ABB Oil Movement & Blending Applications

- State-of-the-art OM&B Applications for Refinery Offsites and Terminal Tank Farms

- Experience & Global Reach
  - >200 man-years of application engineering experience
  - gained over 30 projects, covering 70 blenders, in a dozen countries

- Full-Scope, Closed-Loop Solutions comprising:
  - Industrial IT DCS
  - all required field instrumentation
  - online analytical instrumentation
  - proprietary chemometric modeling technology
  - advanced blend property control & optimization
  - expert system movements automation
  - FEED through construction capability
  - Pay-for-Performance project financing
ABB OM&B Application Software Packages

- TIMS – Tank Information Management
- RBC – Regulatory Blend Control
- ABC – Advanced Blend Control
- StarBlend – Offline Blend Planning
- iOM&S – Oil Movement & Storage
- CP&S – Crude Planning & Scheduling
Tank Information Management System (TIMS)

- DCS-level interface to multiple tank gauging systems
- DCS &/or NT-based Operator Interface
- Volume calculations from strapping tables or formulas
- ASTM/API volume correction
- Gross/net volumes & capacities
- Operating states
Regulatory Blend Control (RBC)

- standard configuration & programming for Advant, Symphony, & Industrial-IT DCS
- manual or automatic line-up
- automatic sequential control for start-up, ramps, and shutdown
- flow ratio control
- pacing control
- built-in simulator for testing and operator training
ABB’s IIT DCS Technology

Aspects & Objects

Built-in OPC connectivity

Full implementation of IEC 61131-3 standards (SFC, ST, & “blockware” used)

Revision control via Control Builder Control Modules, not monolithic compiled code

Offline, closed-loop testing via soft controller
Advanced Blending Control (ABC) Package

- Native-Windows, client-server design:
  - Oracle relational database
  - Visual Basic HMI
  - nonlinear optimization

- Comprehensive operations tool for:
  - offline planning
  - blend & general transfer order management
  - physical movement line-up
  - pre-blend optimization
  - optimal online control
  - monitoring & reporting

- Supports its own configuration & maintenance
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ABC Blend Optimization

- **Objective:**
  - maximize profit,
  - minimize give-away, &/or
  - minimize recipe deviation

- **Subject to Constraints:**
  - planner/operator recipe limits (simple bounds)
  - physical tank inventory/pump capacity/rundown mass balance limits (can further constrain recipe)
  - product property specs (nonlinear property correlations)
ABC Blend Optimization Features

- Objective to maximize profit, minimize give-away, &/or minimize recipe deviation
- GAMS nonlinear modeling/solution technology
- Utilizes StarBlend GAMS formulation for consistency when offered with offline planner
- User-tunable heel correction rate smooths transition at on-spec volume
- Multi-header/multi-period formulation allows individual or global optimization
- Can be extended to incorporate future blends
ABC Online Optimization/Control

\[ \tilde{y}_{\text{min}, \text{max}} \]

Volume-Average (TQI) Control

[Diagram of optimization process]

\[ f \]

\[ x_{\text{sp}} \]

Flow Ratio Control

\[ \lambda \]

Blend Property Prediction

\[ y \]

Optimization

Blender & Analyzers

Property Vector

Component Ratio Vector

Disturbance Vector

Blend Flowrate

Model Dependent

Volume Averaged

ABB
StarBlend™ Offline Blend Planning

- Equiva (Shell) offline application
- Creates optimized plans for multiple blends across multiple time periods
- Integrates with ABC to automatically create blend orders
ABC Blend Optimization Models

- Library of standard models
  - conventional linear, index, interaction, Ethyl RT-70
  - generic & property-specific (e.g., cetane, VLI)
  - EPA & CARB models

- Refinery site-specific models
  - user-defined coefficients for standard correlation structures
  - client-proprietary structures added to GAMSware

- Optional Topnir spectral blend models
  - ABB-proprietary and patented technology
  - Exploits richness of component FTIR spectra to improve accuracy of blended property predictions
  - Approach virtually eliminates the need for conventional lab analyses of component stocks
  - Can provide recipe-independent, linear blend indices to higher level planning & scheduling systems

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Conventional Blend Model Prediction

Recipe

Lab Analyses:
- RON: ASTM D-2699
- MON: ASTM D-2700
- RVP: ASTM D-323
- DIST: ASTM D-86
- AROM: ASTM D-1319
- OLEF: ASTM D-1319
- BENZ: ASTM D-3606

Nonlinear Correlations:
- \( \sum_{i=1}^{M} \left( \sum_{j=1}^{N} \sum_{k=1}^{n} \alpha_{ijk} \cdot y_{ijk} \right) \)
- \( \sum_{i=1}^{M} \left( \sum_{j=1}^{N} \sum_{k=1}^{n} \beta_{ijk} \cdot z_{ijk} \right) \)
- \( \sum_{i=1}^{M} \left( \sum_{j=1}^{N} \sum_{k=1}^{n} \gamma_{ijk} \cdot w_{ijk} \right) \)
- \( \sum_{i=1}^{M} \left( \sum_{j=1}^{N} \sum_{k=1}^{n} \delta_{ijk} \cdot v_{ijk} \right) \)

