Yields reconciliation using Sigmafine in an agile refinery

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Agenda

1. Presentation of *IPLOM* refinery
2. Yield reconciliation objectives
3. The project
4. The model
5. Analysis of reconciled data
6. Achieved results
7. Future developments
Refineries in Italy
IPLOM Refinery

- **Tanks storage in Genoa**
- **Genoa Harbor**
- **PIPELINES**
- **Passo dei Giovi**
- **Crude storage**
- **PROCESS PLANT**
- **Finished Product Storage**
- **Railway Loading**
- **Truck Loading**
- **Pipeline 8”**
Refinery Data

- Has refined and delivered oil products in Busalla since 1943
- Productive capacity: 45,000 bbl/day
- Refines Diesel oil, low sulfur fuel oils, bitumen
- Total area: 126,000 m²
- Tanks: 56
- Storage facilities: 300,000 m³
- 8” and 16” Pipelines: 25 Kilometers
Refinery Data

- Favorable logistic location:
  - close to the Padana Valley
  - connected to the harbor (8” and 16” pipelines)
  - railway loading (equivalent to more than 80 trucks/day)
- employees: approx. 200 people
- approximately 200 people daily employed in the allied activities
- more than 600 allied
Plant capacity

- Atmospheric - vacuum distillation: 45,000 bbl/day
- Diesel oil and fuel oil purification: 23,000 bbl/day
- Gas and water purification, sulfur recovery: 345 bbl/day
- Electric energy and steam production (cogeneration): 5 MWe + 8 MWt
**IPLOM: an agile refinery**

- Efficiency, agility in taking the opportunity of business
- Wide range of customers to be satisfied
- Many operating modes
- Wide range of products
- 110 crude switching (running plans) per year
- Average length of a campaign: 2.5 days
- Performance during a crude switching: 4 hours
Yields reconciliation objectives

- Operations:
  - Calculation and Presentation of KPI
  - Real-time evaluation of plant performances

- Accounting:
  - Aggregation of campaign results
  - Accuracy of data from the plant floor

- Engineering:
  - Verification of theoretical yields
  - Evaluation of upsets and performances during a crude switching
**Previous situation**

- Material balance calculation was done daily using an ad-hoc application built in Excel
- Lack of a data infrastructure able to collect and distribute plant data
- Lack of flexibility in modelling different plant configurations
- Strong involvement of personnel
- A good redundancy of measures, about 120%
Project guidelines

- Replace ad-hoc tools with a product-based solution
- Flexible plant configuration -> dynamic reconciliation model
- Completely automatic hourly reconciliation mode
- Archiving/presentation of results
- Integration with accounting system
The choices

**PI**
- Real-time data infrastructure

**Sigmafine**
- Data reconciliation
- Dynamic model management

**PI-ProcessBook/PI-DataLink**
- Integrated data presentation
- Distribution/analysis of results
Project management

- Collaborative approach
- Strong involvement of refinery personnel
  - process engineer for model development
  - automation engineer for DCS integration support
- Local distributor (Pimsoft) for product and integration services
- Duration: 3 months
Model design

- Suitable for frequent and automatic reconciliation (hourly)
- Able to represent all possible plant configurations
- Tanks and movements not included
- Mass balance
- All compensations/validations solved at DCS/PI levels
Dynamic modelling

- Model structured on many “layers” (around 50)
- A running plan is represented by a subset of layers
Layers management

- Example of two different layers combinations in the model
Functional architecture

- **Accounting System**
  - Running Plan definition data
  - Running Plan reconciled yields

- **PI System**
  - ACE KPIs
  - Compensations
  - RP procedures

- **LIMS**
  - Analysis for compensations

- **DCS**
  - Process Data

- **Sigmafine**
  - Layer management

- **Yields and KPIs presentation**

- **Control Room**
  - PB Running Plan Manager
Running Plan manager/1

- Located in control room
- Selection of new running plan from accounting DB
- Declaration of running plan (campaign) change
Running Plan manager/2

Automatic actions triggered by running plan manager

- Start Running Plan
  - Set Sigmapine model layers according running plan configuration
  - Download theoretical data from Accounting System
  - Update theoretical density/viscosity of products for compensation of DCS flow rate measures

- End Running Plan
  - Aggregate running plan reconciled data
  - Update Accounting system
Quality indexes

- Automatic reconciliation requires **KPIs** to provide an immediate and simple indication about the “goodness” of the reconciled data.

- **Reliability Index** -> reliability of reconciled yields related to theoretical ones.

- **Performance Index** -> indicates if the plant is producing more valuable stuff compared to the theoretical performance.
# Yields and KPIs Presentation

**Current/Shift/Running Plan**
- Reconciled vs. Theoretical Yields

## Running Plan KPIs

### IPLOM - Presentazione RESE

- **Ultima riconciliazione eseguita:** 13-Jan-03 15:59:59
- **Inizio lavorazione:** 10-Jan-03 21:59:26
- **Fine transitorio:** 10-Jan-03 23:23:33

**Carica impianto:** 4769 t/d

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Plant monitoring/1

Early morning meeting plant situation report

Theoretical yields from running plan

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Plant monitoring/2

Running plan

Theoretical yields from running plan

Reconciled yields from running plan
Upset identification/evaluation

Reliability Index

- gasoil
+ residual
Reconciled vs. theoretical yields across more running plans
Comparing two running plans of the same campaign

Reliability index

Reconciled yield
Achieved results

- The use of PI and Sigmafine enabled the refinery to achieve better control and knowledge of its performances.

- KPIs and yields are calculated and available in real-time giving an homogeneous trend of the production to all refinery people (from operating people to the production manager).
Achieved results

A posteriori analysis and comparison of reconciled and theoretical data lead to:

- Clear reduction of transition time especially during the change of production
- Gasoil-diesel yields improvement of about 1%
Future developments

- Daily Complete refinery model in progress
  - inclusion of tanks and fiscal movements
  - integration with hourly yields model

- Use of Composition tracking to evaluate the crude tanks composition

- Sigmafine4 and PI-Application Framework
  - Migration of dynamic reconciliation to PI-AF

- PI-ICE
  - distribution of yields and KPIs cockpits