PIMSOFT
INNOVATIVE SOLUTIONS

# Leverage Sigmafine Advanced Analytics

## A focus on Component Balance and Tracking Analyses

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engineering data for digital transformation

# More answers to business and operations with Sigmafine advanced analyses

**How to back allocate production by oil wells and by shareholders?**

**What is the cost of a production batch?**

**Can I improve the estimation of valuable metal content in the ore?**

# The Sigmafine analyses portfolio

## Reconciliation analyses:

- Sigmafine balance: linear, based on mass, volume, energy, etc.
- Energy balance: bilinear, coupling mass and energy balance
- **Component balance:** **bilinear, coupling mass and components**

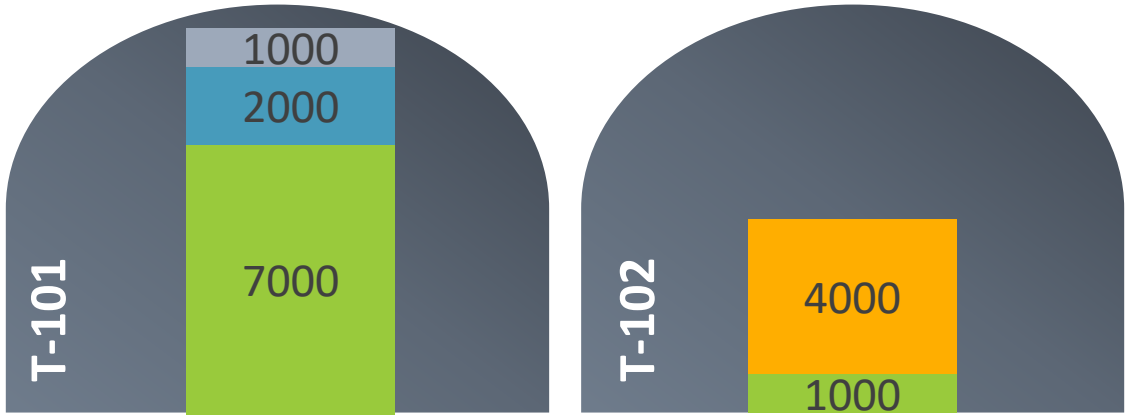
## Tracking analyses:

- **Composition tracking:** **tracks string data type across the model**
- Quality tracking*: infers physical numerical properties for blends of materials

*As additional license

# Composition Tracking

# Composition Tracking follows material dynamic of the facility




Azer Basrah Ebok Zafiro

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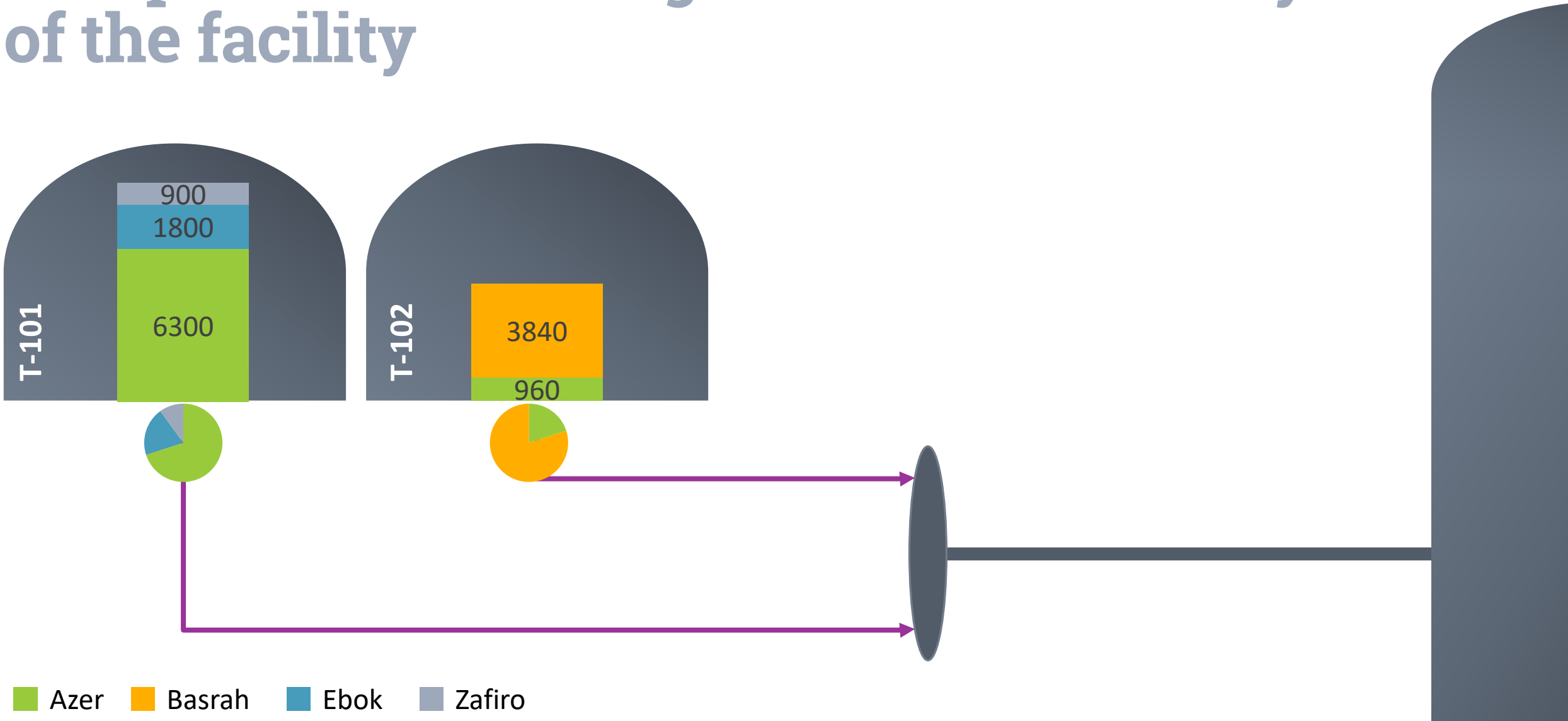





