Model & Improve the wash cycle of a Bio Inactivation Skid

B.Sc. (Honours) in Applied Physics and Instrumentation

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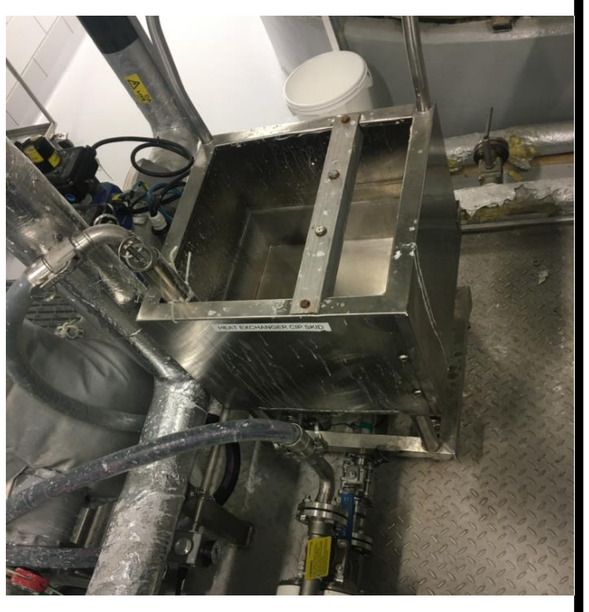
Current Skid Problems & Proposed Solution

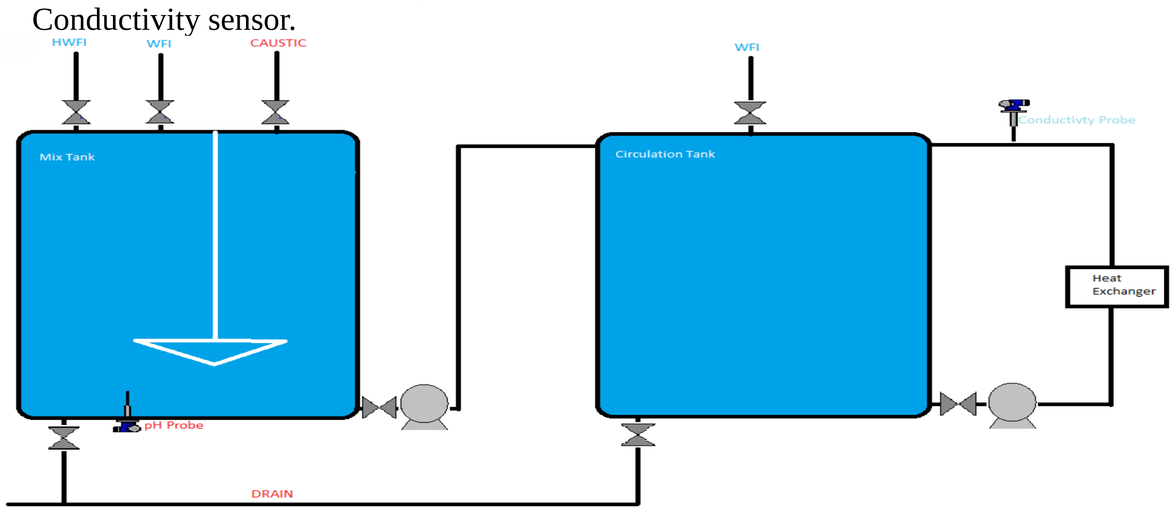
Current Skid Problems

- Manual Cleaning Routine, seen in pictures below.
- Wash mixture not monitored. Leads to inadequate wash mixture.
- Unsafe environment for operator due to caustic spills.
- Fouling within heat exchanger, current wash process does not get rid of all the fouling.
- Wash cycle not routinely completed.



Proposed Solution

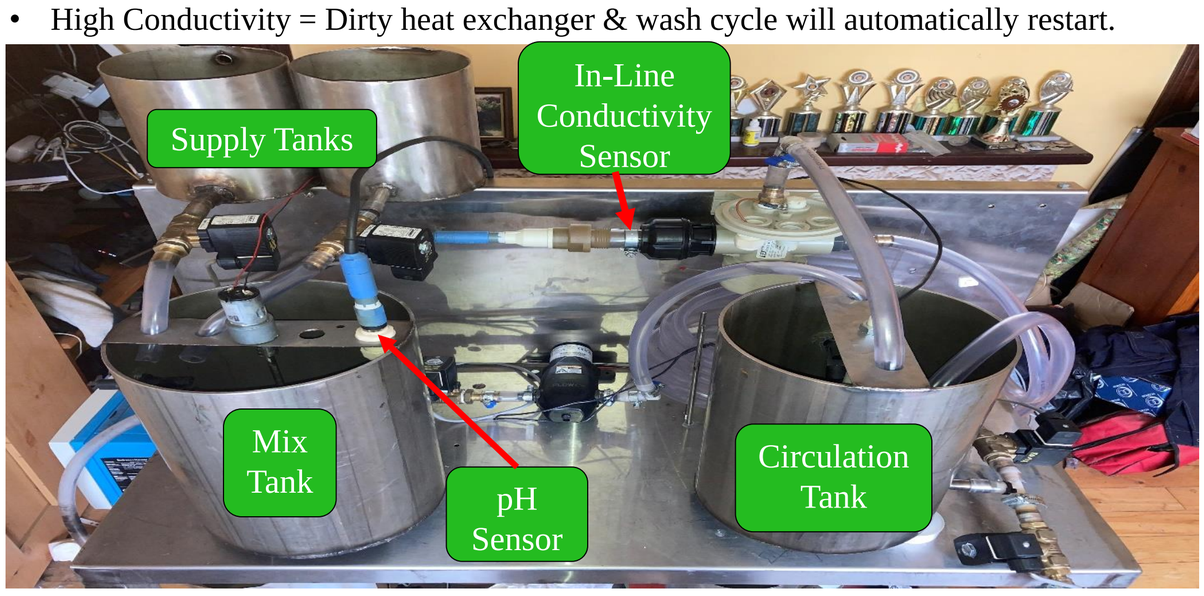
- Create a fully automated wash cycle.
- The new skid will comprise of two tanks. One Mix Tank & One Circulation Tank.
- The wash mix will consist of a mixture of HWFI & Caustic solution. A pH of 12.5 is a desirable pH for an adequate wash mixture.
- Cleanliness of heat exchanger will be tested with a WFI Rinse & an 'In-Line' Conductivity sensor.

