Case Study: How IntelliSense.io's Thickener Optimization Application turns BASF test work into a real-time flocculant advisory

Introduction

Thickeners are applied in the industry as liquid-solid separation unit operations to achieve the following primary process objectives:

a) Maximum process throughput
b) Maximum recovered solution clarity (Thickener overflow clarity)
c) Maximum solids underflow density (Underflow mass % solids)

The characteristics of the suite of settling aids (flocculants and coagulants) available on the market generally favour one or two of the above, while sacrificing the third for any given dosing regime. For example, a high underflow density operating regime will favour throughput, but compromise overflow clarities.

The balancing of these objectives would already be a challenge if the thickener feed mass flow and material properties were constant. However, these change constantly. Due to changes in the ore properties and upstream process performance, feed properties such as the feed flow rate, slurry density, particle size distribution and pH vary all the time. And all of these not only alter the solids loading of the Thickener, but they directly impact the effectiveness and nature of the flocculant chemistry.

It is therefore no surprise that operators and metallurgists are struggling to find the right flocculant dosing to maximise their Thickener performance.

Our Solution

BASF and IntelliSense.io, as industrial partners, have combined their respective expertise in ore beneficiation chemistry and industrial AI technology - to solve this challenge for the minerals processing industry.

The Chemistry

With technical representation and a strong on-site presence in over 100 countries, BASF are well versed in the chemical interactions among process variables. This is especially bolstered by their wealth of experience in doing test work in the mining industry. As part of BASF's standard flocculant screening and dose optimization, laboratory test campaigns are conducted to assess the response of slurry liquid-solid separation pertaining to the aforementioned criteria.

Their *Flocculant Chemistry Response* test work particularly provides metallurgists on-site with a quantitative understanding of how a given flocculant performs under different feed- and operating conditions. The following diagram provides a summary of the variables involved in this test work:

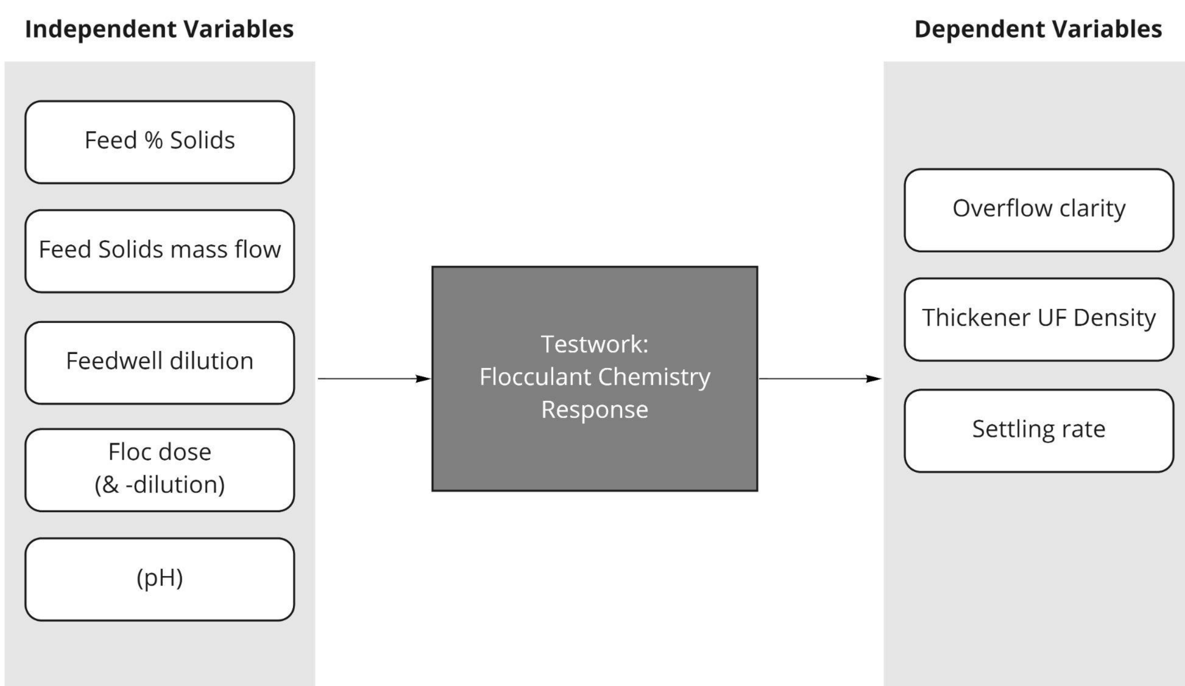

Figure 1: Summary of key variables involved in BASF flocculant test work.

Graphs resembling the following are produced during this test work phase:

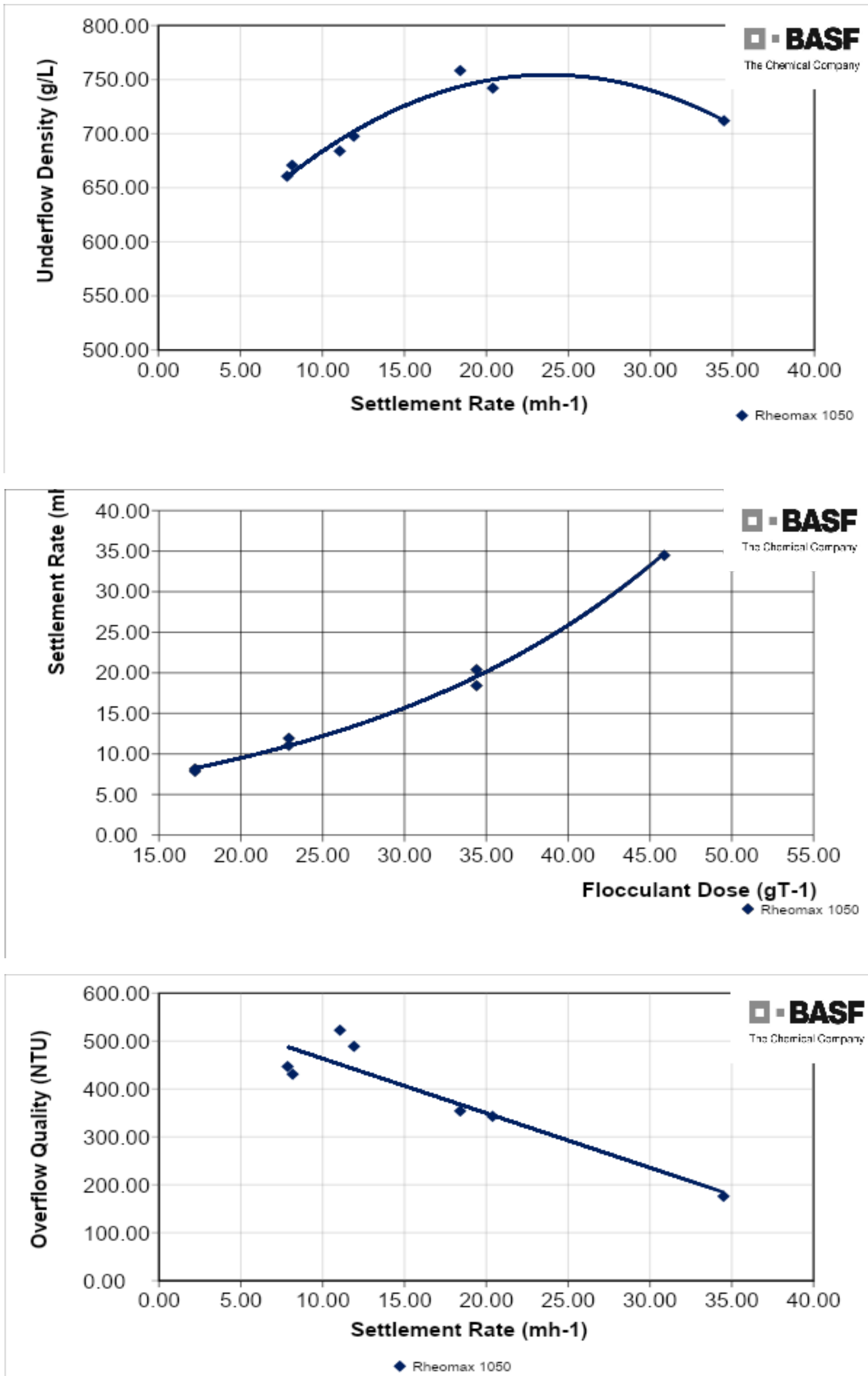

Figure 2: Sample trends from BASF flocculant test work for a specific client.

The Smarts

Harnessing their data analytics and AI capabilities, IntelliSense.io uses the quantitative intelligence in these test work datasets to configure a *Flocculant Operating Regime Model*. This model can predict how a flocculant's performance will change based on feed and flocculant dose conditions, and can be used to simulate different operating regimes.

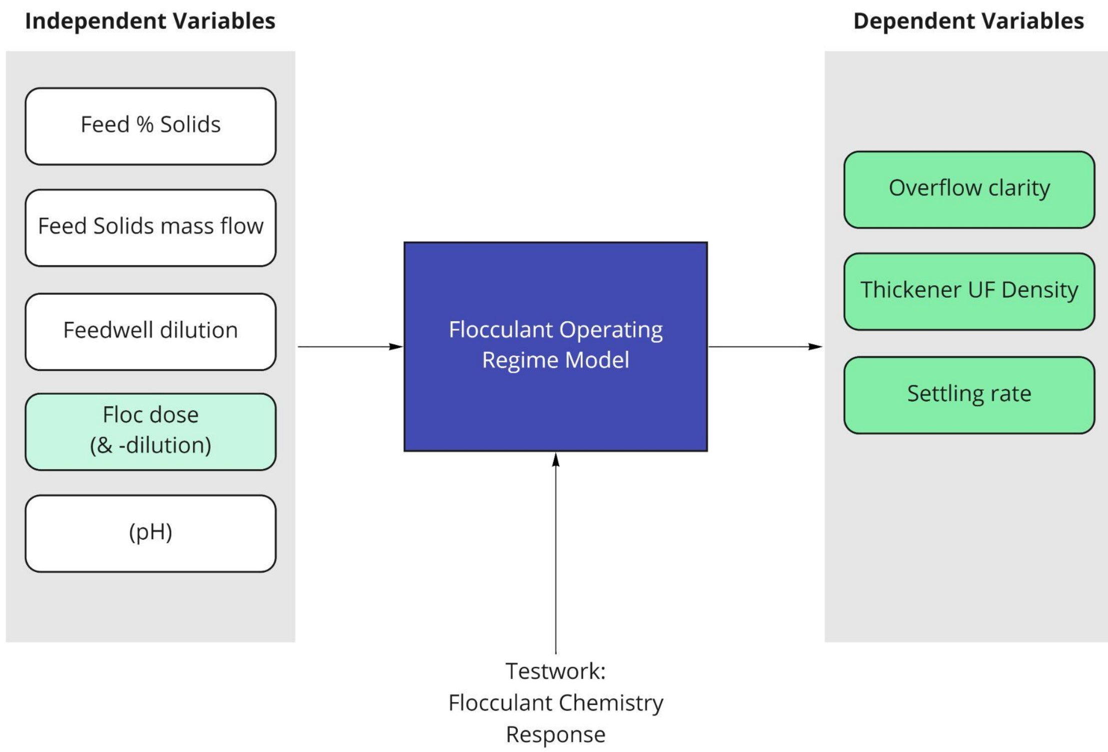

Figure 3: Outline of the Flocculant Operating Regine Model, based on the test work.

Now that a given site's flocculant chemistry has been digitalized, this is incorporated into IntelliSense.io's Thickener Optimization Application. This Application combines the Flocculant Model with a second model: a predictive machine learning model that "learns" how a particular Thickener performs under different operating conditions. For example, what underflow density and rake torque can be expected when a certain type of material is fed into the Thickener at a given flow rate and density. This model implicitly models the complex dynamics of a thickener to deliver its comprehensive digital twin.