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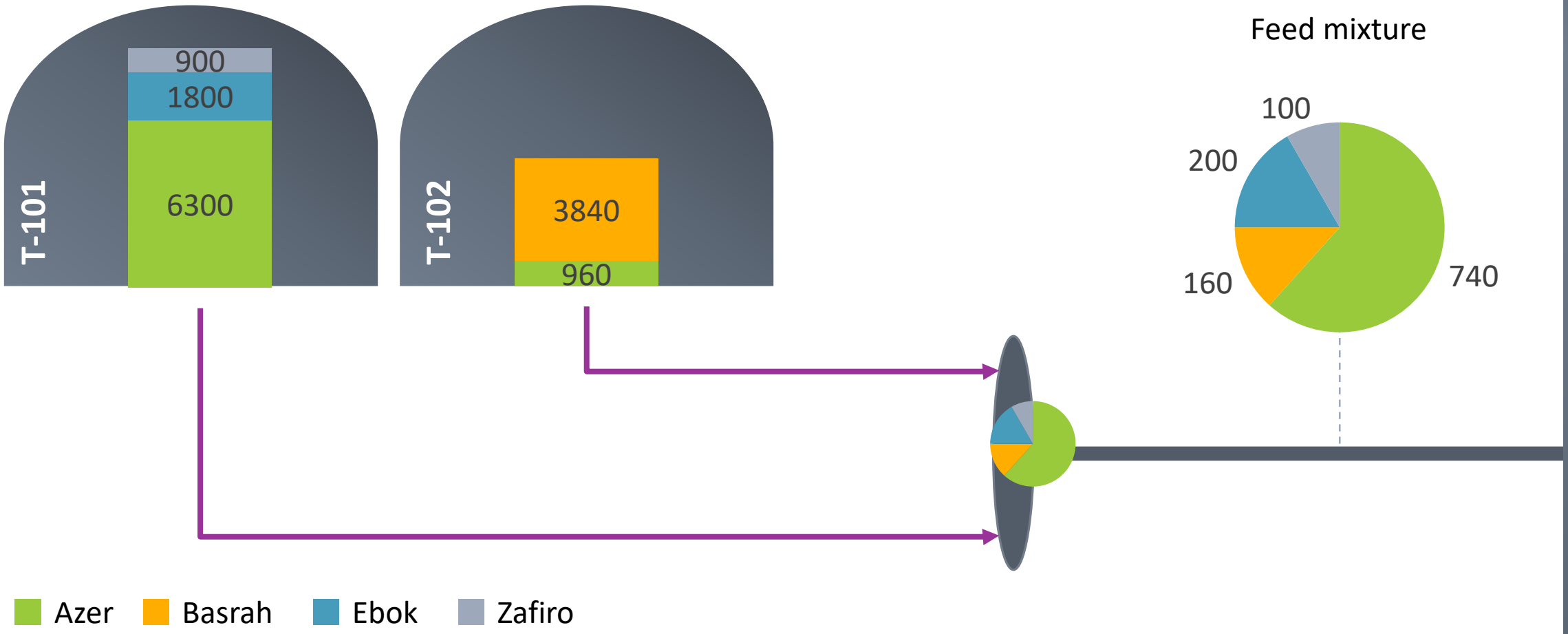





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# Most common theoretical mixing models

## LIQUID TANKS

**WELL MIXED (tanks with homogeneous materials)**

**BAFFLED (tanks with an internal baffle)**

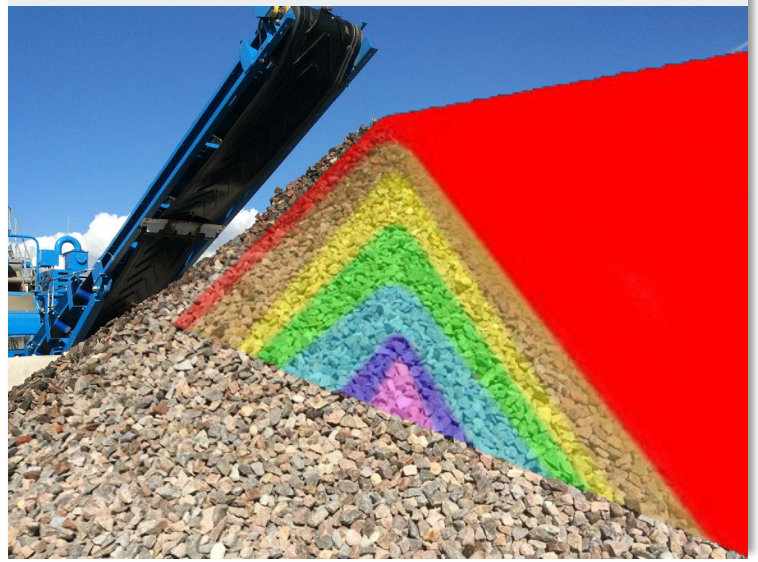
**MAKE-UP PURGE (tanks where fluid mixing is slower than fluid withdrawal)**

