Campaign 8

Operations Summary

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Cellulosic Research and Demonstration Plant

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04/15/2015

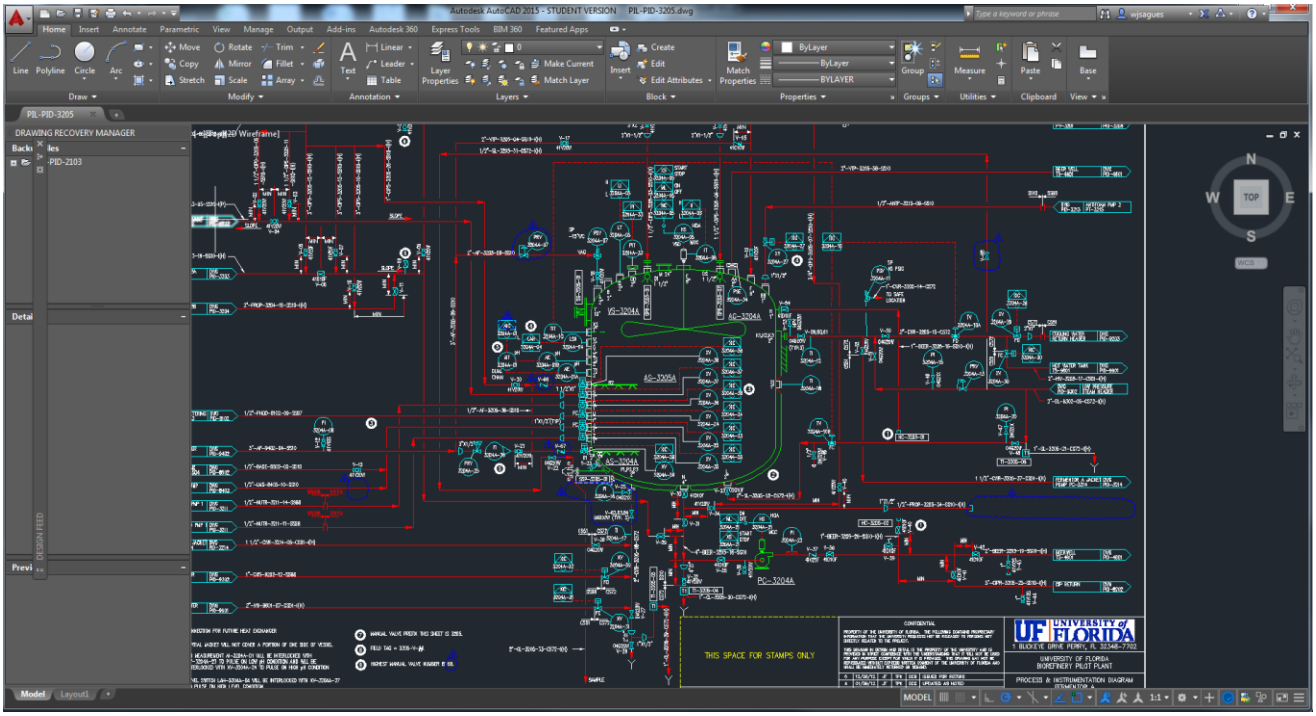
Operations - Campaign 8
01/26/2015 – 01/30/2015

Experimental plan notes:

1. Propagation hydrolysate: 30% 190C
2. Pretreatment temperature: 190C.
3. Liquefaction: 15% solids with 5% enzyme.
4. First campaign trying the new experimental plan of conducting smaller scale fermentations in the propagator 3's.

Operation problems & resolutions:

1. Inaccurate Piping and Instrumentation Diagrams (PIDs)
    - <u>Problem:</u>
        - There are many misrepresented process components in the PIDs supplied to us by the process design engineering firm. The major discrepancies are original valves and steam traps, as well as the modifications to the process which were done after the plant was fully constructed.
    - <u>Resolution:</u>
        - We have been asking the process design engineering firm for copies of the original autocad files for over a year. We finally received the files, so we are now modifying them to reflect the actual piping and instrumentation in the field. The screenshot below shows work being done by a process engineer at the biorefinery.

