

PI as a Maintenance Tool



King County

King County Wastewater Treatment Division

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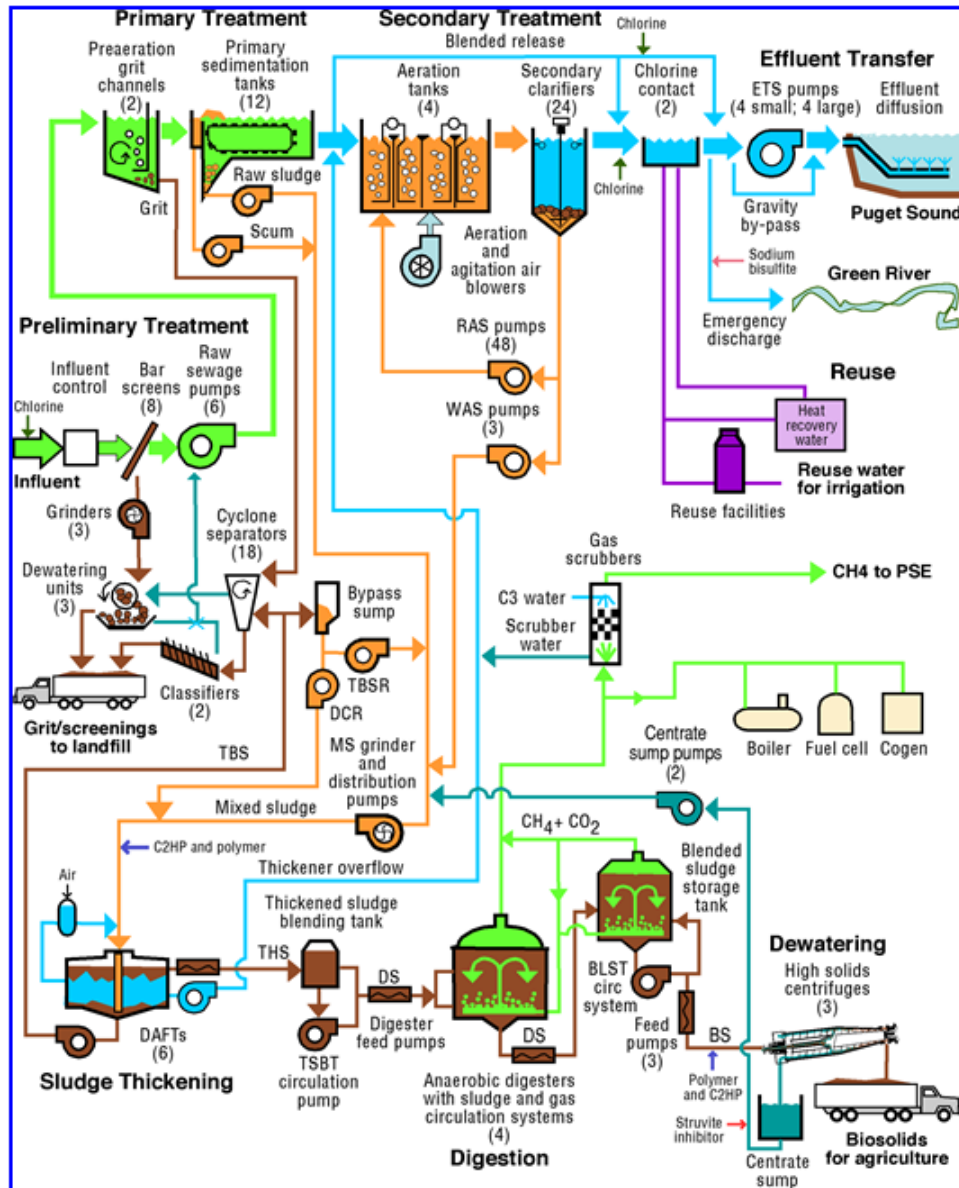
King County's Wastewater Treatment Division serves about 1.5 million people, including most urban areas of King County and parts of south Snohomish County and northeast Pierce County.

It protects water quality and prevents water pollution by providing wastewater treatment to 17 cities and 17 local sewer utilities. 325 miles of sewer pipes, 46 pumping stations, and four treatment facilities are required to manage the region's wastewater, with a fifth treatment facility under construction.



West Point Wastewater
Treatment Plant

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Each part of the treatment process is monitored for a very large variety of parameters, such as dissolved oxygen, various chemical concentrations, flow rates, percent solids, depths, pressures, and temperatures.

PI was purchased to help Operations staff make sense of all this data for better process management.

