Real-time crude oil data for refinery decision making

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Introduction to AVEVA and supply chain software
Assay Data and timely assays
Real Time Crude (RTC) overview
Results and future developments
Summary
**AVEVA is a leader in industrial digital transformation**

- FTSE 100 listed on the London Stock Exchange
- Combined with Schneider Electric software business on 1 March 2018
  - Included the Spiral Unified Supply Chain Management software suite

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<th>Category</th>
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<td>R&amp;D Centers</td>
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<td>% of Sales on R&amp;D</td>
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<td>% of R&amp;D NextGen programs</td>
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- Oil and Gas
- Chemicals
- Food, Beverage, CPG
- Marine
- Life Science
- Mining
- Infrastructure
- EPC
- Power
Spiral Unified Supply Chain Management

The Vision we are able to bring to our customers

- **Single, unified, enterprise** application across all supply chain activities
- Enable **new workflows** that cross traditional tool boundaries
- **Built-in collaboration** providing broad user accessibility to a unified decision-making tool
- Enable better decision making through **transparency, interactivity and analytics**

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**Oil & Gas Downstream Value Chain**

- Trading
- Planning
- Scheduling
- Operations
- Distribution
**AVEVA’s Innovative Approach**

**Spiral Unified Supply Chain Management**

- **ASSAY**
  Crude & feedstock modelling and knowledge management
- **PLAN**
  Plant optimization with integrated Analytics and multi-period
- **NETWORK**
  Supply & distribution network optimisation
- **SCHEDULE**
  Plant scheduling including feed and blend optimisation
- **PROCESS MODEL GENERATOR**
  Base Delta regression from plant and simulator data

**Key Points:**
- **Assay data** is fundamental to the AVEVA’s supply chain software
  - Key input to developing robust refinery plans and schedules
- The problems of data transfer have been solved in Spiral’s tools
  - Unified system allows the same assay data to be retrieved anywhere in the suite of software
- **Real-time** assay data is one of AVEVA’s current areas of focus
Assay data
Measuring assays

Refining qualities of crude oil

- **Assay data** comprises information about boiling distribution, refining qualities, transport qualities etc. of a crude oil to be processed
- Typically the measurement process for a full assay is time-consuming, taking days or weeks
- Often, assay data is out of date at the time it needs to be used
  - Crude oils show substantial short-term variation from cargo to cargo, and longer term variation over time as crude oil sources change
  - Measuring a reliable assay for a new cargo is infeasible using traditional assay methods
Real-time crude assay data

The need for real-time crude assay data

- Assay data is fundamental to several areas of supply chain modelling, such as:
  - Crude purchase selection, operational planning, detailed scheduling etc.
- Being able to make a decision with up-to-date data can make a substantial feasibility and/or economic difference
  - E.g. operational feasibility implies conservative limits in crude blend proportions, if an assumed standard assay is used; a real-time assay for the cargo opens up blend flexibility
  - Economic evaluations can differ markedly

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Real Time Crude overview
Overview of Real Time Crude (RTC)

Extended-range IR spectroscopy and crude assay modelling

- AVEVA’s Real Time Crude (RTC) is designed to allow complete crude oil assay data to be generated rapidly from a small sample
- AVEVA’s RTC system consists of 2 parts:
  - Apparatus to measure an extended-range infrared (IR) spectrum from a small sample (~20ml)
  - Software to analyze these spectra to generate a complete crude oil assay
- The analyzer is available as a lab version, and an online version – both proven to give equivalent results
Use cases

Real-time crude assays when and where they are needed

**Detailed crude inspection**
- Online Analyzer set up at discharge port, pipeline or tank farm
- Real-time analysis allows IR spectra to be routinely acquired
- Spectrum is uploaded and an assay is generated
- The full assay is distributed seamlessly and immediately through the unified supply chain management system
- Technologists can make use of the assay for refinery acceptance decisions, re-optimisation decisions etc.

**Cargo analysis**
- Offline Analyzer set up at load port
- An operator measures an IR spectrum and uploads it
- A full assay is generated and available to experts
- Experts receive an updated assay at cargo receipt time, allowing new trades/plans/schedules to be evaluated with more certain knowledge of the crude quality

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IR Spectroscopy

Extended-range Fourier Transform Infrared Spectroscopy

- AVEVA’s technology partner is AIT (Applied Instrument Technologies), part of Schneider Electric
  - AIT’s analyzers utilize patented ExxonMobil technology
- IR spectra are measured up to wavenumbers beyond 1000 cm\(^{-1}\)
  - IR Spectra capture the nature and abundance of hydrocarbon bonds in a sample, which mathematical models can interpret as differences in sample qualities.
  - Extended range enhances available information content compared with conventional NIR (near infrared) measurements
Crude assay modelling

Generation of complete and consistent assays

- AVEVA has 20+ years of experience, in its Spiral set of crude assay tools, of modelling the nature of crude quality variation
- For a large set of crude oils, spectra and conventional assays are measured
- These are used to train an “IR model”
  - The variation in the spectra is characterised numerically
  - These are used as input to AVEVA’s standard crude assay models
- When deployed, the result is a complete, consistent assay, for all standard properties and boiling ranges
Case study

Proven technology

- The approach of using spectra and AVEVA’s Spiral Assay modelling is proven and attested
  - Shell has publicly presented its implementation of AVEVA’s (Spiral’s) IR-based assay modelling system
- Note: AIT’s analyzer extends the spectrum captured beyond the ranges used in this case study
  - Additional relevant spectral signal ranges captured
  - Improved assay modelling potential
Results and future development
Early results

Crude assay prediction quality

• Training data consists of spectra and conventional assays
  • “One-out” tests give good results
• Comparisons show good results for key refining properties
  • Even properties not directly characterised by IR spectra (e.g. metals) are nevertheless well predicted due to the Spiral assay models
• Prediction improvements are ongoing as the dataset grows
Future development

Collaboration, improved tuning and new functionality

- RTC improvement relies on participation by our customers
  - More assay data and samples lead to improved model quality
  - It’s free to take part – only buy the system/software if the results work for you. Participate if you can!

- Improved tuning of how the extended IR range is used
  - The extended range offers clear advantages, and as more data is collected, tuning can be improved to take best advantage

- BlendAnalysis functionality
  - BlendAnalysis is a feature in Spiral crude assay tools which allows blend recipes to be determined on the basis of blend measurements
  - RTC technology supports an extension to this workflow
Conclusions

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Summary

RTC for timely assays and better decision making

• AVEVA already offers a unified environment for managing the refining supply chain

• RTC brings together an enhanced analyzer and well-established crude oil assay software to make real-time assays possible
  • Timely assay data enables more informed decisions (e.g. in crude trading, refinery operations planning, refinery planning and scheduling etc.)
  • AVEVA’s supply chain software architecture allows immediate distribution of the assays

• RTC is collaborative: companies share conventional assays and samples with AVEVA. As the pool of training data grows, RTC assays continue to improve
  • Contribute if you can!
ABOUT AVEVA

AVEVA is a global leader in engineering and industrial software driving digital transformation across the entire asset and operational life cycle of capital-intensive industries.

The company’s engineering, planning and operations, asset performance, and monitoring and control solutions deliver proven results to over 16,000 customers across the globe. Its customers are supported by the largest industrial software ecosystem, including 4,200 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 4,400 employees at 80 locations in over 40 countries.

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