Replacing Missing Instrumentation with Data Science

Calculating Virtual Flow Rates for Chemical Injection

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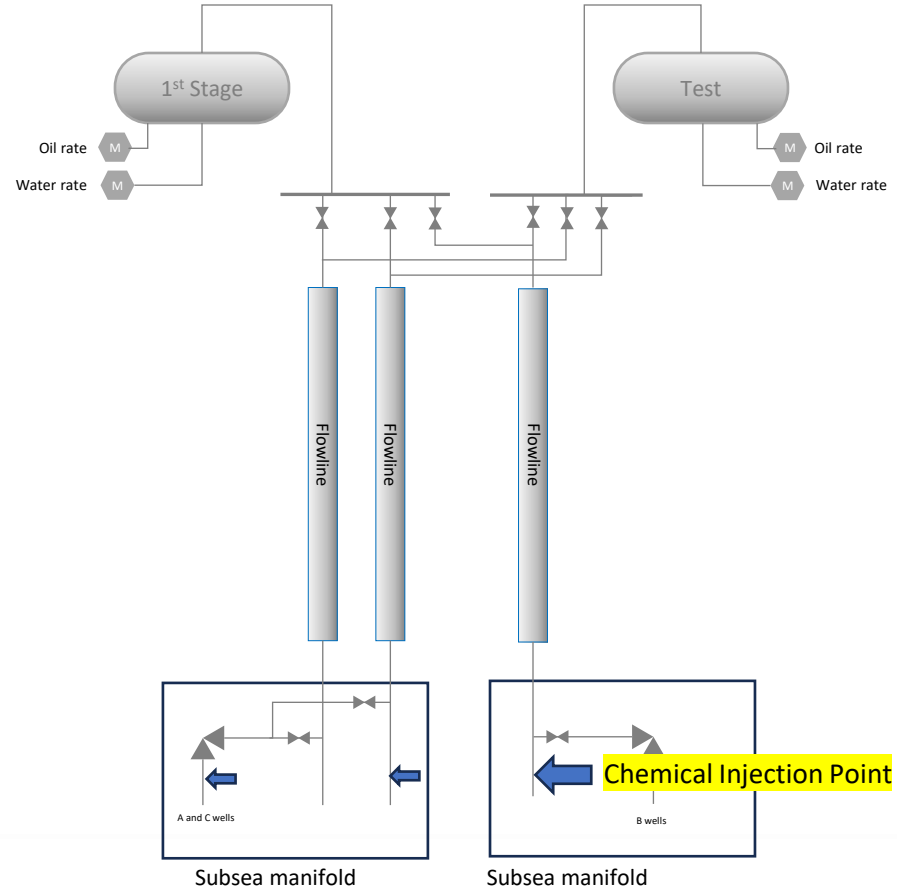
The problem

- Operator could not see if chemical injection was within spec
- No online measurement of chemical injection rates
- Could only be checked weekly in hindsight (manual spreadsheet based process)



Why Accurate Dosing Matters

- Overdosing wastes money and causes operational issues
- Under-dosing means you do not get the performance
  - Depends on the chemical but can be poor separation, corrosion, increased discharge to sea, fouling etc.)

Both under and overdosing demulsifier causes Poor separation

Ideal separation

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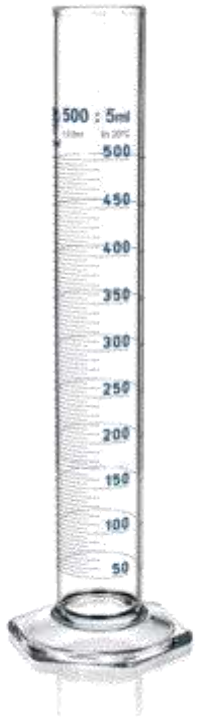
Missing information is chemical flowrate

As-is

Periodic manual calibration cylinder for checking rates

These rates were written down on a board next to the injection system.

Could not react to changes in process flow to maintain the dosage.



To be

A clear actionable view

- Real-time dashboard shows:
  - Chemical concentrations
  - Recommended dosage ranges
  - Suggested rate adjustments
- Traffic light system:
  - Green = OK
  - Orange = Action required
- Engineers can upload Excel sheets to update dosage limits.

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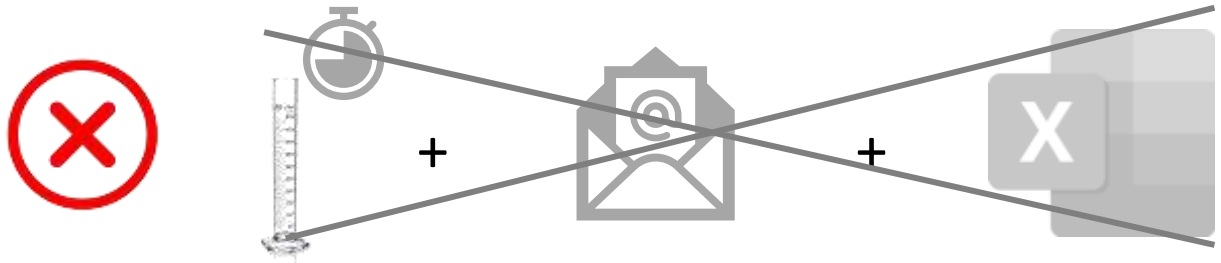
The plan