The combination of these two models mean that the Thickener Optimization Application draws on a hybrid modelling approach to deliver a robust digital twin that employs the best of the worlds of chemistry and digital. The following diagram summarises the Inputs, Virtual Sensors and Predictions typically involved:

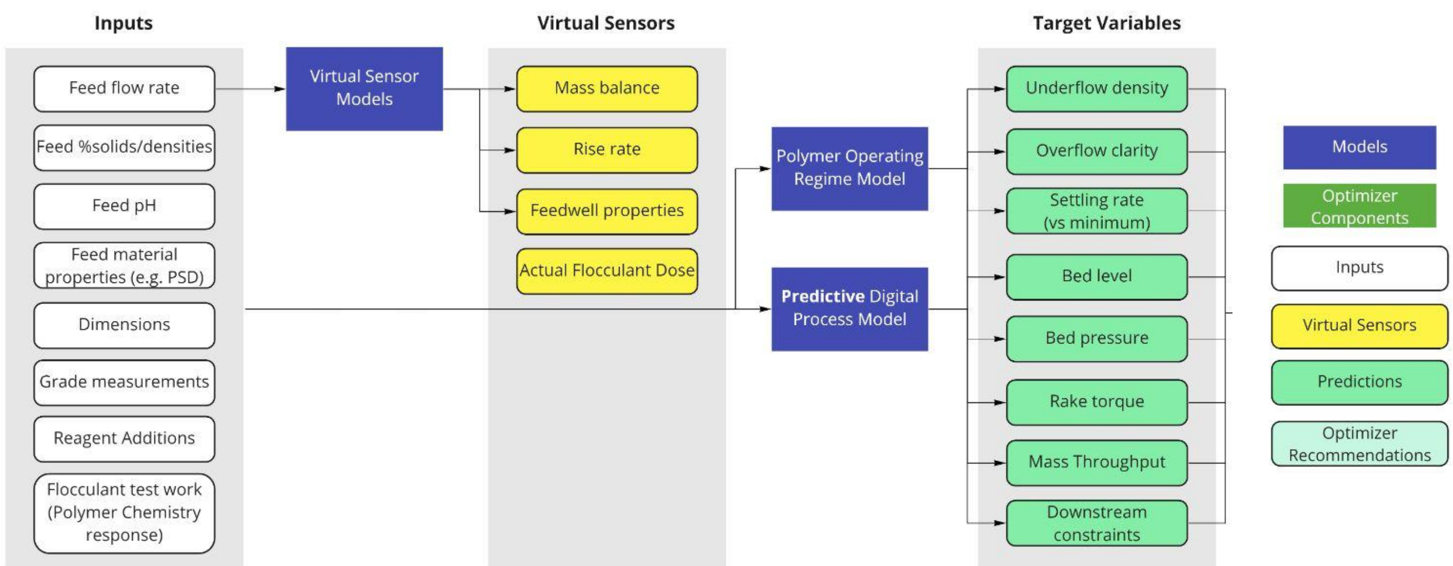

Figure 4: Summary of the Thickener Optimization Application's Inputs, Models, Virtual Sensors & Predictions.

Real-time Optimization

With these Models in place. BASF and IntelliSense.io work with the client to understand their priorities for each particular thickener. This prioritisation and relative weighting of objectives are done in IntelliSense.io's brains.app AI platform - and it's called the *Value Driver*. An example of a Value Driver is shown below:

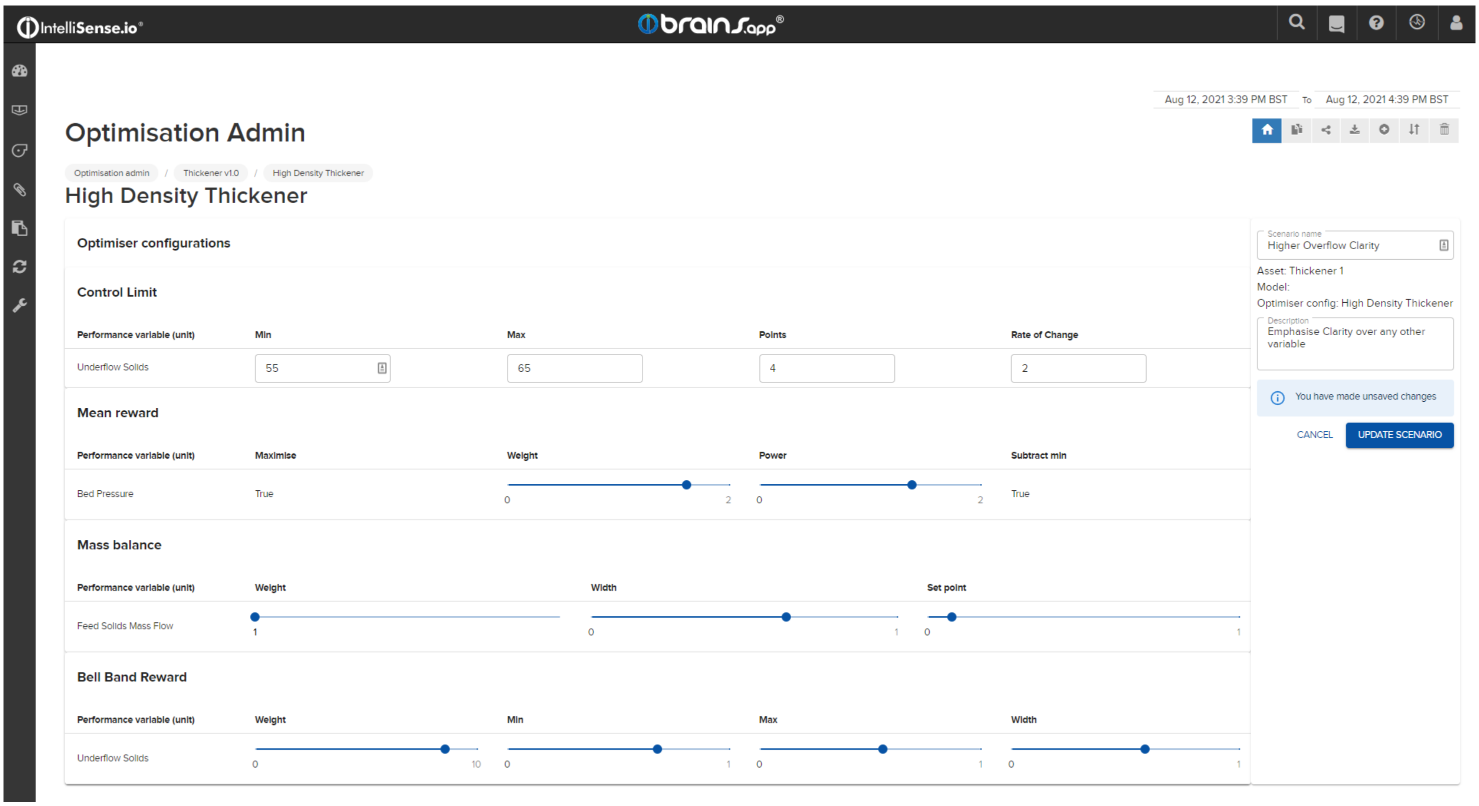

Figure 5: Example of a Value Driver being configured for the Thickener Optimization Application.

The Thickener Optimization Application then uses both the predictive Digital Process Models (chemistry and process) and the Value Driver, to provide metallurgists and operators with a Real-time Optimizer for their particular thickener. This Optimizer uses the live process data (input data in Figure 4) to not only ***predict*** how the thickener will perform an hour into the future - but it ***recommends*** optimal control variable setpoints to Operators in real-time.

These recommendations can either be provided to an Operator as an advisory (see Figure 6 below), or can be directly sent to the lower level control system.