## PIPELINES, SILOS

**FIFO (separation layers, plug-flow modeling for pipelines)**

## STOCK PILES

**LIFO: last loaded is the first to be removed**

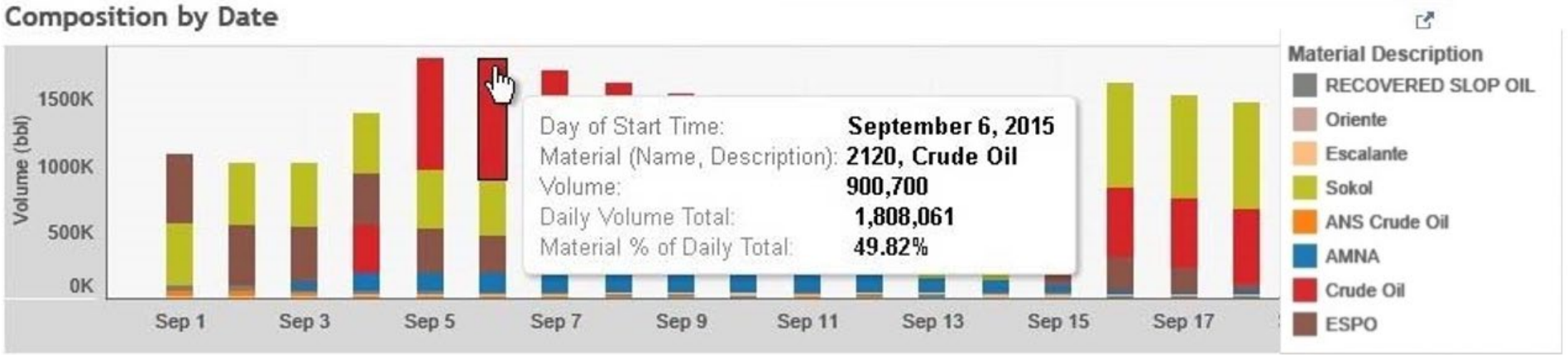


# Aggregation of crude types and daily totals

SUNCOR ENERGY

Composition totals for the refinery

Translated to daily totals





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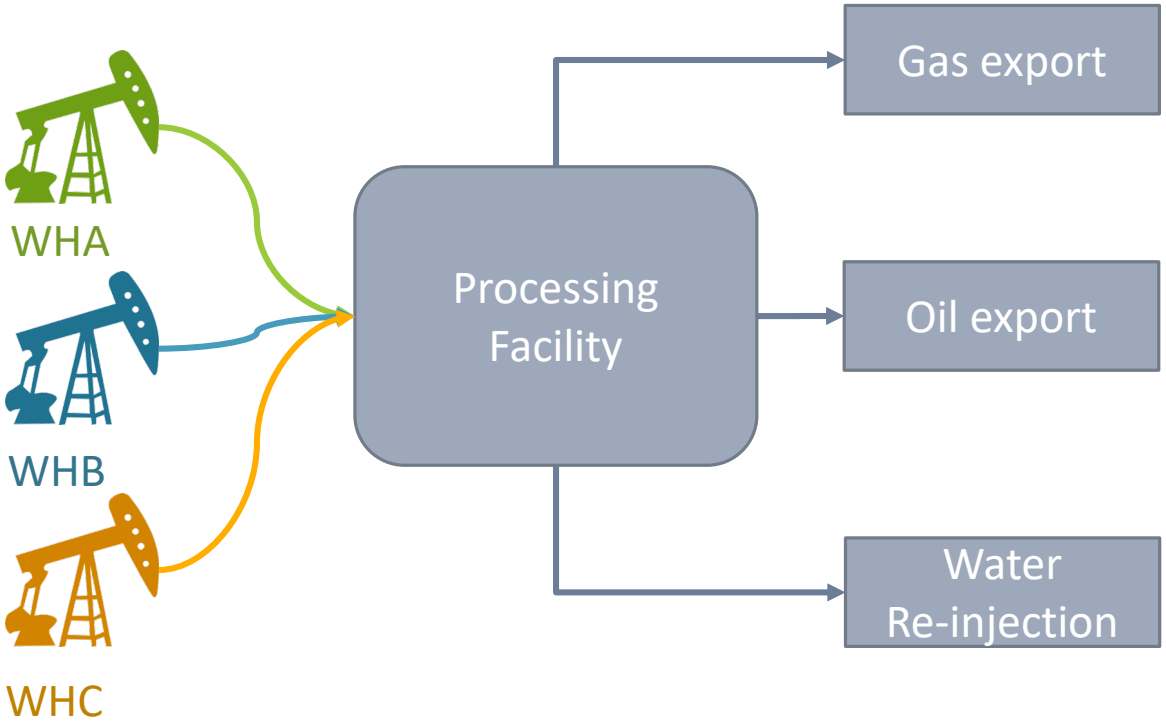
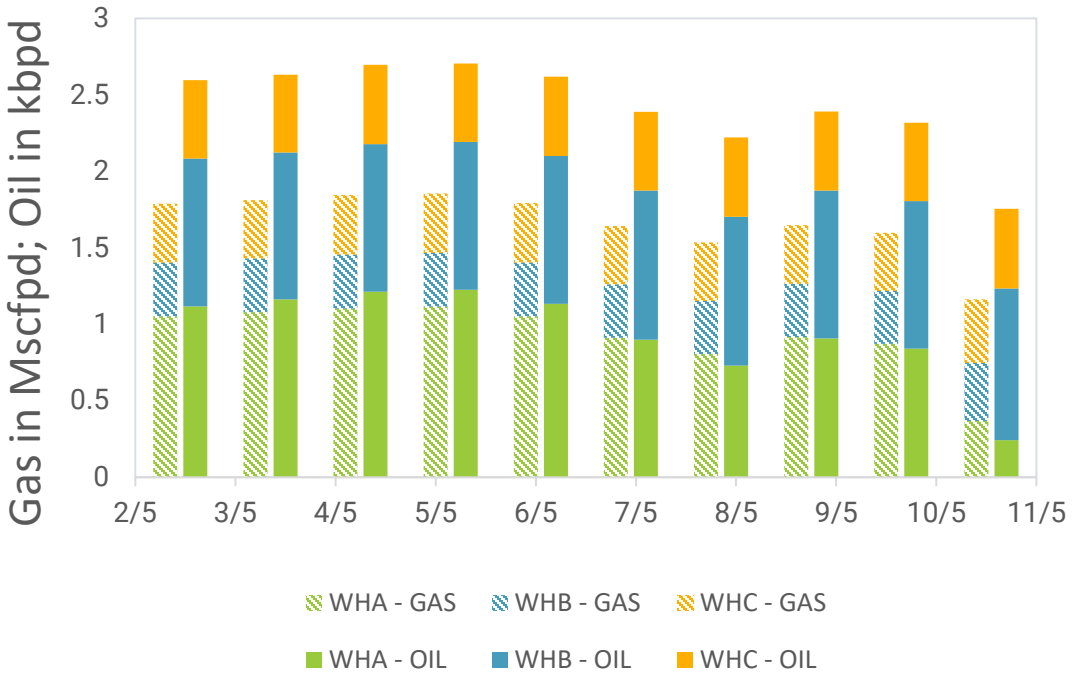
# Production allocation according to the source