Replace manual measurements emailed to shore + weekly spreadsheet with realtime dosage based on change in tank levels plus process flows for 12 tanks/8 chemicals

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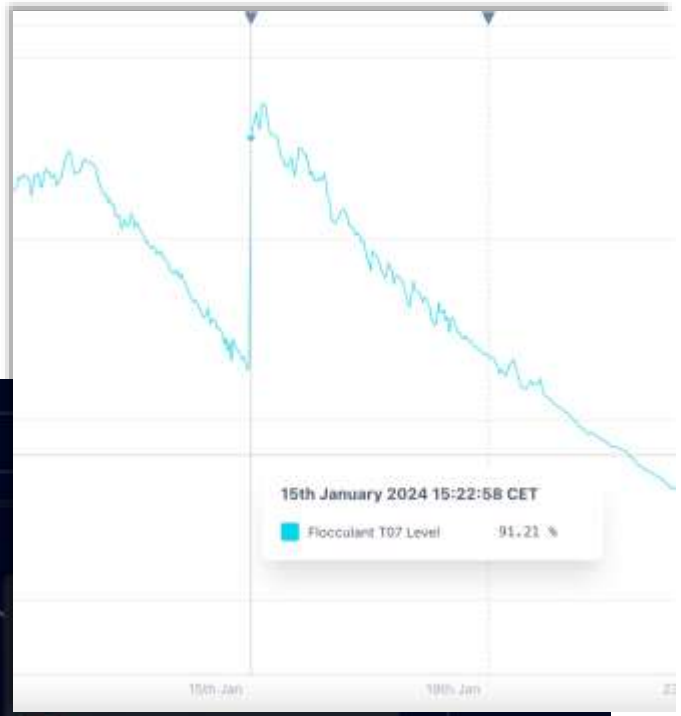
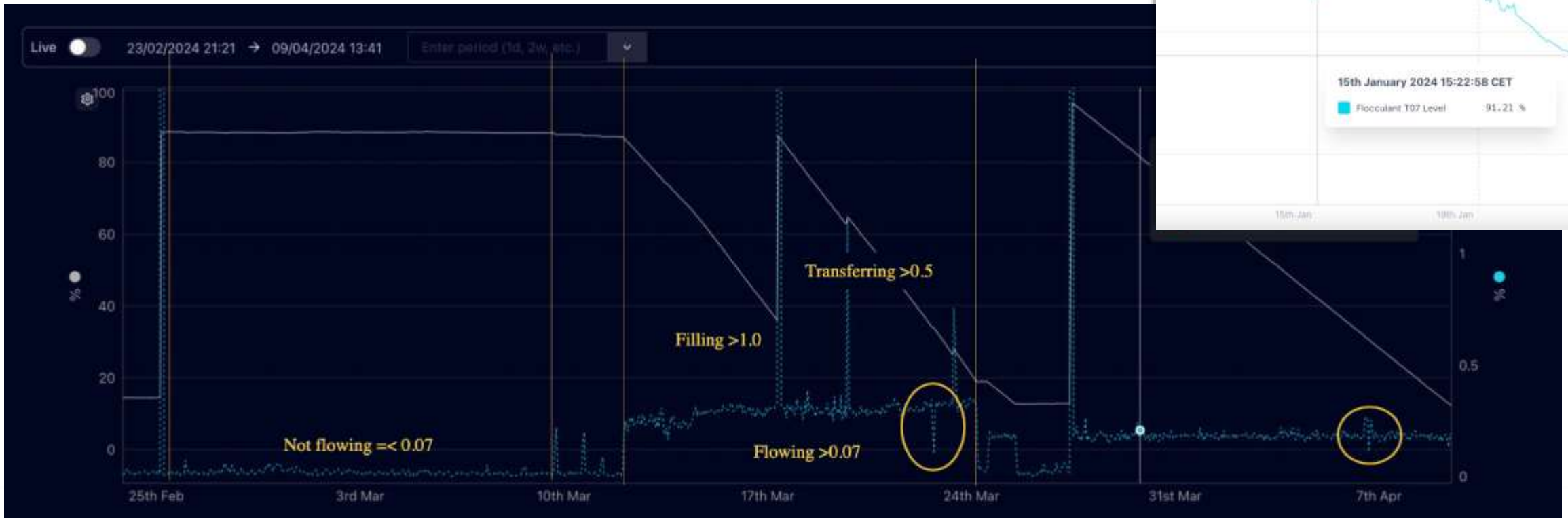
Detecting states of flow