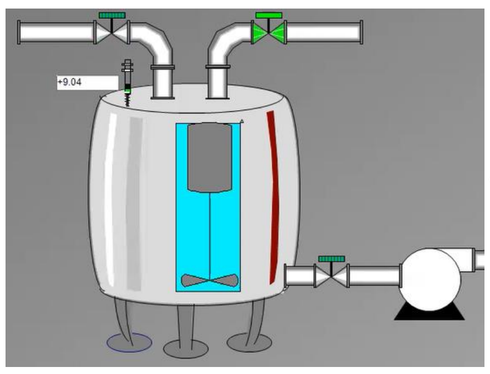


Model Creation

Model Creation

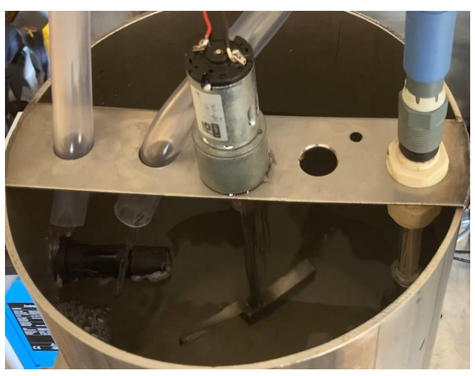
- The model was created using Stainless-Steel which is resistant to corrosion.
- The skid is controlled using an S7-300 PLC.
- An Endress + Hauser liquiline was used to transmit the pH & Conductivity readings to the PLC.
- Low Conductivity = Clean heat exchanger & wash cycle will finish.
- High Conductivity = Dirty heat exchanger & wash cycle will automatically restart.

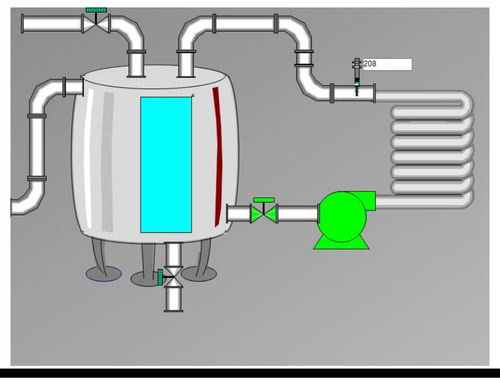




Mixing Sequence

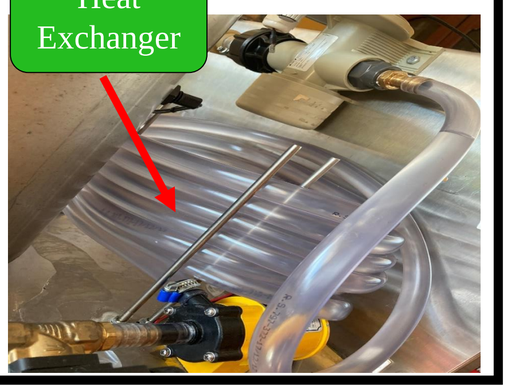
- HWFI added
- Mixer on
- Caustic added
- pH >12.4<12.6





Circulation Sequence

- Wash mix circulated
- WFI Rinse
- Conductivity Test
- Finish Cycle Or
- Restart Cycle



Results

Improved Mixing Sequence

- Main problem was with the manual wash process.
- Implementing agitator improved the mixing of the HWFI & Caustic solution.
- The implementation of a pH probe within the tank to ensure that the mix will not be circulated until the desired pH is achieved.

Fully Automated System

- The system designed is fully automated and needs no outside interference to run.
- Major upgrade from the previous system where everything had to be completed and operated by a technician.
- Not only does this make the process more efficient it also makes more time available for technicians to complete other work within the plant.
- Now an operator only has to press a button on a laptop screen to begin the cycle. There is an Emergency Stop button in place if the process ever needs to be shut down.

Improved Efficiency of Bio Inactivation Skid

- With the new automated system the wash cycle is now completed routinely compared to the erratic schedule previously followed. This means the heat exchanger is operating at optimal efficiency at all times.
- Before if the heat exchanger failed it might be overlooked and the washing would end, Now with the automatic restart function the wash cycle will not end unless the heat exchanger is clean.

Conclusion

- The solution I proposed and created to improve the wash cycle of the Bio Inactivation Skid can only be seen as a success. The new system is fully automated and improves the overall efficiency of the Bio Inactivation Skid.
- This project has helped develop my skills further as an engineer, and being able to work on a project that is applicable in the automation industry has prepared me for my future career.

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1) AlfaLaval, 2020. Tube-in-Tube heat exchangers. [Viewed Feb 2021]
Available from: https://www.alfalaval.com/products/heat-transfer/tubular-heat-exchangers/tube-in-tube-heat-exchangers/
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