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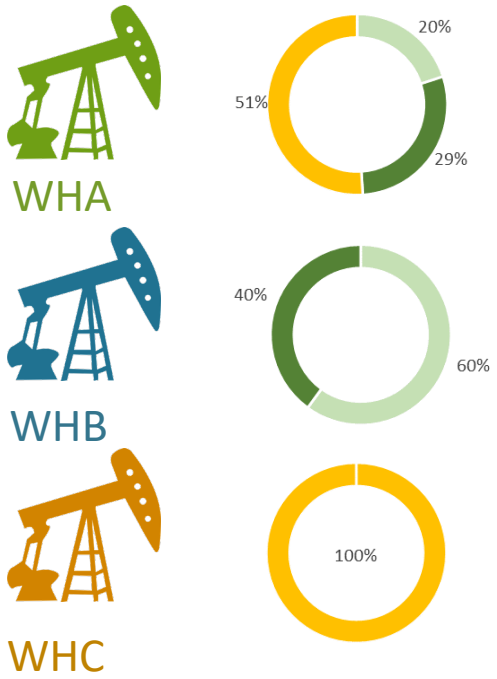
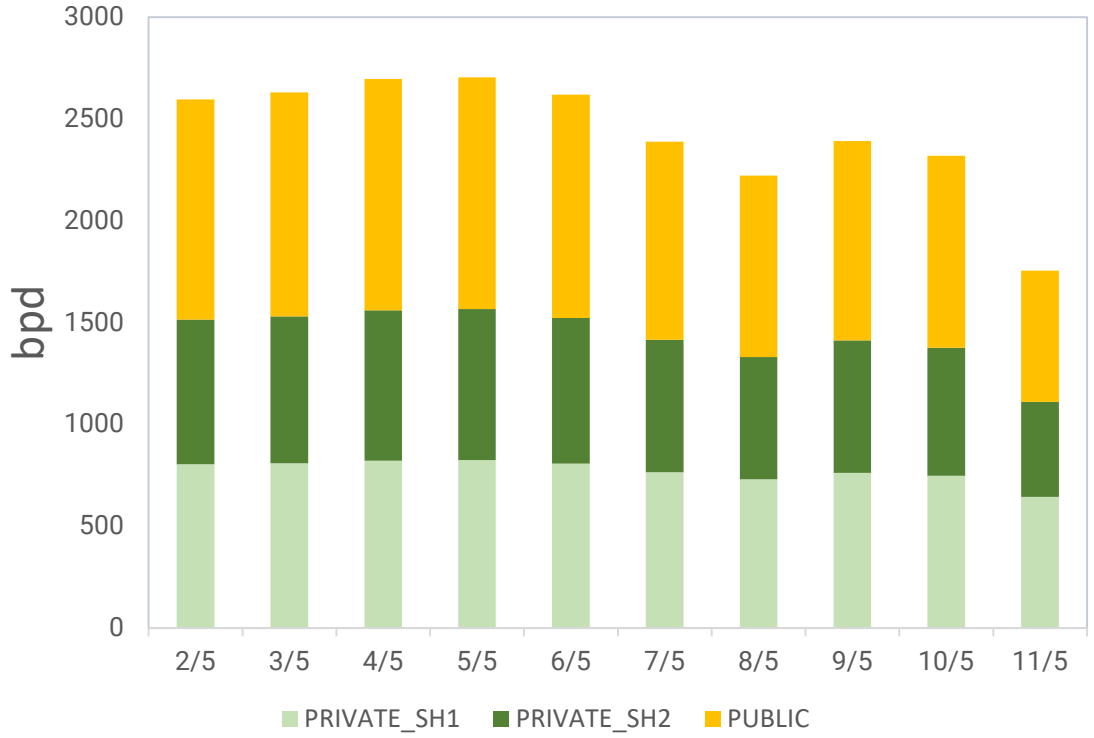
# Allocate production by shareholder

## WELLS' OWNERSHIP




## OIL PRODUCTION BY SHAREHOLDER







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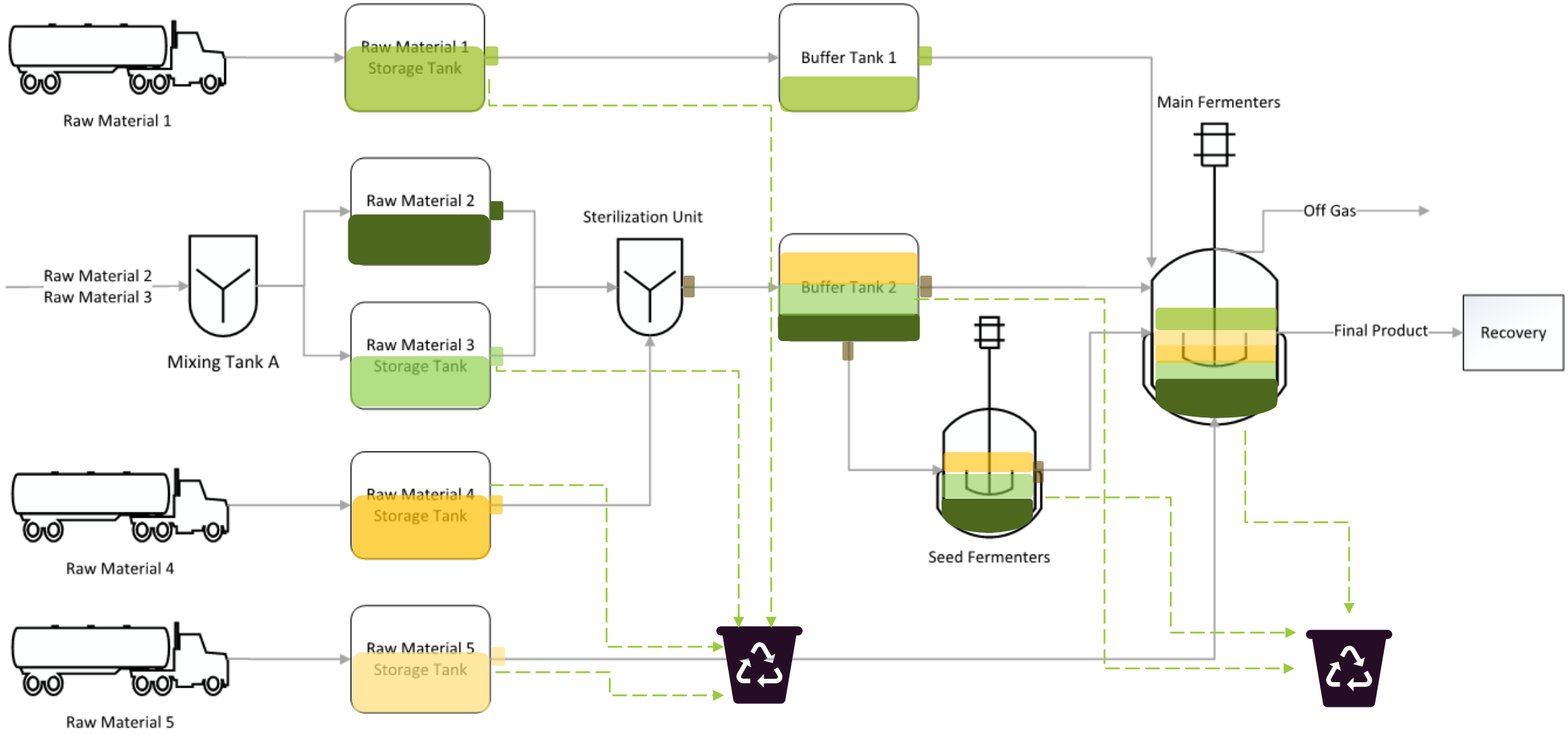
# Cost evaluation of a pharmaceutical production







