Mike Trivunovic

UOP’s Modular Solutions Implementation for Refiners

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UOP Offers Complete Solutions for Refineries and Petrochemical Plants

- Complete Technology Package
  - Planning and Consulting Studies
  - Basic Engineering Design
  - Engineering Services
  - Advanced Process Control & Monitoring
  - Catalysts & Adsorbents
  - Key Mechanical Equipment
  - Modular Solutions
    - Installation support
    - Inspection Services

- UOP has been delivering Refining Modular Solutions for over 30 years

Simplify Process Technology Implementation with UOP’s Comprehensive Solutions
Modular Process Unit Delivery: UOP Technology Transfer Through Modularization

Example above is a 19 month delivery for a modular Penex in Pakistan ~ 3 months required to install 20 modules
Benefits of UOP’s Modular Approach

Lower Cost
- **UOP Fixed Price**
- Superior quality via shop fabrication & UOP inspection
- Effective labor
- Avoid cost overruns and change orders
- **Earlier start-up**

Shorter Schedule
- **UOP basic/ detailed design, fabrication, & site services**
- Parallel path design, procurement, fabrication & site
- **Extensive UOP MOD experience**

Smoother Site Works
- **Fewer disruptions to operations**
- Less site construction & congestion
- Improved safety and security
- Less waste & material loss

Modular Approach Reduces Cost, Schedule, and Risk
Continuous Innovations in UOP’s Modular Portfolio

- CCR Regenerator
- Merox™ Treating
- Chlorsorb™ Unit
- Recovery Plus™ system
- Recovery Max™ system

- Platforming™
- Isomerization
- Hydrotreating

- Iso-Alky™
- CDU
- Olefins Reduction

- UOP Modular Refinery
- PetroPlex™ is UOP’s new Integrated Naphtha Complex

UOP Continues to Expand Modular Offerings and Delivery More Value
Project Development Model – Refinery Project

Significant Incremental Revenue from Early Start-Up
Refinery Capacity Enhancement
Including a New Modular Penex Isomerization Unit
Refinery Capacity Enhancement

Multiple Units Revamped for 20% Capacity Increase and Meet Clean Fuel Requirements
### Case Study: Refinery Capacity Enhancement

#### New Modular Isomerization Unit

<table>
<thead>
<tr>
<th>Production Needs (Revamp Obj’s)</th>
<th>Project Implementation Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased crude processing capacity</td>
<td>• Schedule – Pressure to implement Euro III standards quickly</td>
</tr>
<tr>
<td>– 100,000 BPSD to 120,000 BPSD</td>
<td>• FEED work not completed</td>
</tr>
<tr>
<td>– Reduce reliance on fuel imports</td>
<td>– Revamp study not completed</td>
</tr>
<tr>
<td>• Process additional indigenous crudes/condensates feed compositions:</td>
<td>– Design basis not defined</td>
</tr>
<tr>
<td>– Light, low in sulfur</td>
<td>– Basic Engineering for Isomerization Unit not available</td>
</tr>
<tr>
<td>– Low in Conradson carbon</td>
<td></td>
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<tr>
<td>• Improve final product specifications</td>
<td>• Size and complexity of revamp project implementation for refinery team</td>
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<tr>
<td>– Euro II to Euro III</td>
<td></td>
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<tr>
<td>• Optimize feed blend and flow scheme</td>
<td>• Overall schedule for Isomerization unit underestimated</td>
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<tr>
<td>• Debottleneck downstream process units</td>
<td>• Disruption to existing units and unit down-time</td>
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<tr>
<td>• Minimize modifications and overall Capex</td>
<td>• Restrictive plot space availability</td>
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**Objective:** Increase Capacity and Improve Product Quality Within Shortest Schedule
Case Study: Refinery Capacity Enhancement
New Modular Isomerization Unit