Some tanks had a very unstable level signal



- Standard Deviation can be used to identify flowing states



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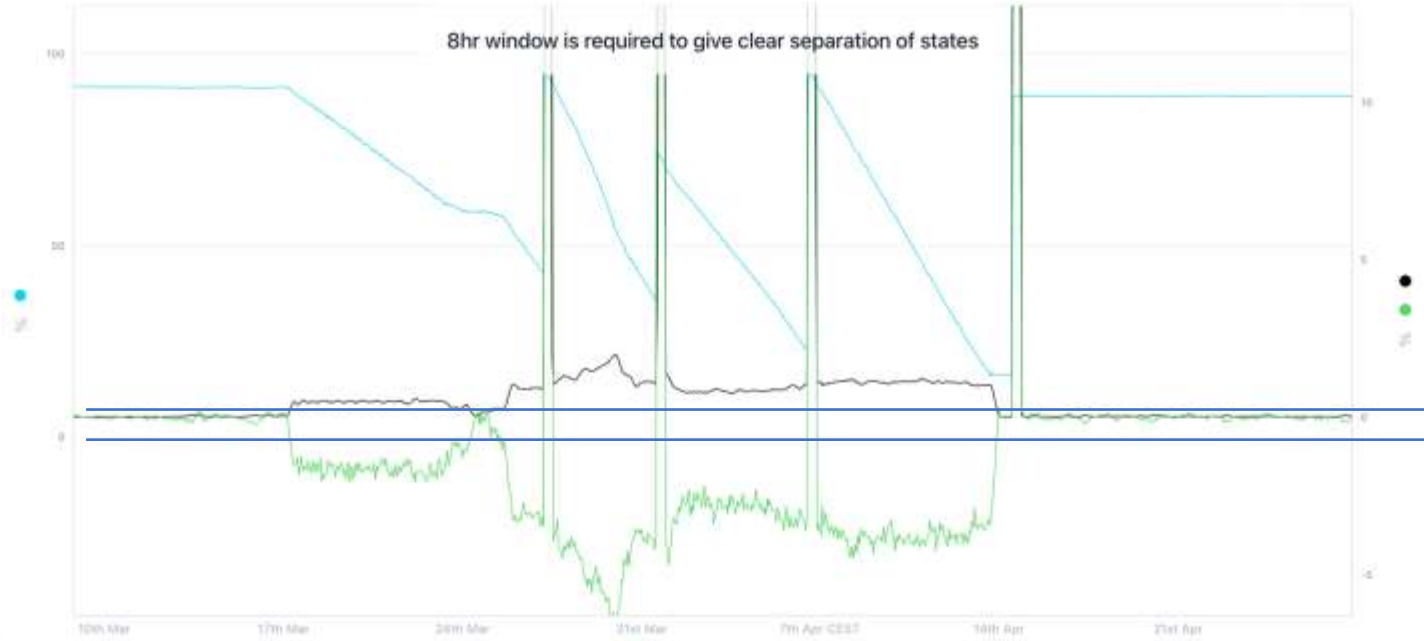
Identifying tank flowing state

- Use combination of STDDEV & DIFFERENTIAL to identify features
- Need to derive clear separation of states to avoid “chattering”



Flowing when STDDEV above this level

And DIFF below this level

Dealing with real data

- The real data was extremely noisy

1hr STDDEV and DIFF is too unstable

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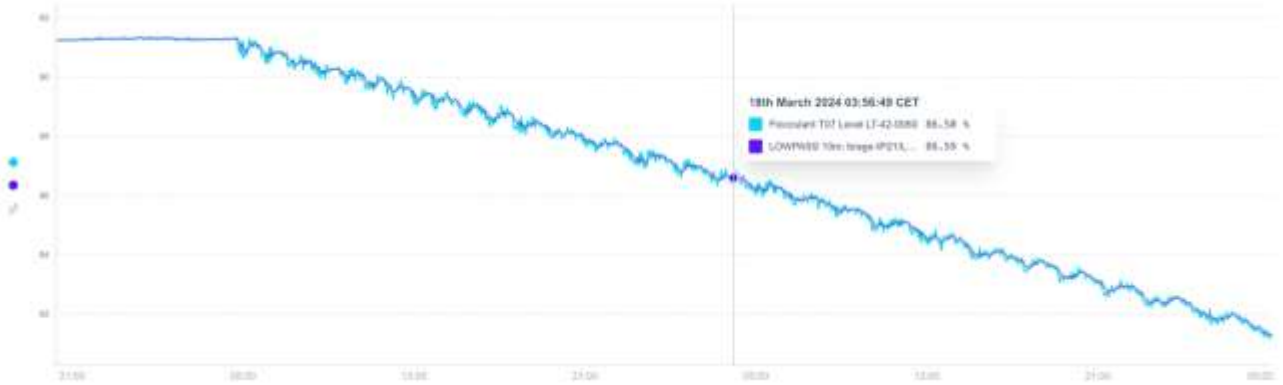
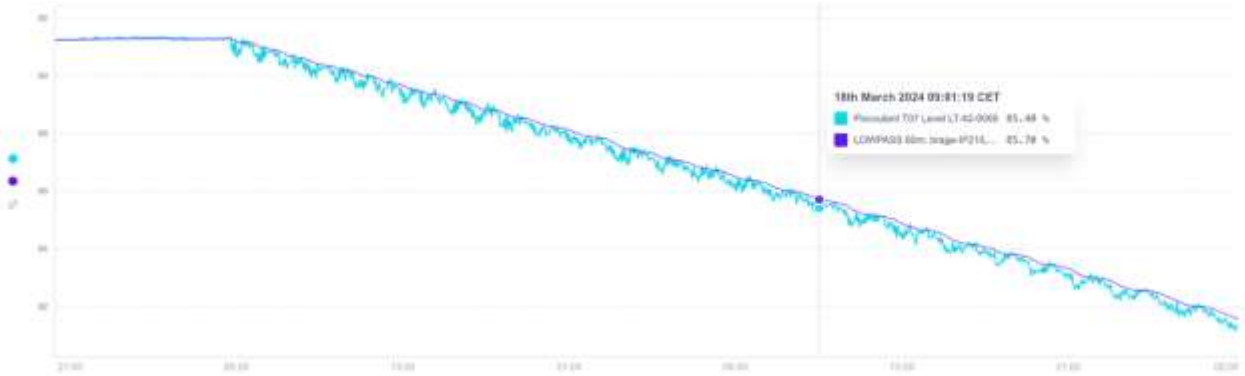
Lowpass filter improves signal

