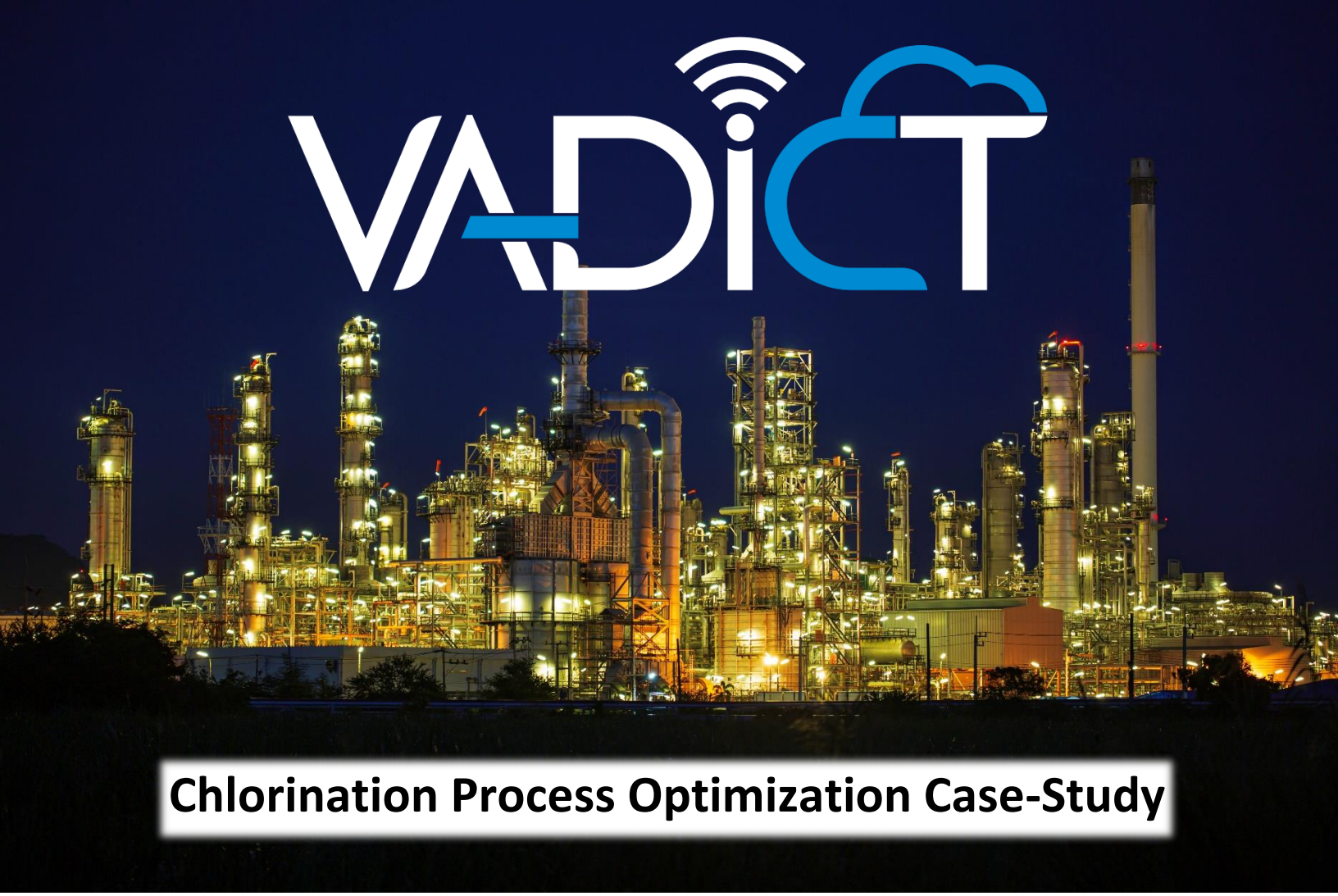


# Chlorination Process Optimization Case-Study


**SUMMARY:**

Industrial enterprises face production losses due to various factors such as equipment reliability, process parameters, availability of process experts round the clock, etc. The automation systems can handle normal operating conditions based on static logic implemented, but fail to handle situations outside normal operating conditions. A different approach is required to be able to tackle the challenges of process industries – one that dynamically learns from past failures and predicts future failures. Such an approach is made possible by Vadict through its Process Optimization products that leverages latest advances in data-science (AI/ML) and advanced sensing to solve some of the most challenging problems faced by industrial enterprises.

This case-study demonstrates how such an advanced approach can reduce the failures in a Chlorination process by 98%.

## PROBLEM STATEMENT:

Vadict Process Optimization Analytics Solution was tried out for a company manufacturing pigments using Chlorination process. Chlorination batch reactor is a jacketed vessel with agitator (including VFD for initial start up).