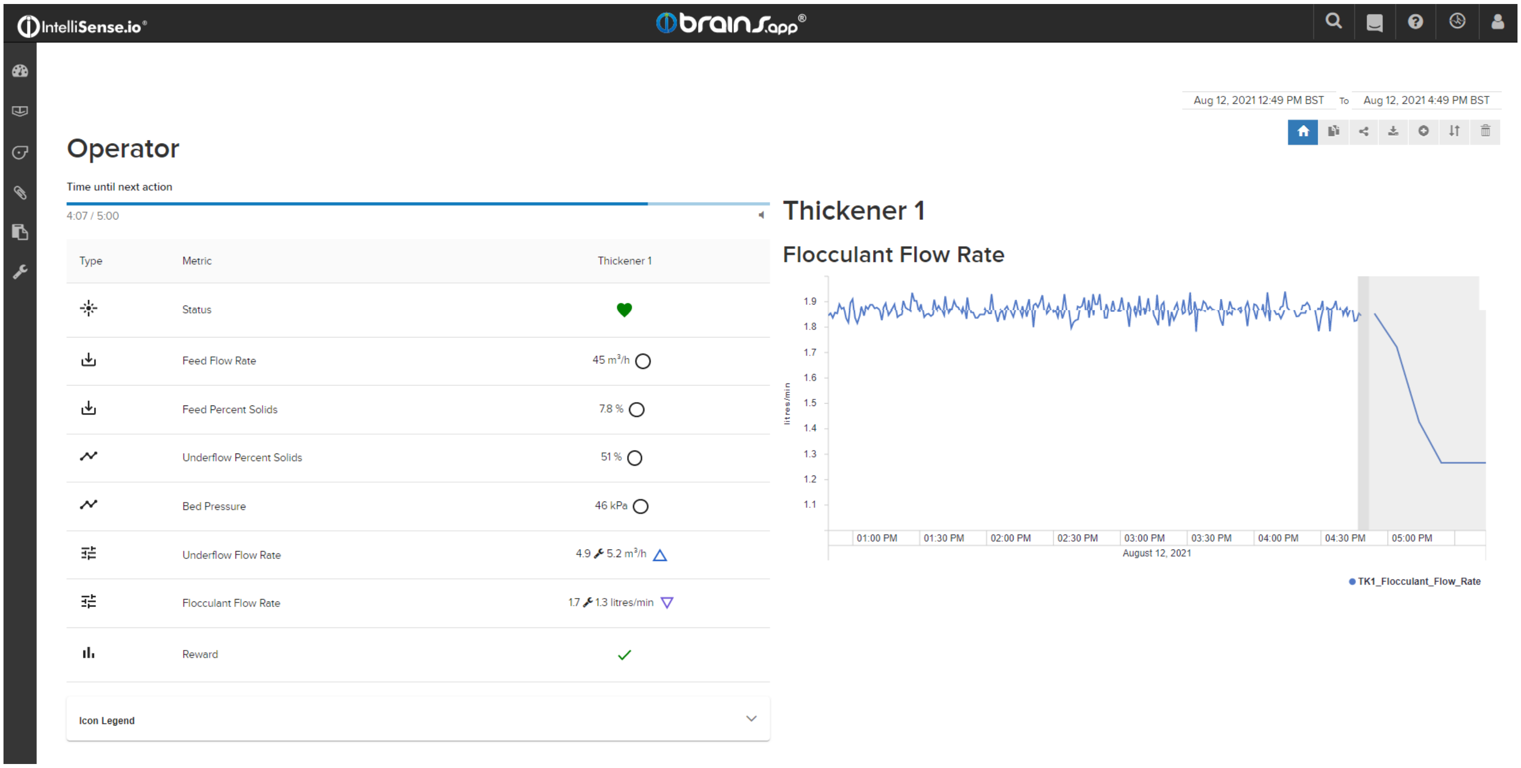

Figure 6: Operator Screen, providing the Thickener Optimizer's recommendations to an operator as an advisory. The gray area on the right of the graph shows the recommended flocculant flow rate 60 minutes into the future.