10 min window

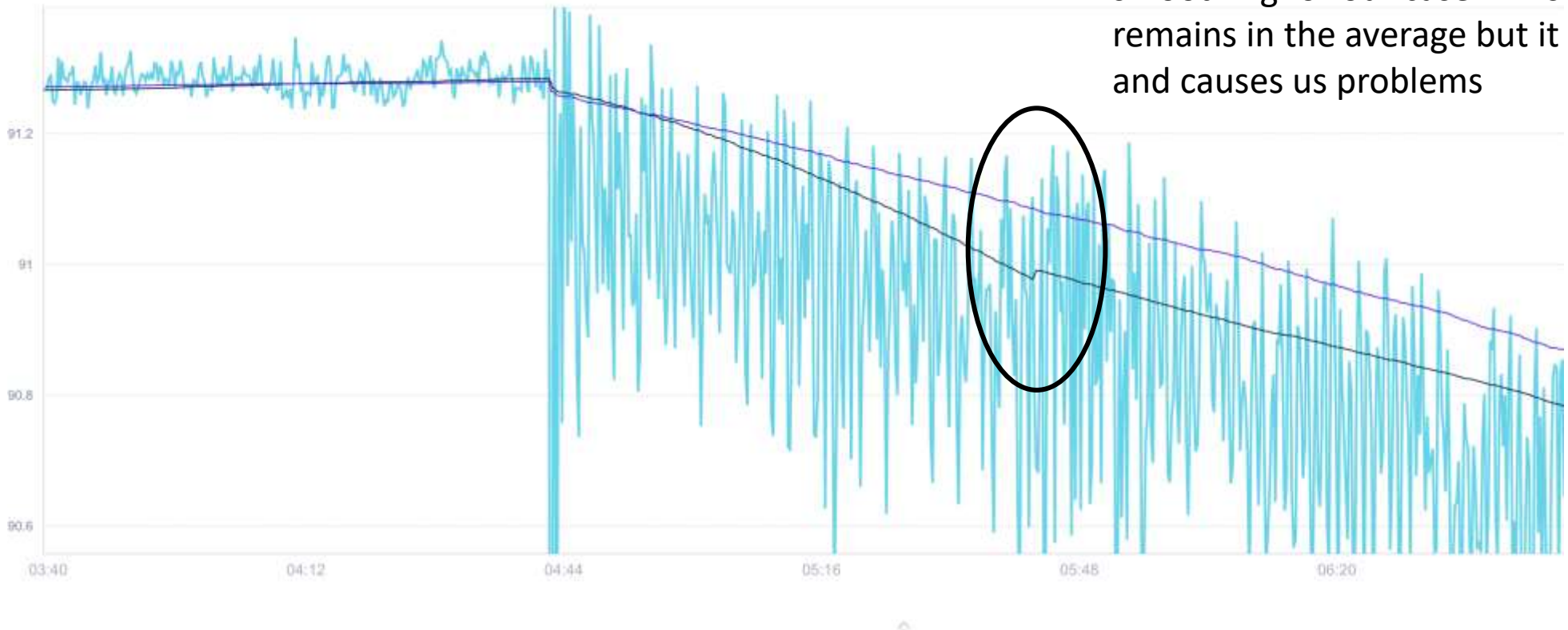


60 min window



Lowpass vs Average

60 min Lowpass filter gives better smoothing for our case. This ”feature” remains in the average but it is not real* and causes us problems



* This would imply a top-up of approx. 2 litres which is not possible

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Combining LOWPASS with DIFF gives clear separation