UOP’s Approach for Project Implementation

Phase 1 - Optimization and Configuration Study

- Define technically feasible / economically optimum flow scheme by:
  - Maximizing process units which are adequate as-is
  - Minimizing process units requiring revamp
  - Identify New Unit(s)- e.g.- Isomerization

- Provide a fixed-price proposal for new modular isom unit

Phase 2 –Parallel Path Execution

- Issue process studies for revamped units
- Supply new Modular Isom Unit
  - Basic engineering, detailed design & procurement activities overlapped for optimal schedule

- Work proceeded in parallel for modular isomerization unit

Result: Parallel execution scheme to achieve shortest schedule
Case Study: Refinery Capacity Enhancement
New Modular Isomerization Unit

UOP’s Revamp Solution

- Revamp of Crude Unit, DHT, NHT, Gas Con, LPG Merox, and CCR Platforming Unit
- Addition of a new 14,000 B/D Modular Penex™ Process Unit
- I-82 Penex Catalyst
- New PSA unit for increased H₂
- Supply of DCS/DRCS and PSA control system as integrated package

Refinery Benefits

- ~20% increase in total refinery throughput
- Higher utilization of lower value naphtha into high octane gasoline
- Upgrade from Euro 2 to Euro 3 gasoline product specs
- Fast track execution meeting mandated timeline
  - Schedule: 88 months, FCA fabrication shop
  - 9 Months faster than traditional stick build approach, earlier revenue!

Project KO

<table>
<thead>
<tr>
<th>Month 0</th>
<th>Design Complete</th>
<th>Ship 1st Modules</th>
<th>Final Shipment</th>
<th>M C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>18</td>
<td>20</td>
<td>26</td>
</tr>
</tbody>
</table>
UOP Modular Merox™ Unit Implementation

- Fuel Gas Extraction
- LPG Extraction
- LSR Gasoline Sweetening
- Isom
- Platforming™ Unit
- ATM Crude Tower

- Saturate Gas. Con.
- Naphtha HDS
- Diesel HDS

- Fuel Gas
- LPG
- Gasoline
- Kerosene Jet Fuel
- Diesel

- FCC
- LPG Extraction
- FCC Gasoline Sweetening
- Alkylation InAlk Cat. Con.

- Heavy Fuel Oil

- UOP Modular Equipment Offering Available
Case Study:
5,000 B/D Kerosene Jet Fuel Sweetening
Modular Merox™ Unit Implementation

Objective: Add Kerosene Jet Fuel Production & Increase Refinery Profitability

• Location: West Africa
• Refinery: 21,000 B/D heavy conversion refinery
• Process Units: Atmo distillation, VAC, HCU, DHT, Visbreaker, Reformer

Production Needs (Revamp Obj’s)
• Meet growing local jet fuel demand and decrease imports- Gov’t requirement
• Meet Jet-1 fuel specs
• Increase refinery profitability
• Use proven technology

Project Implementation Challenges
• Quality and quantity of local skilled construction labor
• Limited experience refinery project managers and engineers
• On-site safety issues with operating unit
• Rainy weather impact on construction
• Limited plot space
• Tight project schedule
Case Study: 5,000 B/D Kerosene Jet Fuel Sweetening Modular Merox™ Unit Implementation

UOP Technology Solution

- Addition of a new 5,000 B/D Modular Merox™ Process Unit (fixed price)
- Designed for Kerosene treatment to Jet A-1 specs
- Operations Training

Refinery Benefits

- Production of A-1 Jet Fuel
- Increase profitability
- Fast track schedule for modules, < 1 year
- Low risk project implementation
- Easy Installation

UOP Merox process reduces acids and converts mercaptans to disulfides using UOP’s proprietary fixed-bed catalyst, caustic, and air
Case Study:
5,000 B/D Kerosene Jet Fuel Sweetening
Modular Merox™ Unit Implementation