Predictions:
- RON
- MON
- RVP
- DIST
- AROM
- OLEF
- BENZ

M properties
\( \times \)
N components

M property models
Topnir Spectral Blend Model Prediction

Recipe

Lab FTIR Spectra:

Spectral Blend Model:

Predictions:
- RON
- MON
- RVP
- DIST
- AROM
- OLEF
- BENZ

N component spectra

1 model

Improved Accuracy
ABB Online Analytical Instrumentation

- Largest, most extensive supplier of online analytical instrumentation in the industry, with online analyzers for crude, fuel oil, kerosene, jet fuel, gasoline, and diesel in-line blenders
- Vista Model 4100 RVP analyzer is the industry standard
- Bomem Advance FT-NIR offers
  - high wavelength accuracy and precision
  - extremely low maintenance
  - model transferability between instruments
- Vista II Process GC for applications requiring extremely accurate distillation analysis
- Vista II Fuel Sulfur Analysis to 100 ppb
- Pastech is the industry's leading analytical instrumentation system integrator
ABB Blending Solutions

Closed-loop capability, closed-loop responsibility

ABC
Property Control & Optimization

RBC
Base Regulatory & Sequential Control

Blender

Analyzers
FTIR & Conventional

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Phased Offline-to-Online Project Plan

- **Implementation:**
  - Begin with Bomem laboratory FTIR (purchase or Easy/R lease)
  - Develop Topnir chemometric models
  - Implement ABC for optimal, offline planning
  - Close ABC loops when inline blender, RBC, & online analyzers are installed
  - Retain bench FTIR for component analyses

- **Benefits:**
  - Early return on low initial investment
  - No investment compromised
  - Closed-loop solution investment across multiple CAPEX budget cycles
  - Phased training & site acceptance
Intelligent Oil Movement & Storage (iOM&S)

- Graphical, object-oriented, expert system technology
- Optimal path selection, sequencing, & monitoring of typical tank farm operations
- Improves utilization of storage and equipment and efficiency of receipts, internal transfers, and shipments
- Enforces SOPs, safety, and environmental policies
- Eliminates incompatible material contamination
- Optional Crude Planning & Scheduling package
iOM&S Functions

- Select equipment (tanks, valves, pumps) for movements per daily operating orders
- Automatically select optimal path
- Generation of equipment operation sequences
- Terminate movements or swing source and destination tanks at specified levels or volumes
- Calculate stop gauges and total volumes shipped for custody transfer
- Monitor field element feedback, alarm, and service statuses
- Monitor tanks for improper movements
- Track movements and line contents to enforce material compatibility
iOM&S Movement Types

- tank to tank transfer
- tank water drainage
- tank circulation
- batch receipts & shipments, via pipeline or ship
- perpetual receipts & shipments, via pipeline
- sequential blend (sequential transfers from several component tanks to the same product tank)
- simultaneous blend (parallel transfers)
- manual transfer operation (operator specifies the source and destination, and the field elements to be committed)
iOM&S Software Design

- iGES/AIEM (G2) graphical object-oriented design for tank farm objects & connectivity
- Underlying Oracle relational database
- G2 is completely hidden from operator and configuration engineer
  - engineer interface via iGES
  - operator interface via browser
- Configuration requires:
  - topology (from plot plan, PFD, P&IDs)
  - project-specific rule-base
- Can use inherent DCS/SCADA/PLC-level sequence table processing capability, or drive individual devices directly.
Crude Planning & Scheduling (CP&S)

- Planning (~30 day) and scheduling (~3 day) of tank farm receipts, transfers, blends, and shipments
- Completely integrated with iOM&S package
- Proven MIP technology optimizes inventories, distribution, production, and giveaway
- Native-NT application integrated with MS Access & Project
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- **Description**: CPG Demand for Refinery
- **Start Time**: 4/21/99 2:45 PM
- **Duration (hrs)**: 7
- **Transfer Amount (1000 bbl)**: 73.2
Economic Losses at the Blender

- Octane Giveaway
- Volatility Giveaway
- Sub-Optimal Recipes

VS.

- Reblends
- Inventory Cost
- Demurrage
- Missed Shipments

Bottom Line = $0.05 - 0.25/bbl lost profits

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Economic Benefits: Property Giveaway

Octane
- a reduction of 0.15 octane is generally achievable
- savings realized chiefly in lower reformer severity
- using a typical value of an "octane barrel":
  \[(0.15 \text{ ON})(\$0.25/\text{ON bbl})(100,000 \text{ bbl/day})(350 \text{ days/year})\]
  \[= \$1,312,500/\text{year}\]

RVP
- an increase of 0.5 psi is generally achievable
- savings realized by maximizing n-butane volume
- using a typical value of a "psi barrel":
  \[(0.5 \text{ psi})(\$0.08/\text{psi bbl})(100,000 \text{ bbl/day})(350 \text{ days/year})\]
  \[= \$1,400,000/\text{year}\]
# Savings Beyond “Zero Giveaway”

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