Data Driven Control Strategy for Dewatering of Inactivated Bio-solids in Centrifugal Decanters

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Helix Lab

Introduction

Project Description:

The conventional method of optimizing polymer dosing in the centrifugal decanter is typically based on trial and error. In this approach, the operator adjusts the polymer dosage by considering the amount of suspended solids in the reject water and the quality of the cake produced by the centrifugal decanter. However, incorporating sensors to determine the total suspended solids (TSS) can be costly and lacks versatility, as it cannot be easily integrated into every decanter.

The project aims to address this issue by integrating machine learning techniques, incorporating two different variables: the TSS of the retentate and color values obtained from a camera. By analyzing these variables, the system can accurately determine the TSS present in the retentate, leading to automated polymer dosing within the system.

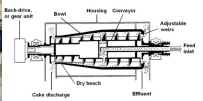
The project has been carried out with collaboration from Helix lab and Novozymes A/S.

Waste Water in Industry

The waste water coming out from the biotech industry consists of biomass, process waste water and various other impurities. This is treated carefully within the treatment plant. The process includes various tasks from inactivation of biomass, denitrifying, separation of inactivated biomass sludge, etc.

Centrifugal Decanter:

Centrifugal decanter is used for the separation of solid and liquid phase from a sludge. Sludge can be defined as a wet biomass waste from industry which is a mixture of biomass and water and various other smaller impurities



Polymer Dosing:

Polymer dosing, an integral part of the waste water treatment process, aids in the aggregation and flocculation of fine particles, further improving the separation efficiency. Traditionally, determining the optimal polymer dosage has relied on empirical approaches and manual adjustments, which can be time-consuming and non efficient way of using the resources of the industry.

Machine Learning:

By using advanced algorithms and data-driven models, machine learning techniques can analyse various parameters and optimize the polymer dosage dynamically. This innovative approach allows for real-time adjustments and improved treatment outcomes, ensuring the most efficient use of resources.

Linear Regression:

It is the most broadly applied statistical techniques to investigate the relationship between one dependent variable and one or more than one independent variable.

Methods

Current Method:

The current method for determining the optimal dosage of polymer in the centrifugal decanter involves taking the TSS (total suspended solids) measurement of the concentrate. However, this process is time-consuming, as it requires regular sampling and analysis. The operator needs to collect samples of the concentrate, perform TSS measurements, and then adjust the polymer dosage based on the results. This trial and error approach can be inefficient and may result in suboptimal dosing, leading to compromised process efficiency and quality of the final product.

Purposed method:

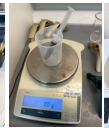
A proposed method for optimizing the polymer dosing in the centrifugal decanter involves utilizing a camera to capture the color value of the reject. By analyzing the color value, it is possible to determine the concentration of total suspended solids (TSS) in the reject water.

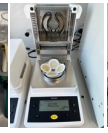
Degassing Tank and Camera:

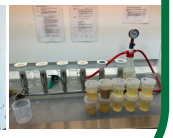
A cylindrical stainless steel tank has been installed at the outlet of the decanter to collect the reject water. The retentate, upon exiting the decanter, is allowed to settle in the tank for a few seconds. Subsequently, the liquid is discharged from the bottom of the tank through a pipe with a conical outlet.

Sampling:

A sampling period of two weeks was conducted following the installation of the tank. During this period, samples were collected every 20 minutes while varying parameters such as polymer dosage and feed flow. The collected samples were handled with care and transported to the laboratory for further analysis.



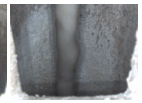


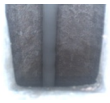


Outcome

Degassing Tank:

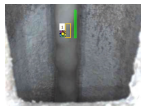
After conducting numerous trial and error iterations and systematically solving each problem, a fully functional tank system was successfully developed. This system effectively received the reject water and ensured a consistent laminar flow during its discharge.

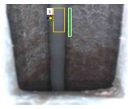




Camera Adjustment:

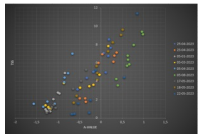
The adjustment of the camera was carried out by adopting the same principle as degassing tank. The distance and the window at which the camera is fixed, and the capture window of the camera was fixed by carrying out different trials and sampling of the reject water. This adjustment was important since the camera should always focus on the image of the flow and not that of the background.

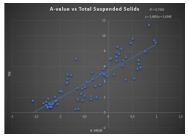


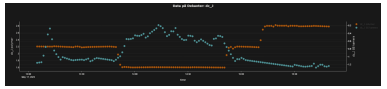


Data Analysis:

After conducting the measurement campaign, the obtained data was analyzed, revealing an average linearity of above 75% between the two variables for different days between the TSS and color value. Achieving this level of correlation was one of the primary objectives in integrating the system with the decanters. The next process is to aggreagate the data and get a valid result between the two variables.







In addition to the data analysis, further analysis involves integrating a machine learning model into the system. This model is designed to detect the TSS levels in the centrate, thereby facilitating the optimization of polymer dosing in the decanters. By integration of machine learning, the system can automatically adjust the polymer dosage based on the detected TSS levels, leading to efficiency and performance of the decanters.

Perspectives

Project:

- Integrate automated polymer dosing in the system
- Solving different problems encountered during the project.
- Get the system validated for other decanters.
- Get the system up and running in server.
- Save time and human resources.

Helix Lab:

As a Helix Lab Fellow, I had the incredible opportunity to engage in project work with industry professionals, allowing me to immerse myself in the real-world applications of my studies. This experience provided me with valuable insights into the diverse projects being undertaken in the industry, deepening my understanding of their intricacies and challenges. Moreover, the futuristic infrastructure of the lab provided an innovative environment where cutting-edge technologies were explored and harnessed.

The apartment provided during our stay for master thesis is great. This provides the environment to talk with other fellows regarding study and projects, lifestyle, countries. It was a wonderful experience to share different views and have a relaxing environment during the stay.

Personal:

Looking ahead, I am eager to capitalize on the knowledge and experience I have gained through my studies, internships, and project works. Armed with these invaluable resources, I aspire to make significant contributions in the future, utilizing my skills and expertise to drive transformative changes and advancements in the industry.