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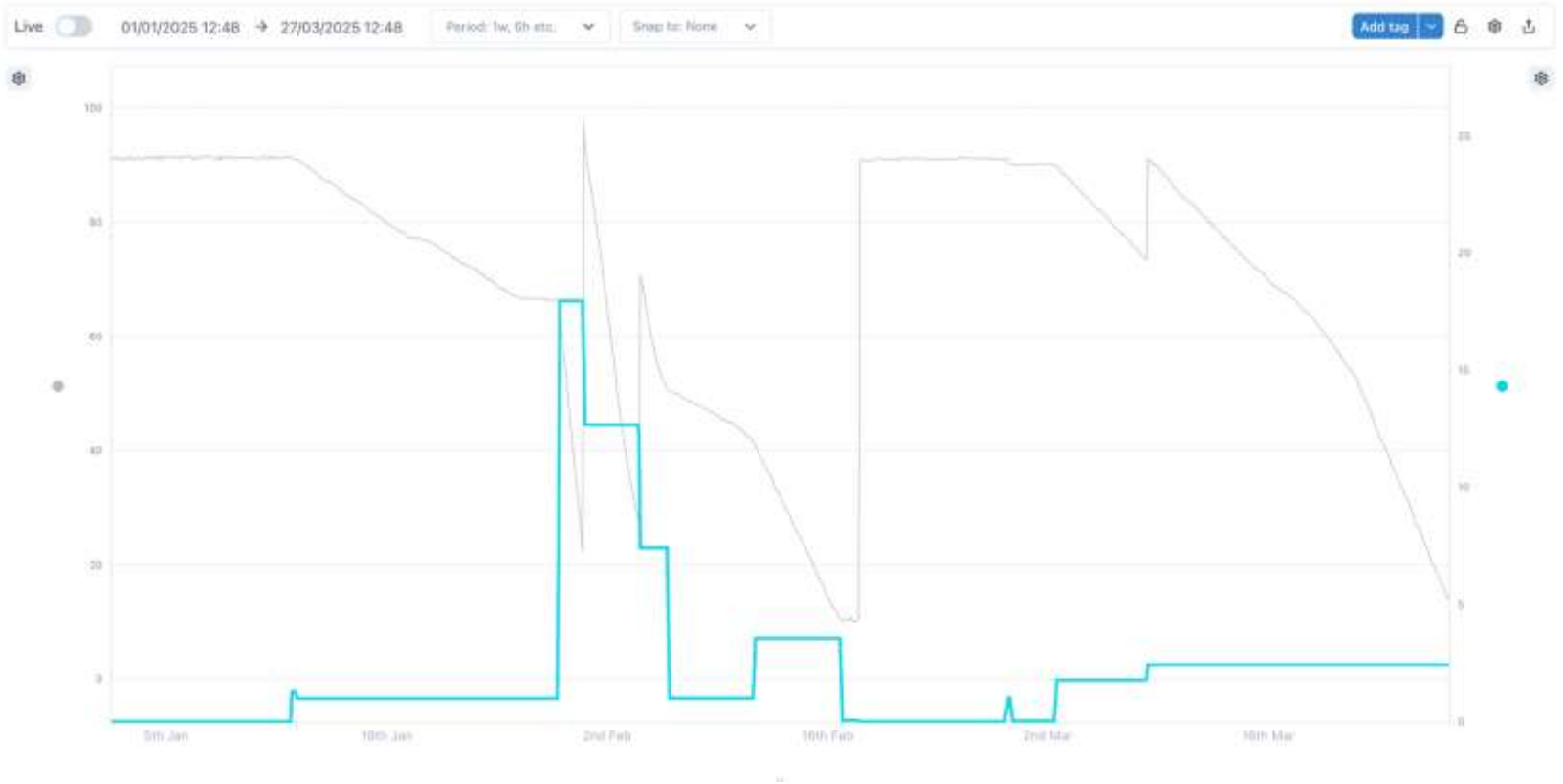
Live version