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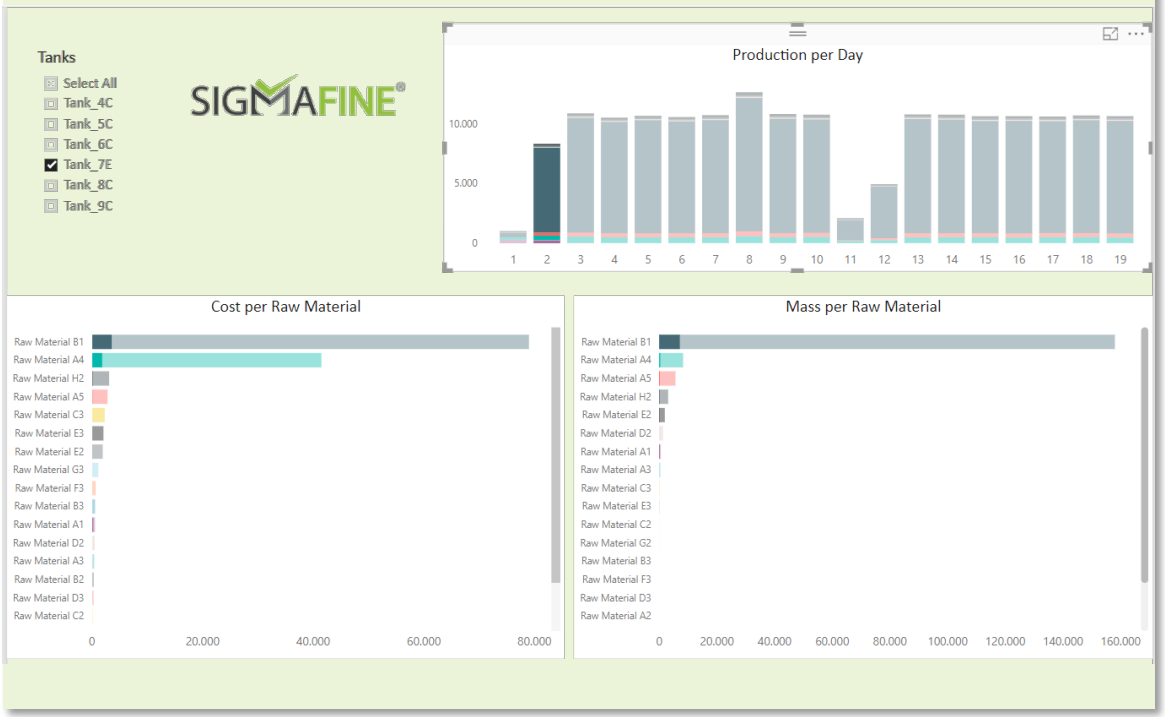
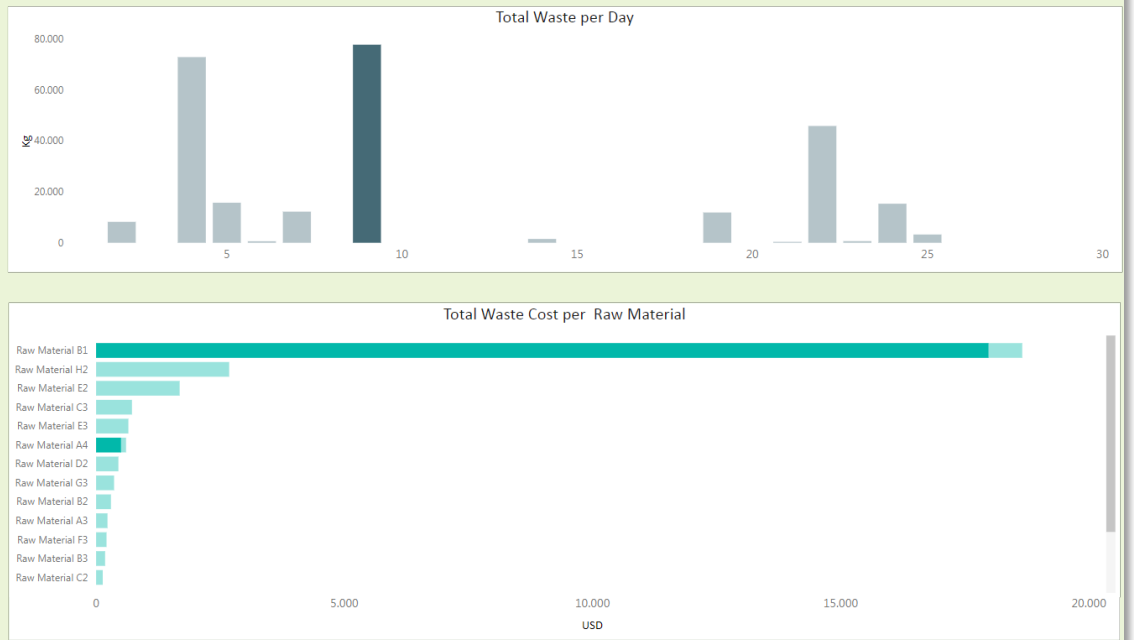
# Aggregation of tracking results by material and by inventory