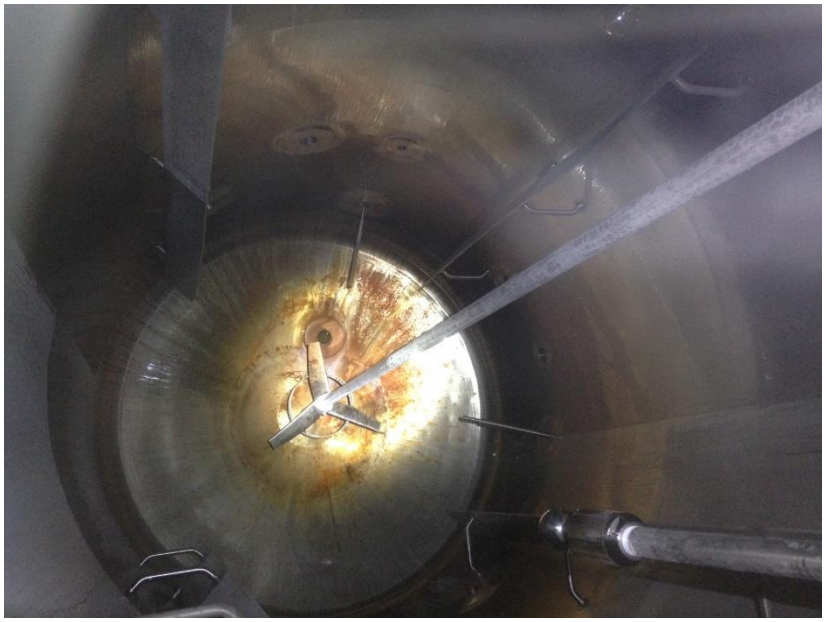


2. Presteam bin transfer conveyor
    - <u>Problem:</u>
        - The chute between the presteam bin transfer conveyor and the plug screw clogged several times. This caused delays in the campaign which resulted in overgrown seeds in the propagator 2s (see problem 4 for more information).
    - <u>Resolution:</u>
        - Fortunately, the clogging problem was resolved during the campaign by reducing the pre-steam livebottoms to 80%.
        - After the campaign was over, we positioned a live streaming camera to look into the presteam bin, and we kept the level such that the agitator was always gently mixing biomass. With the camera in place, it was confirmed that the level sensor cannot be trusted, so we now strictly use the camera.
    - <u>Status:</u>
        - Resolved, but we must run at a lower speed. See the “Campaign 12 Operations Summary” for current status.
3. Pretreatment knife gates
    - <u>Problem:</u>
        - Both the top and the bottom knife gates were leaking steam. We could still operate, but it was clear that the damage was only getting worse.
    - <u>Resolution:</u>
        - The knife gates were taken down for inspection after the campaign, and the seat seals were found to be broken apart. This was surprising considering we had installed new seals right before the campaign, so they had less than 100 hours of operation on them.

        - We decided that our spare, re-surfaced ball valves deserve a shot, now that we have all needed components to reinstall them. We plan on using them in the next campaign.
    - Status:
        - Resolved (as of 04/15/2015). The ball valves are working great.
4. Propagator 2 sugar depletion
    - Problem:
        - Due to the delays caused by the pretreatment system, the propagator 2 seeds started to run out of sugar.
    - Resolution:
        - The temperature was reduced to 86^{o}F and xylose was added to give them a boost. Xylose was chosen over glucose because it keeps the microorganisms metabolism working similarly to the way it was with hydrolysate.
    - Status:
        - Resolved. See the "Campaign 12 Operations Summary" for current status.
5. Propagator 3 slurry fermentation
    - Problem:
        - No growth, and the reason was likely due to the inoculation method used. Once the 40 gallon seed in each propagator 2 was ready, we transferred it into an empty propagator 3 and then added slurry on top of it at a slow rate. The image below is of the 40 gallons before slurry was added. There was no nutrient addition, mixing or pH adjustment for an extended length of time (about an hour), and this likely led to the cells dying out.
        - Another possibility for no growth was the higher toxicity of the 190C slurry.
    - Resolution:
        - Add slurry to the propagator 3's prior to transfer, such that at time of inoculation there is pH control and agitation.
            - This plan ended up not working either, as is evident in the subsequent operations summaries.
        - Reduce harshness of pretreatment by reducing the temperature from 190 to 185C.
            - This plan ended up not working either, as is evident in the subsequent operations summaries.
    - Status:
        - Not resolved. More information in subsequent campaigns.

6. Propagator 2 spargers
    - Problem:
        - Spargers for propagator 2A and 2B were found to be clogged with water prior to sterilization. This was likely due to no air flow during the prior clean in place procedure.
        - After sterilization, the propagator 2B sparger became clogged with water again. This was likely due to someone forgetting to turn the sparger back on as the tank started cool down.
    - Resolution:
        - Changes to the procedures to ensure nobody forgets to purge air through the spargers during CIP and immediately after SIP.
    - Status:
        - Resolved.
7. Propagator 3 sparger
    - Problem:
        - The propagator 3A sparger became severely clogged when transferring the slurry from the propagator into the decanter feed tank. This was due to raising the pressure in the vessel too high with sterile air prior to transfer – it reached 13+ psi, and the spargers have a 15 psi supply.
    - Resolution:
        - Add to procedure to not allow pressure in propagator vessel to rise above 10 psi during or before transfer of slurry.
    - Status:
        - Resolved.

8. Propagator 3A steam pipe corrosion
    - Problem:
        - During SIP of propagator 3A, old stagnant corrosion from the steam supply line caked itself onto the bottom surface of the tank (see image). This tank had not been sterilized for many months, therefore the steam line had not been used for many months. The corrosion would not have been an issue if there was a steam trap and drain installed in the steam line.



    - Resolution:
        - Install a steam trap in the line or regularly clear the line out.
    - Status:
        - A steam trap has not been installed but we are routinely clearing the line.
9. Propagator 3A and 3B agitators
    - Problem:
        - While agitating with the full 800 gallons of 15% slurry in each propagator 3, we noticed the motors were running very hot.
    - Resolution:
        - The IR temperature reading was only about 140°F, so this is acceptable for the time being. We have two spare motors in case one fails.
    - Status:
        - Not a big issue yet.