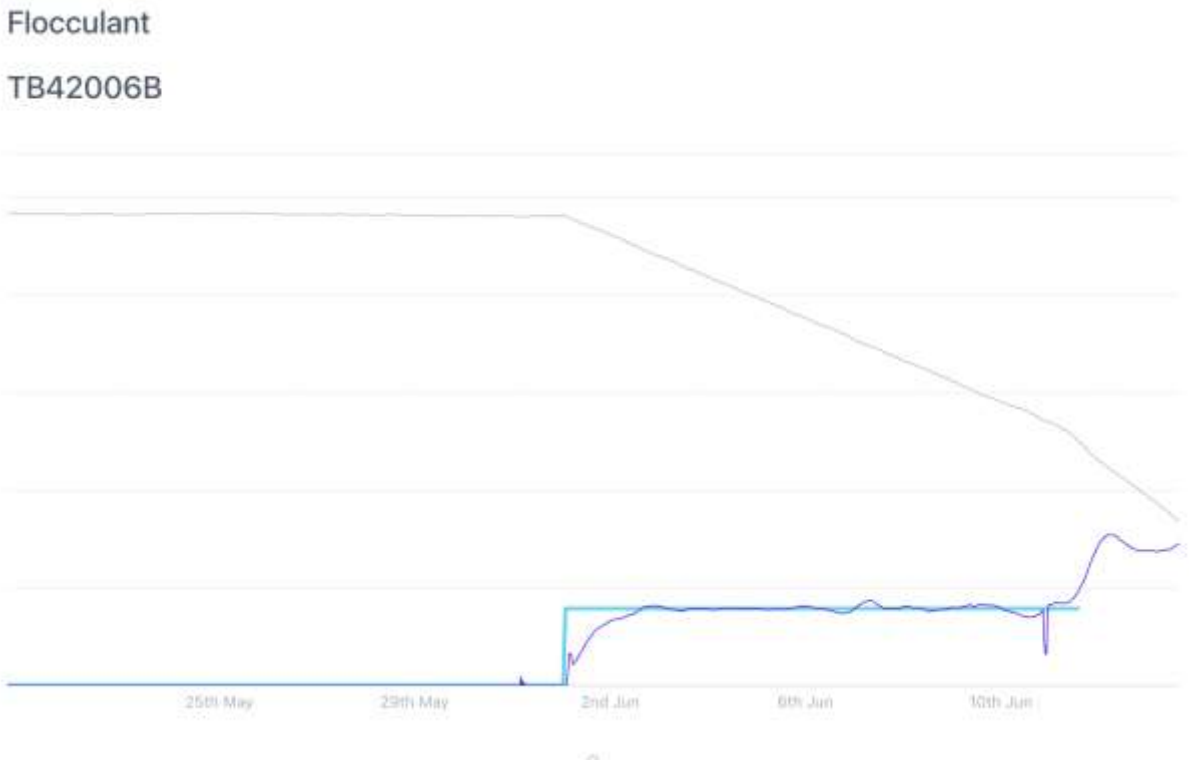
- Runs every 5 minutes
- Calculates the flowrates based on sliding window
- Window size is chosen to smooth out instability
- Good for responding quickly to changes offshore
- Susceptible to variability – not so useful for historic analysis

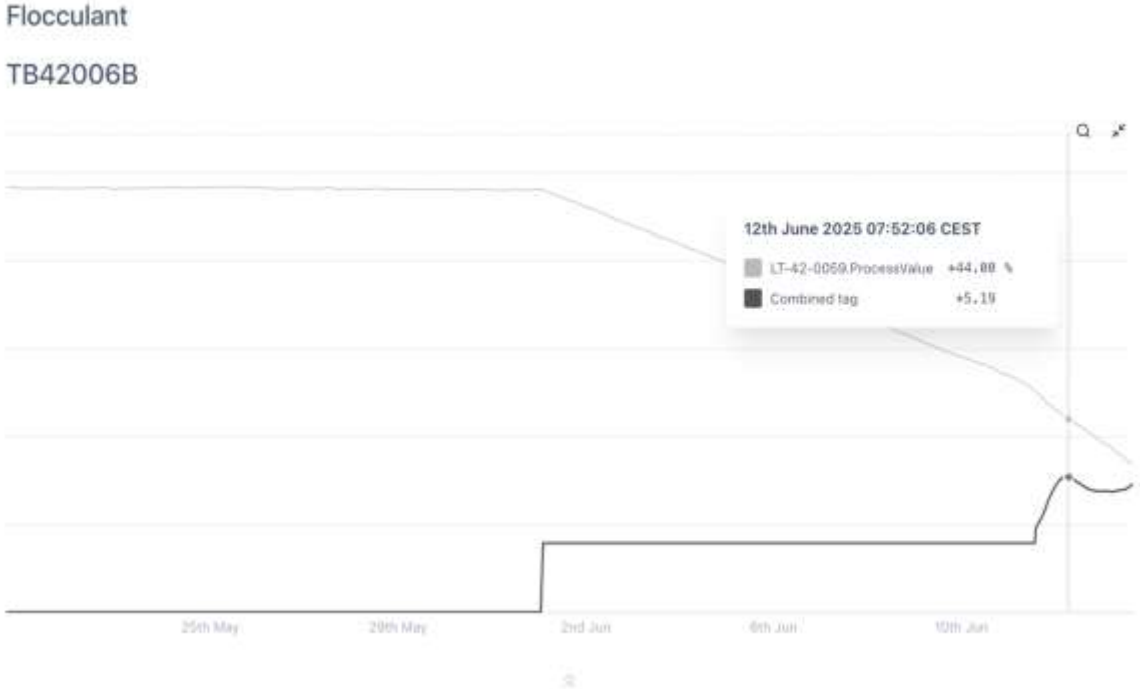
Hindsight version

- Event based
- Very accurate
- Calculates the flowrates for complete episodes
- Only calculates the flowrate at the end of an episode
- Excellent for retrospective analysis
- Cannot be used to detect changes in realtime