## PRODUCTION




## WASTE







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# Component Balance

# Data reconciliation analysis that applies conservation of mass and chemical species

## Balance constraints:

$$\sum_{i=1}^{m} F_{i,j} = 0; j = 1..n$$

where *n* is the number of balance points

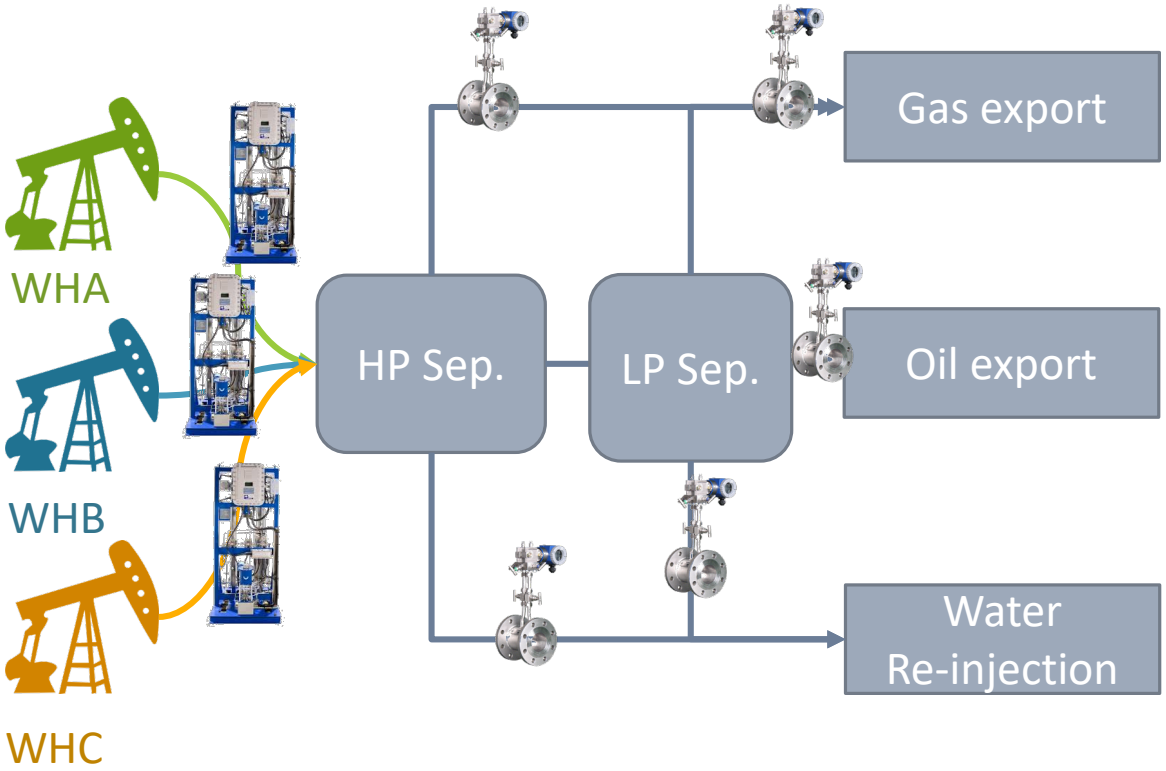
$$\sum_{i=1}^{m} F_{i,j} \cdot x_{i,k} = 0; j = 1..n; k = 1..s$$

where *s* is the number of chemical species

Optional:

$$\sum_{k=1}^{s} x_{i,k} - 1 = 0$$

# Validate Multi Phase Flow Meters through measurement redundancy after phase separation




- Use both gas and oil export measurements and the less accurate MPFMs
- Apply component balance to reconcile overall mass and phases
- Associate appropriate tolerance to each meter for reconciliation tuning
- Address poor performing meters based on Sigmafine quality indicators
- Automatically run the Analysis for near real time monitoring (e.g. hourly run)

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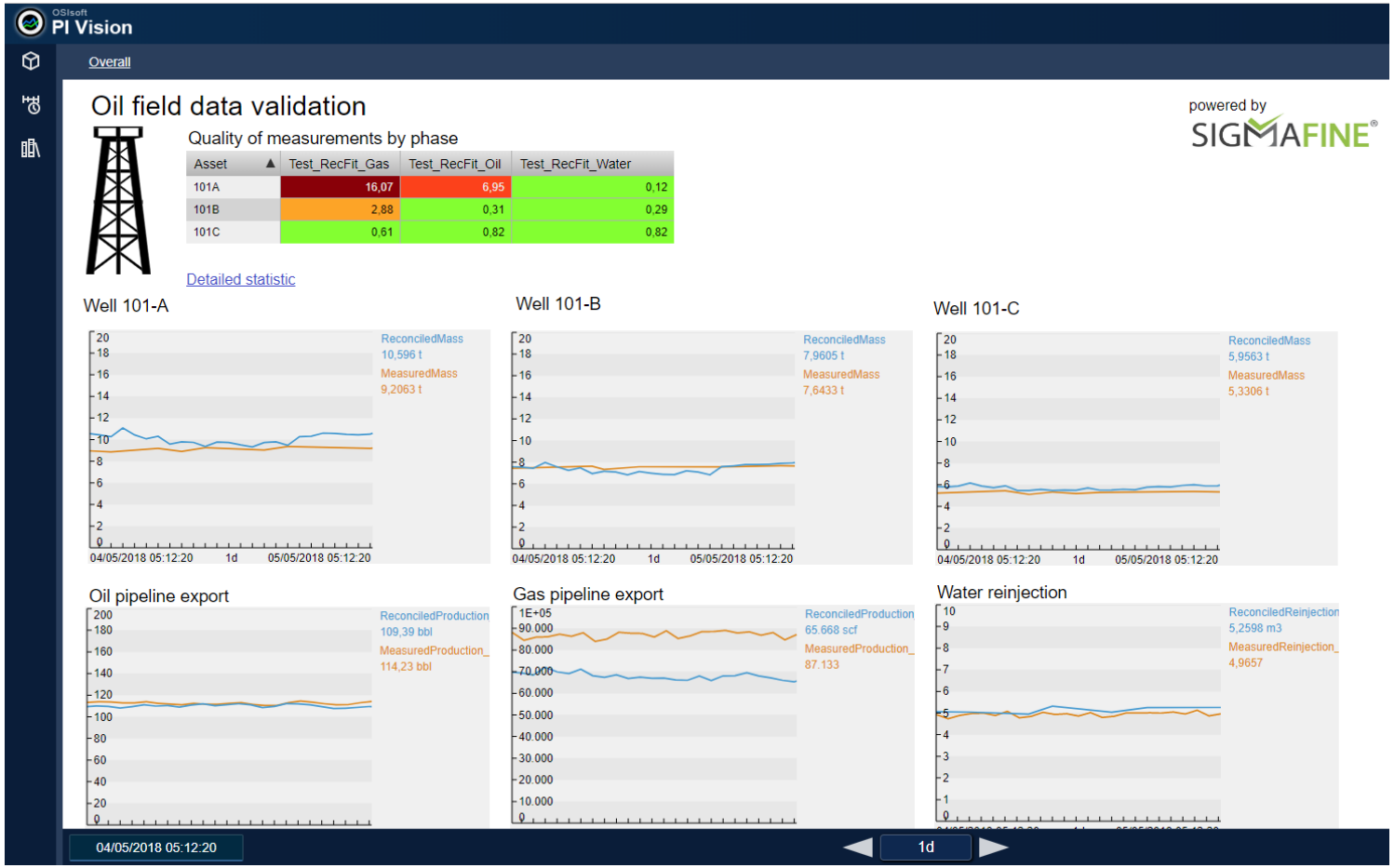
# Measurement reliability dashboard