Typical control variables for which the Thickener Optimization Application provides setpoints are summarized in Figure 7 below:

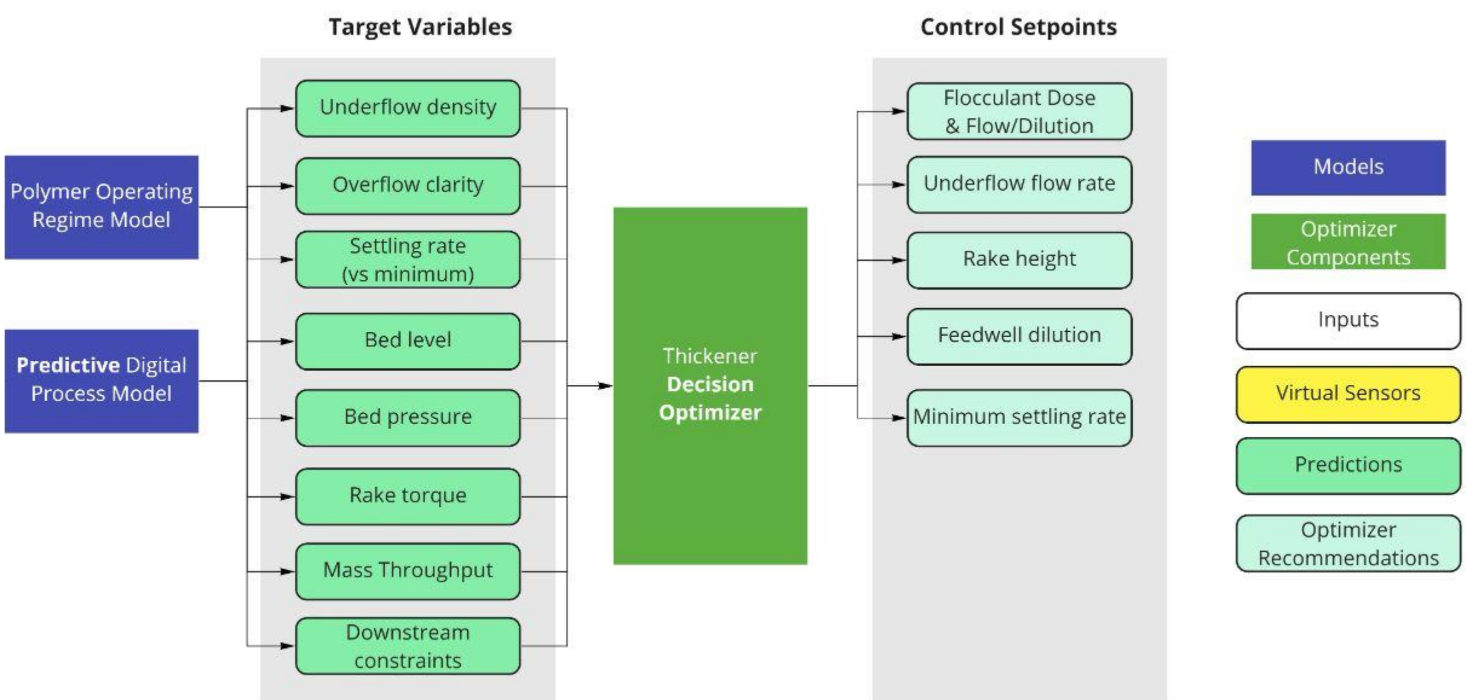

Figure 7: The Predictions and Recommendations made by the Thickener Optimization Application.

Conclusion

By drawing on a unique synergy between hands-on chemistry and a fit-for-purpose AI, the Thickener Optimization Application makes it possible for sites to truly optimize their thickener operations. This includes continual optimization of the flocculant dose, as well as physical operation of flows and the rake. This means that the thickener operation can maximise their desired thickener operating regime across a range of feed conditions.

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