Combining the two





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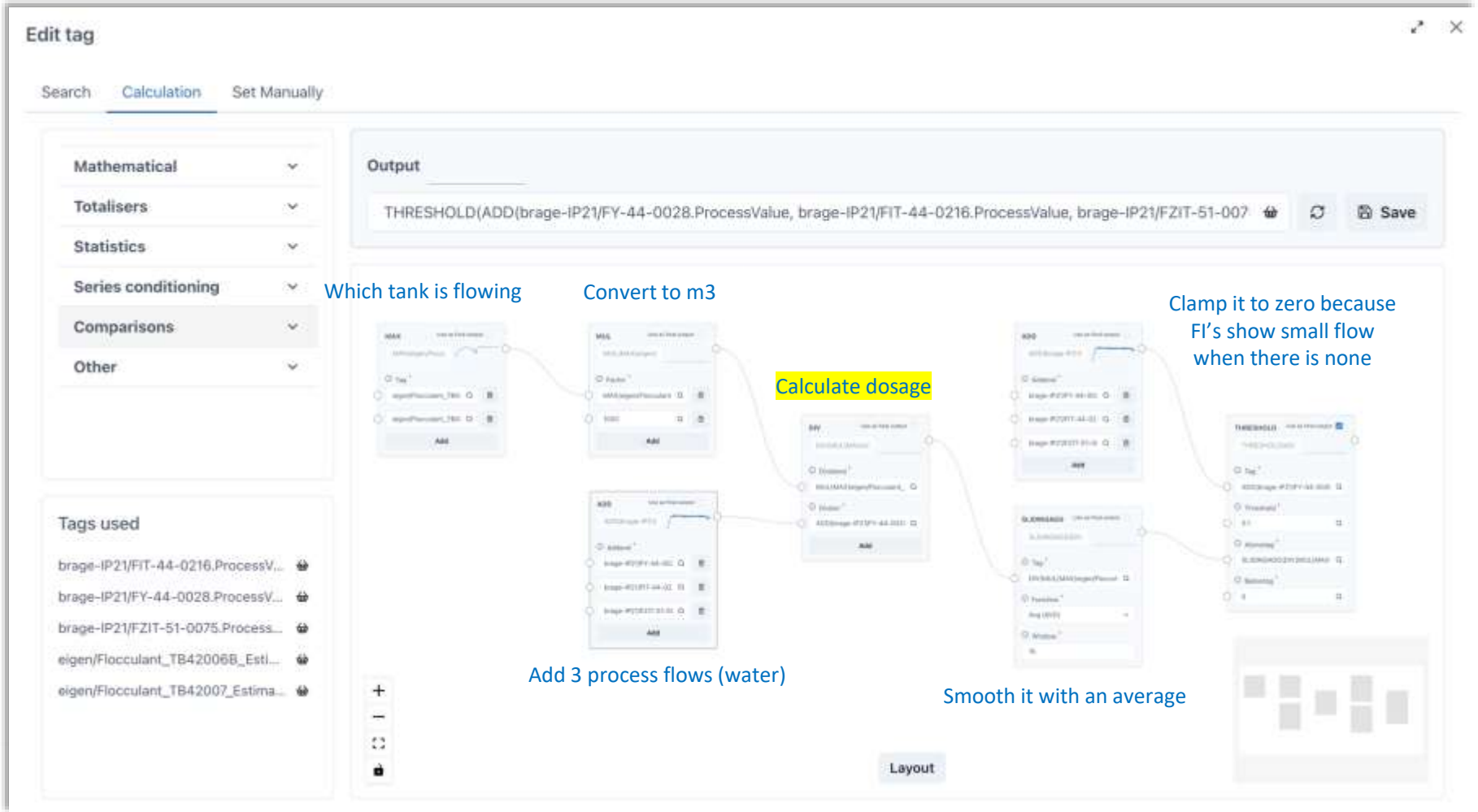
Calculating the dosage in ppm

- Simple in principle:

$$\frac{Chemical\ rate\ (l/h) \times\ 1000}{Process\ fluid\ rate\ (m^3/h)}$$

- In practice there are several steps
- All of it is done in an online calculation to create a soft tag (virtual timeseries)



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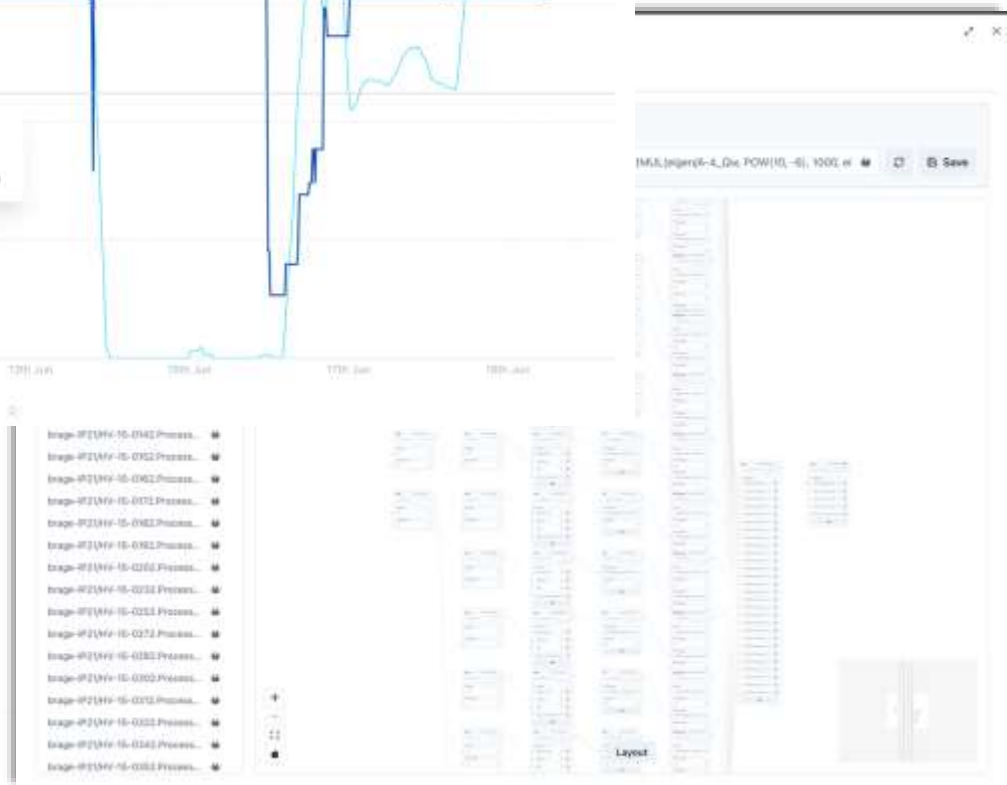
Calculating recommended dosage in l/h