Validation of MPFM Phase split data

Validation of wells production

Validation of exports and reinjection

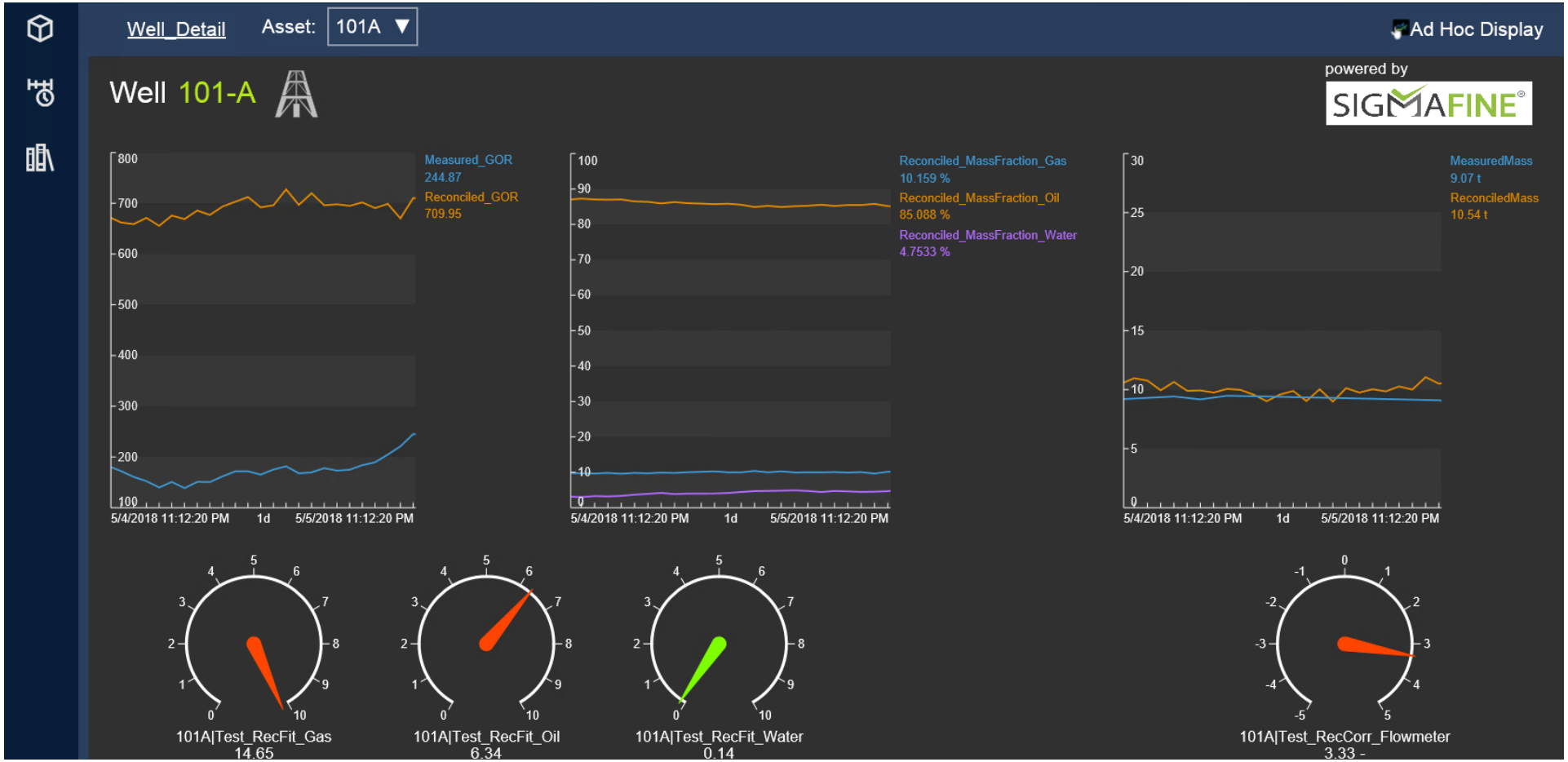



Major issue in gas phase measurement of well 101-A

Overall production rate looks fine

Bias on gas measurement of export pipeline

# Detail on the worst performing MPFM with unreliable Gas/Oil ratio




Validated figures and KPIs (e.g. GOR)

Data Quality indicators

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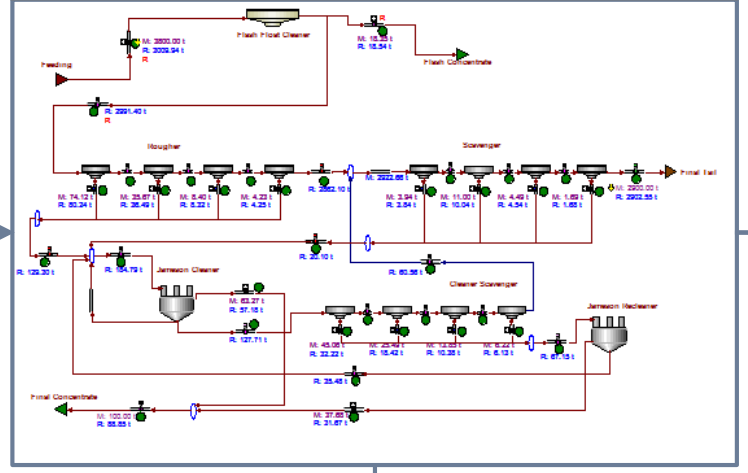
# Metal processing affected by data quality issues: poor / missing data

