered at $ 102 / MMBTU
Case B is a more powerful option to meet Business Process Objectives.
Knowledge Management

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Optimized Process Selection (Between Two Cases)

CASE "A"

UNIT REVAMP PROJECT

- Total Cost: US$ 37.94 Million
- US$ 31.5 Million, 83%
- US$ 2.18 Million, 6%
- US$ 4.23 Million, 11%

CASE "B"

TOTAL PACKAGE REPLACEMENT PROJECT

- Total Cost: US$ 14.4 Million
- US$ 10.5 Million, 73%
- US$ 2.72 Million, 19%
- US$ 1.21 Million, 8%

The Best Suitable Process
Aspen HYSYS and Aspen Process Economic Analyzer utilized to achieve optimized project selection results with less capital expenditure.

Cost comparative study showed selecting new complete package is highly advisable.

Aspen Process Economic Analyzer helped to define project scope of work more accurately by integrating with operating cost, capital cost, and schedule.
Knowledge Management

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Project Life Cycle

Influence - Expenditures

Major Influence  Rapidly Decreasing Influence  Low Influence

Aspen HYSYS and Aspen Process Economic Analyzer will have more influence
Project Life Cycle Analysis

Influence - Expenditures

Major Influence  Rapidly Decreasing Influence  Low Influence

Additional funds are required

Resulting higher cost impact due to poor process selection and re-engineering

Final Authorization

Front End Loading

Identification  Feasibility  FEED  Contract Action  Execution  Operate & Monitor

Gate  Gate  Gate  Gate  Gate  Gate
Final Authorization

Influence - Expenditures

Major Influence  Rapidly Decreasing Influence  Low Influence

Additional funds are required to complete the project

Front End Loading

Project Life Cycle Analysis

Identification  Feasibility  FEED  Contract Action  Execution  Operate & Monitor

Gate  Gate  Gate  Gate  Gate  Gate

Influence - Expenditures

Engineering influence continues & leads to additional costs
Business Results and Benefits

• Cost savings in maintenance policies
  – Up to 20% reduction in annual savings cost

• Cost savings in spare parts cost
  – Up to 30% reduction in annual costs of spare parts inventory

• Reduction in insurance premium (highly critical for company OPEX)
  – 20% reduction in annual premium cost with new package

• Customer satisfaction is a top priority and with new package units

• Downstream facilities (transport pipelines, LPG plant) integrity ensured

• Project life cycle time (1 year) optimized by selecting the right process at the right time

• Ensures reliability and the availability of the production process