UOP Modular Merox Unit Scope

- Basic Design by UOP
- Detailed Design including 3D Model
- Module Fabrication in Shop
- Project Management
- Quality Control and Inspection
- Preparation for Shipment
- UOP Field Operating Services- Start-Up

Comprehensive Check Out

Designed with Operators in Mind

3D Model of UOP Merox Unit

Comprehensive Check Out

Designed with Operators in Mind

UOP is Uniquely Positioned to Modularize UOP Units...With Quality in Mind
Case Study:
5,000 B/D Kerosene Jet Fuel Sweetening
Modular Merox™ Unit Implementation

Case Study Conclusions

• UOP Kerosene Merox Unit successful addition to produce A-1 Jet Fuel
• Modular execution provided high quality system with operations in mind
• Fast track schedule and easy installation allowed for trouble free start up
Case Study: 25 K B/D Naphtha Complex Revamp
New Modular Isomerization Unit
Case Study: 25 K B/D Naphtha Complex Revamp
New Modular Isomerization Unit

Production Needs (Revamp Obj’s)

- Meet growing local gasoline demand
- Upgrade ~50/50 Euro III/ IV production to 100% Euro IV gasoline specs
- Accommodate 25% crude capacity increase
- Increase Naphtha utilization / decrease export
- Decrease MTBE usage

Project Implementation Challenges

- Tight project schedule with fixed compliance deadline
- Short turn-around: implement in 5 - 6 weeks
- Minimize disruption to operating plant
- Limited / narrow plot space for new Isom unit

Objective: Increase Capacity and Improve Product Quality Within Shortest Schedule
Case Study: 25 K B/D Naphtha Complex Revamp
New Modular Isomerization Unit

UOP’s Revamp Solution

• Limited revamp of NHT & CCR Platforming Unit
  – Capacity increases of 140% for NHT and 150% for CCR
• Addition of a new 10,000 B/D Modular Penex™ Process Unit and integrate with existing 8,000 B/D Penex Unit

Refinery Benefits

• 70% increase in gasoline production from original design
• 90+% utilization of lower value naphtha into gasoline product
• Meets Euro IV gasoline product specs
• No import / use of MTBE
• Fast track execution meeting mandated timeline
  – Schedule: 15 months, FCA fabrication shop
  – 9 Months faster than traditional stick build approach
Case Study: 25 K B/D Naphtha Complex Revamp
New Modular Isomerization Unit

- Modules Fabrication Progress
  February 2017
- Compressor Suction & Discharge,
  Drum & Coolers
- Modules Delivery and Installation
  at site March-April 2017
- UOP delivered ~ 60 modules

Timeline:
- Project KO: Month 0
- Design Complete: 7
- Ship 1st Modules: 11
- Install Modules: 15
- Mechanical Completion: 18

UOP 8080E-19
Case Study: 25 K B/D Naphtha Complex Revamp: New Modular Isomerization Unit

Case Study Conclusions

• Innovative revamp engineering by UOP successfully integrated new flow scheme and Modular Penex unit with existing Naphtha units
• 70% increase in gasoline production
• Upgrade to EURO-IV / V Gasoline without MTBE
• 90+% utilization of lower value naphtha
• New modular Isomerization Unit implemented in 18 months fast track schedule
• UOP managed revamp from design to fabrication, start-up, and production
• Customer managed the installation of the modules with UOP support on-site
UOP Modular Solutions for Technology Implementation

- **Fixed Delivery Schedule**
  - Parallel activities to minimize overall delivery schedule

- **UOP offers a Fixed Price** minimizing change orders

- **Performance Guarantees and Mechanical Guarantees** with one partner
  - UOP’s technical support helps customers **maximize profit** by optimizing on-stream reliability
  - UOP’s proven commitment to our customer for every project

- **Accountability Assurance**
  - Single point accountability for the process revamp and critical equipment
  - UOP stands with our customer to ensure successful start-up and **support over entire unit life**

UOP Delivers Modular Equipment with Fixed Schedule and Price & Guaranteed Performance