Oil Refinery Offsites Automation
Advanced Blend Control & Oil Movements Manager

• Oil Movements used for crude terminals, refineries, petrochemical complexes, bulk storage terminals etc
• Advanced Blend Control used for refineries and bulk storage terminals

• Advanced Blend Control integrated with Oil Movements Manager

• Comprehensive System for:
  – Blend and oil movement order management
  – Physical blend and movement line-up
  – Pre-blend optimization
  – Online control and blend recipe optimization
  – Monitoring & reporting
  – Configuration and maintenance
In-line Product Blending - Equipment

Components

- Rundowns
- Tanks
- Pumps
- Flow Stations

Blend Header

- Static Mixer
- Blend Header Analyzers

Products

- Tanks
- Dispatch

Business Objective – Fulfil Orders for Product at Lowest Cost
In-line Product Blending - Constraints

Component Availability?
Pumpable Volume?
Min & Max Flowrate?
Min & Max Flowrate?
Analyser Precision?
Available Room?
Tank Heel?

Component Properties
Tested 2 / Week
Lab Precision?

Product Quality Specifications & Control Targets?

Find Optimum Recipe within Constraints
Refinery Product Quality Specifications & Constraints

- Feasible solution space – squeezed by changing specifications

- Solution space sometimes disappears completely – infeasible

**Gasoline**
- Reduced benzene, aromatics, olefins
- Reduced RVP / DVPE
- Reduced sulphur
- Tighter D86 specifications E70 E100 E150 VLI
- MTBE banned in some countries
- Ethanol added at road truck rack

**Diesel (ULSD)**
- Reduced sulphur
- Reduced PAH
- Increased CN & CI

**Fuel Oil**
- Reduced sulphur (MARPOL)
- CCAI for different ship diesel engines (ISO 8217)
Typical Differences in Optimised Blend Recipe

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Planner / Scheduler

Initial recipe with offline optimisation

Actual closed loop optimised recipe
Blending Business Opportunity – Reduce Costs of...

- Inventory (blend right-first-time, just-in-time)
- Quality giveaway (Octane, RVP, Cetane, Sulfur, CFPP, Viscosity etc)
- Sub-optimal blend recipes
- Correction blends & reblends
- Distress & panic blends
- Downgrading to lower quality grades
- Contamination errors
- Demurrage for missed shipments & pipeline slots
- Tank maintenance & investment in new tanks
Business Opportunity - Reduce Quality Giveaway Cost AKI ON

- Increase quantity of premium grades
- Sell petrochemical naphtha at gasoline price
- Sell higher / buy lower quality components

- Gasoline prices - Regular US$ 2.80, Premium US$ 3.19, / us gallon
  - Premium – Regular = 93 – 87 = 6 AKI ON
  - ON giveaway = US$ 16.38 / 6 = US$ 2.73 / ON / bbl
- Cost to refinery of 100,000 bpd gasoline with 0.25 ON giveaway =
  - 100,000 * 365 * 2.73 * 0.25 = US$ 24.9 million / year
Business Opportunity - Reduce Quality Giveaway Cost RVP

- Sell additional butane at gasoline price

  - Gasoline forecourt prices - Regular US$ 2.80 / us gallon = US$ 117.6 / bbl
  - LPG sales price US$ 0.84 / kg = US$ 82.5 / bbl
  - Regular – LPG = US$ 35.1 /bbl
  - Regular with 0.5 psi RVP giveaway would allow + 0.86 % n-butane to be added to increase RVP from 9.5 to 10 psi
  - Gasoline 100,000 bpd production increased to 100,859 bpd
    - Sell 859 bpd of butane at Regular price
  - Cost to refinery of 100,000 bpd gasoline with 0.5 psi RVP giveaway =
    - 859 * 365 * 35.1 = US$ 11.00 million / year

Use Planning LP to calculate cost of giveaway
Margin Between Sales Specification & Control Target – Depends on Confidence Level

- ASTM Reproducibility
- Supplier Testing Margin
- Refinery Site Precision
- ASTM Repeatability
- ASTM Report Interval
- ASTM Report Interval * 0.5
- EN228 Specification
- Recipient Testing Margin

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How Much of the Business Opportunity Can Be Captured?

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How Is This Achieved?

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Key Issue #1 – Organisation & Culture

• Cross-Functional team
• Cooperative & collaborative working – can do attitude
• Using the same system and data
  – Planners / Schedulers / Blend Schedulers
  – Offsites Operators & Supervisors
  – Blend System Technical Services / Control Engineer
  – Laboratory QA Manager / Technicians
  – Analyser Engineers & Technicians
  – Instruments / Mechanical Equipment / IT Engineers & Technicians
• Close the loop – feedback results to optimise the refinery
Key Issue #1 – Organisation & Culture
Using the Same System and Data

Office Network

- Refinery Planner
- Refinery Scheduler
- Gasoline Blend Scheduler
- Diesel Blend Scheduler
- Fuel Oil Blend Scheduler
- Oil Movements Scheduler
- Laboratory LIMS

Client / Server Network

- Firewall
- Offsites Supervisor
- Offsites Operator
- Offsites Operator

Control Network

- Servers
- Controllers
Key Issue #2 - Blend Header Analysers - FTNIR

NIR Spectra
Lab Results
Model Build & Validation

Models used in online blend header analyser
Key Issue #2 - Blend Header Analysers - FTNIR

- Lab Results include the site precision of your Refinery Laboratory
- FTNIR models will not have better precision than your Lab
- Lab should be responsible for blend header analysers & models
- Not all FTNIR analysers are the same, you get what you pay for – do not buy cheap & nasty analysers

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Key Issue #2 - Blend Header Analysers - FTNIR

- Model calibration & validation sets must be representative
- And cover whole range of operation
- Use bottles of components and mix in the Lab

FTNIR Calibration Model - MON

- SECV = 0.34
- $R^2 = 0.9797$

Customer data inadequate, ABB combined data from other refineries
- X No data at / below Sales Specification or Premium
- X Model data sets highly clustered

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Key Issue #3 – Optimiser Functionality

- Allows optimization and recipe correction even without analyzers
- Multiple bias source types for each property
- Spot and Composite sample handling
- Allows retroactive correction of the blend based on samples and lab result
- Tank quality integration over time TQI
- Data entry can be integrated with LIMS or manual entry in ABC
- Manages all Tank heels, user-tunable heel correction rate
- Manages rundown piping quantity and heel quality
Key Issue #3 – Optimisation Infeasibility Handling

- Optimiser diagnostics advise Operator why infeasible
- Limiting Min and max constraint shown in red
- User Min / Max – consider freeing up if constraining

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Does your refinery need offsites automation?

If you answer YES to the following questions:-

- Capacity > 50,000 bpd crude ?
- Refinery > very low complexity ?
- Components > 2 per product (gasoline, diesel, fuel oil, bunkering) ?
- Products > 1 grade per product ?
- Unconstrained market ?
- Degrees of freedom > 2 ?
- Technical sophistication > minimum ?
- Product quality giveaway > ASTM repeatability ?
- Inventory (products + components) > 15 days ?
- Not enough tanks ?
- Reblends & corrections > 1 / month ?

- Typical project payback < 0.8 years
ABB Offsites Automation - Product and Solutions Centre

- Alan Munns PSC Manager & Product Owner
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- Work with local ABB company to deliver & support solution
- Consultancy for offsites automation, project justification, blending system design & operation
- Projects
- Business Development
- Customer Support & Training
- Software Product Development & Maintenance

- Located in StNeots 80km north of London UK
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