## Slurry – 442 t/h

| Component Name | Value | Tolerance |
|---|---|---|
| Au | 6E-07 | 4.45E-06 |
| Cu | 0.0164 | 0.000328 |
| Fe | 0.0203 | 0.000609 |
| S | 0.0208 | 0.000416 |
| SiO2 | 0.638 | 0.01276 |

## Grinding & Floatation Circuit



## Flash Concentrate – 3,3 t/h

| Component Name | Value | Tolerance |
|---|---|---|
| Au | 2.242E-05 | 1.121E-06 |
| Cu | 0.3619 | 0.007238 |
| Fe | 0.11 | 0.0033 |
| S | 0.218 | 0.00436 |
| SiO2 | 0.227 | 0.00454 |

## Final Concentrate – N/A

| Component Name | Value | Tolerance |
|---|---|---|
| Au | 1.773E-05 | 8.86500000000... |
| Cu | 0.3874 | 0.00774800000... |
| Fe | 0.1155 | 0.003465 |
| S | 0.225 | 0.00450000000... |
| SiO2 | 0.1935 | 0.00387 |

## Tail – N/A

| Component Name | Value | Tolerance |
|---|---|---|
| Au | 2E-07 | 1E-08 |
| Cu | 0.00086 | 1.71999999999... |
| Fe | 0.0156 | 0.000468 |
| S | 0.0107 | 0.000214 |
| SiO2 | 0.654 | 0.01308000000... |

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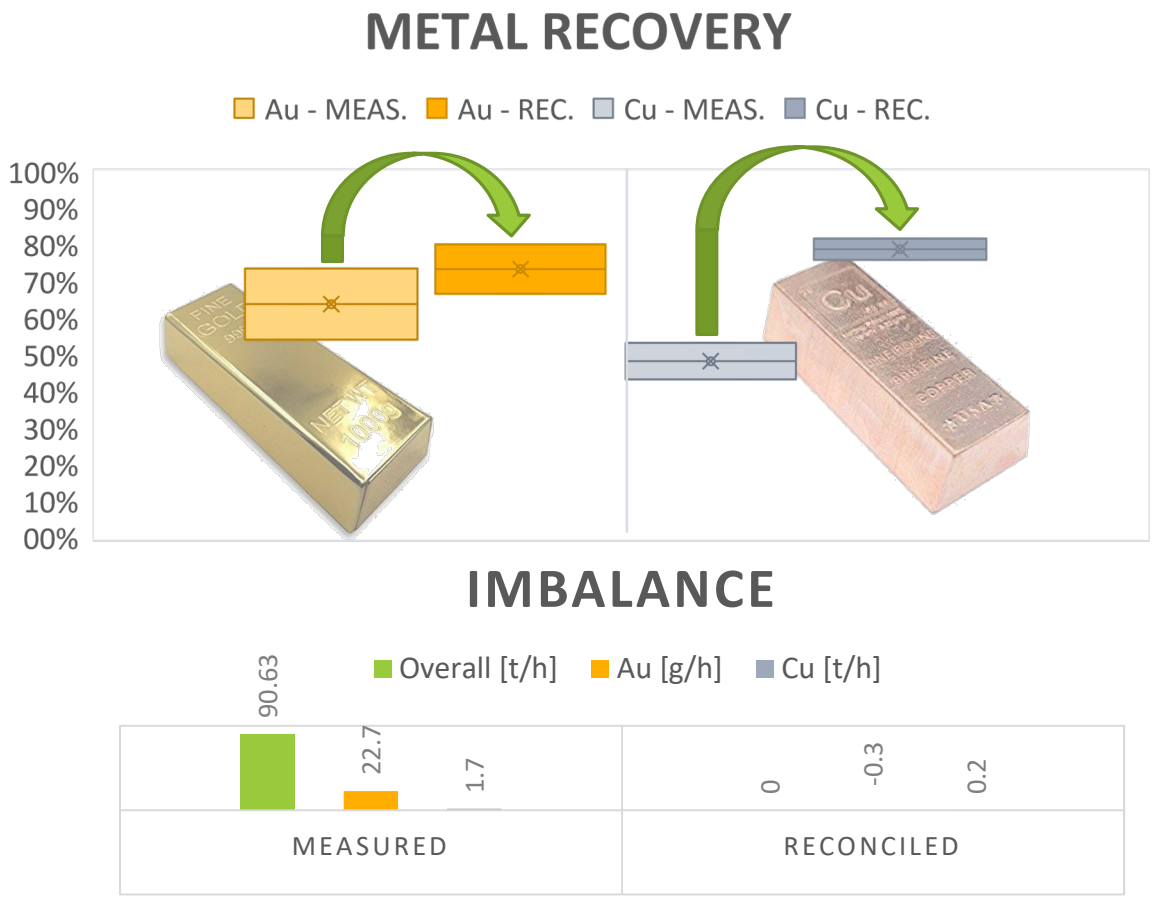
# Component balance for metal accounting

## Metal accounting

- Reliable and consistent metal content and recovery yields
- Estimation of missing measurement
- Consistent with AMIRA code

## Environment

- Improved water balance (fresh water consumption and waste water)
- Auditable by environmental authorities







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# Sigmafine analytics data engineering map

**Metal accounting**: improve estimation of metal content in the ore and recovery yields

**Material tracking**: verify process unit or product yield vs. feed mixture

**Batch cost allocation**: accounting raw materials and waste related to a production batch and feed Machine Learning to find optimal batch duration

**Back-allocate** oil and gas production by source and by shareholder to assess wells' performance and accurate billing

**Oil field meter monitoring**: on-line detection of anomalies in measurements, supporting digital oil field initiatives

Real-time | Hour | Day | Month

Component balance

Composition tracking

# Component Balance vs. Composition Tracking

| | Component Balance | Composition Tracking |
|---|---|---|
| Solver type | Data reconciliation | Tracking and mixing rules |
| Operates on | Values | Strings and Values |
| Data source | Analyzers | Business information |
| PI AF structure for inputs and results | Data table | Data table |
| Configurable at asset level | Yes | Yes |

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