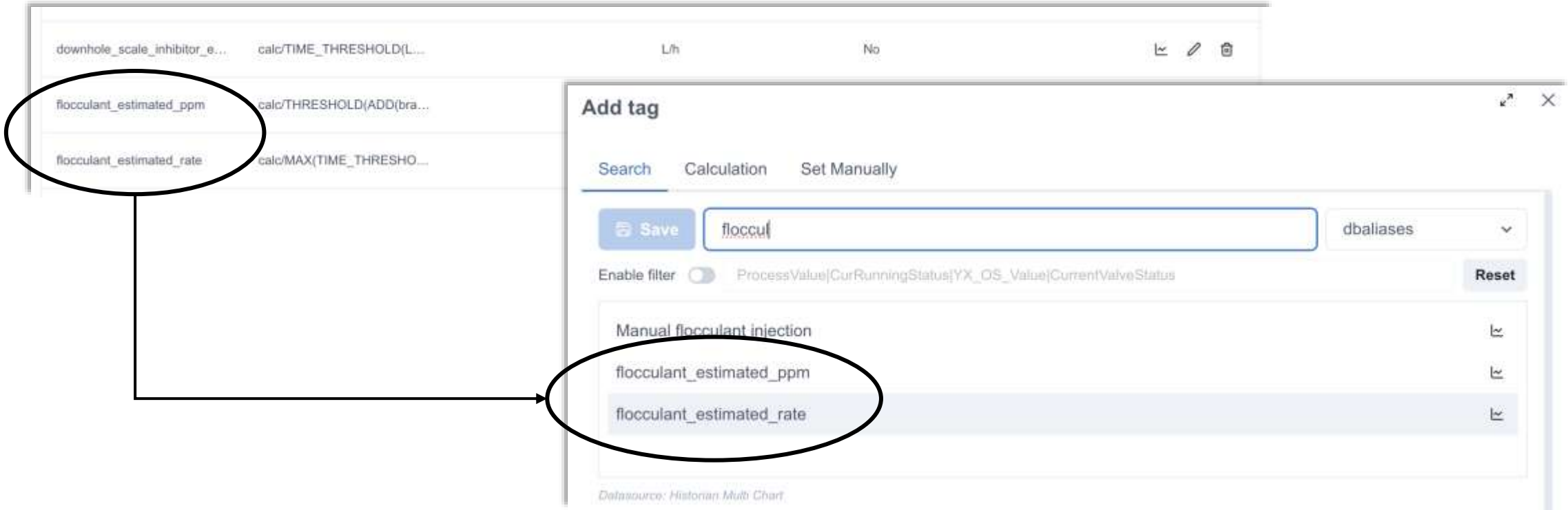
- Simple in principle:

$$\frac{Target\ ppm\ \times\ Process\ fluid\ rate\ (m^3/h)}{1000}$$

- Again, it is done in an online calculation to create a soft tag (virtual timeseries)
- Downhole Scale Inhibitor was a big calculation!
  - Sum(the water rate from the last well test if the well is online)



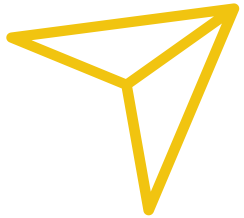
Calcs are saved with an alias for easy access by anyone – same as a “real” sensor



Operational Benefits

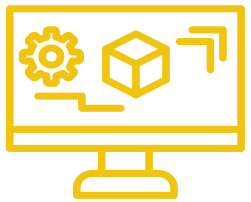
Save time:

Shortens the time of response when the dosing is getting out of the desired range from 1 week to 2-4 hours.



Instant actions:

No longer dependent on a single person or onshore-only access. Offshore operators can act immediately: Take a photo or print the recommendation.



One source of truth:

The data can be found in one place and seen in a single view instead of several tabs in a spreadsheet.

Troubleshooting aid:

Early detection of equipment issues (pumps, valves). Identify when flowmeters require calibration.

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Thank you!

For any further queries, email us at info@eigen.co

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