The Chlorination process depends entirely on having appropriate amount of Chlorine available for completing the reaction. This Chlorine addition rate increase(32, 55, 90, 110 kg/hr) should stop when reaction process ends, after which the Chlorine addition rate should decrease(55, 32 kg/hr). However there is no easy way to know if the reaction has completed with good quality except for counting time elapsed and then testing quality using manual tests. What can be done in automated way to ascertain that the reaction process has completed so that Chlorine addition can be adjusted accordingly? Without this knowledge the chlorine addition/reduction is just based on time elapsed, resulting in quality inconsistency.

## VADICT SOLUTION:

Historical data of process parameters and batch results was obtained offline. Vadict Process Optimization software was used to train an AI model to classify the batch results based on process parameter ranges during the batch. The AI model evaluates the combination of process parameters and predicts true batch success with 98% accuracy, and true batch failures with 85% accuracy. Vadict will integrate such a model to receive real-time batch data and the model would make batch pass/fail predictions in real-time as the batch is in progress. This will allow the customer operations team a greater control over chlorination process outcome.

### Dataset

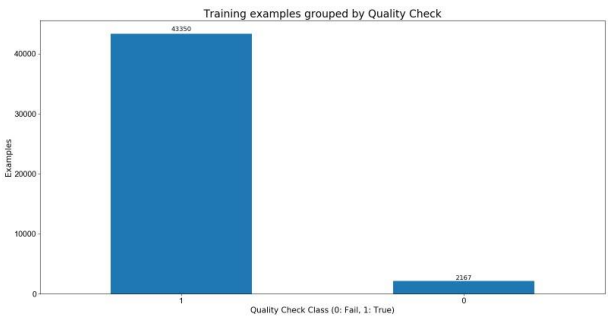
Dataset has 56897 examples.

There are total of 10 process features used for machine learning algorithm:

1. reactor
2. temp_reactor
3. temp_jacket_supply
4. temp_jacket_return
5. temp_oil_return
6. temp_oil_supply
7. valve_oil_supply
8. flow_chlorine_supply
9. totalizer_chlorine_supply
10. valve_chlorine_supply

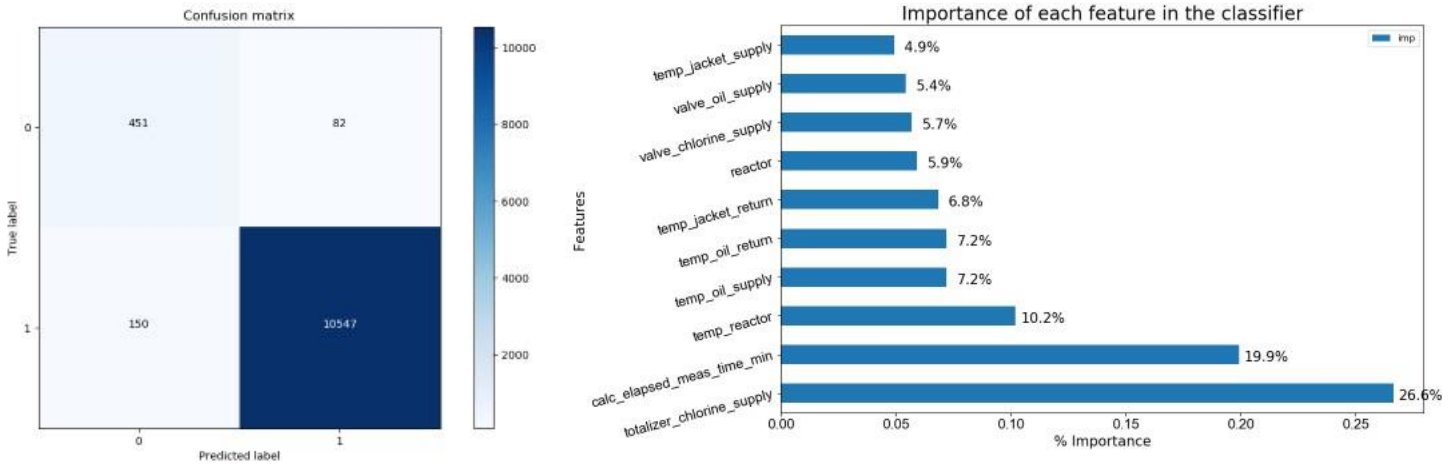
Feature flow_chlorine_supply has missing values and is not used to train classifier.

Dataset is highly imbalanced and need to be treated differently



# Chlorination Process Optimization

- The test results are displayed in confusion matrix below.
- The importance of each feature is displayed in the graph on right
- The accuracy is improved with inclusion ofelapsed_meas_time_min feature.




The Fail Class has an accuracy of 84.6% while Pass Class has accuracy of 98.6%
Combined Accuracy of both the classes is 97.9%

**OUTCOMES:**

- Accurate and real-time prediction of the batch process result based on changing process parameters.
- The batches predicted to fail can either be salvaged or shortened to reduce production losses and resource consumption.
- Easily scale this prediction capability to all reactors in plant. The accuracy of predictions will improve over time with more data.