When process parameters go outside their limits, the Process Analysts alert Maintenance personnel that “something” is wrong with the equipment.

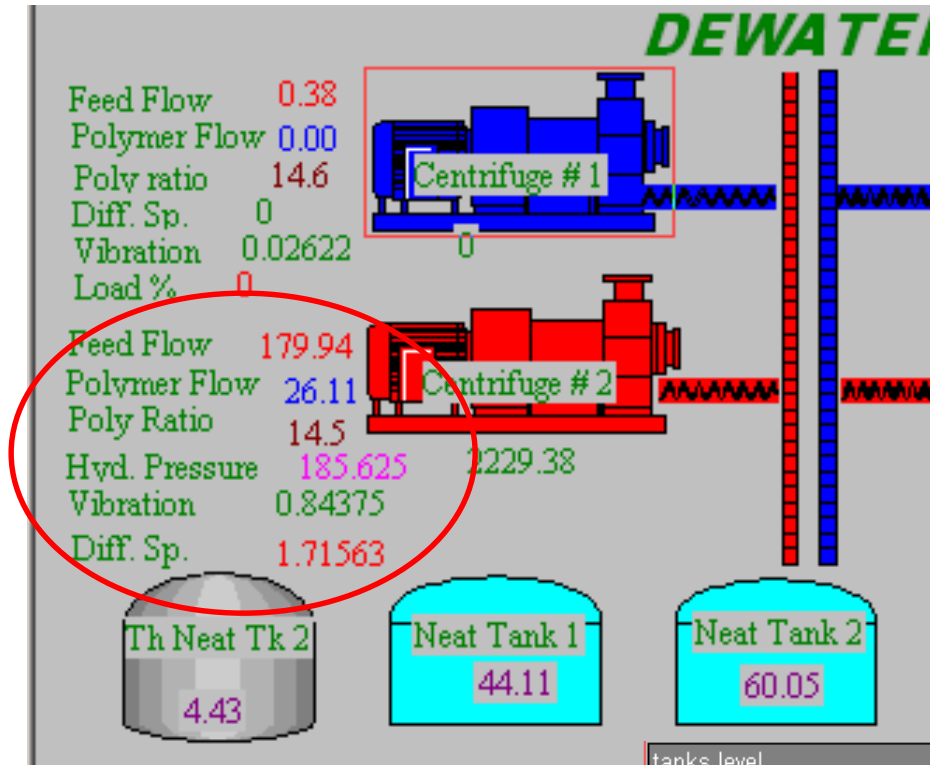
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Very few of the thousands of machines that move and process wastewater, grit, scum, and sludge have machine condition monitoring instrumentation, however, making it difficult to diagnose equipment problems.

Until more machine condition instrumentation data is available, we are depending on process data as a proxy for direct machine condition data in many cases.



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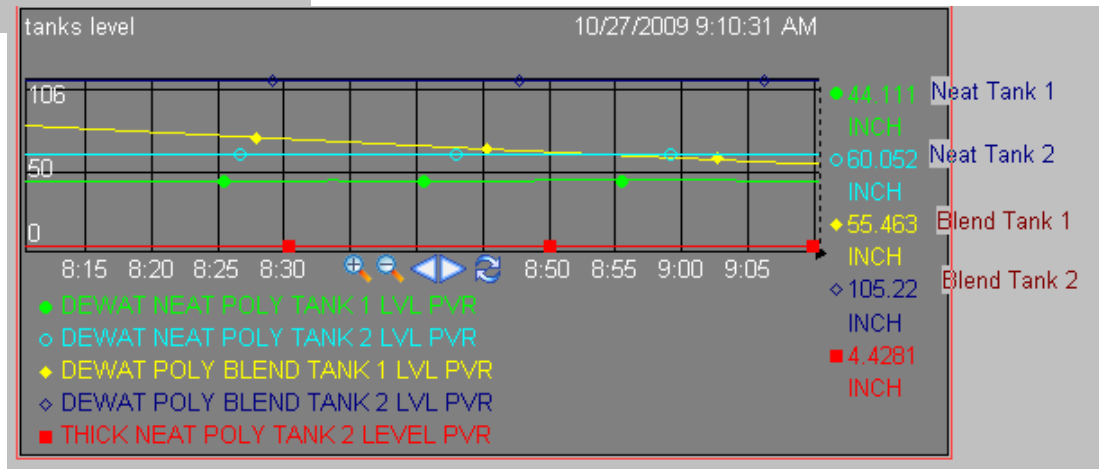


Dewatering process parameters that double as indicators of centrifuge problems:

Differential speed

Feed flow

Polymer tank levels



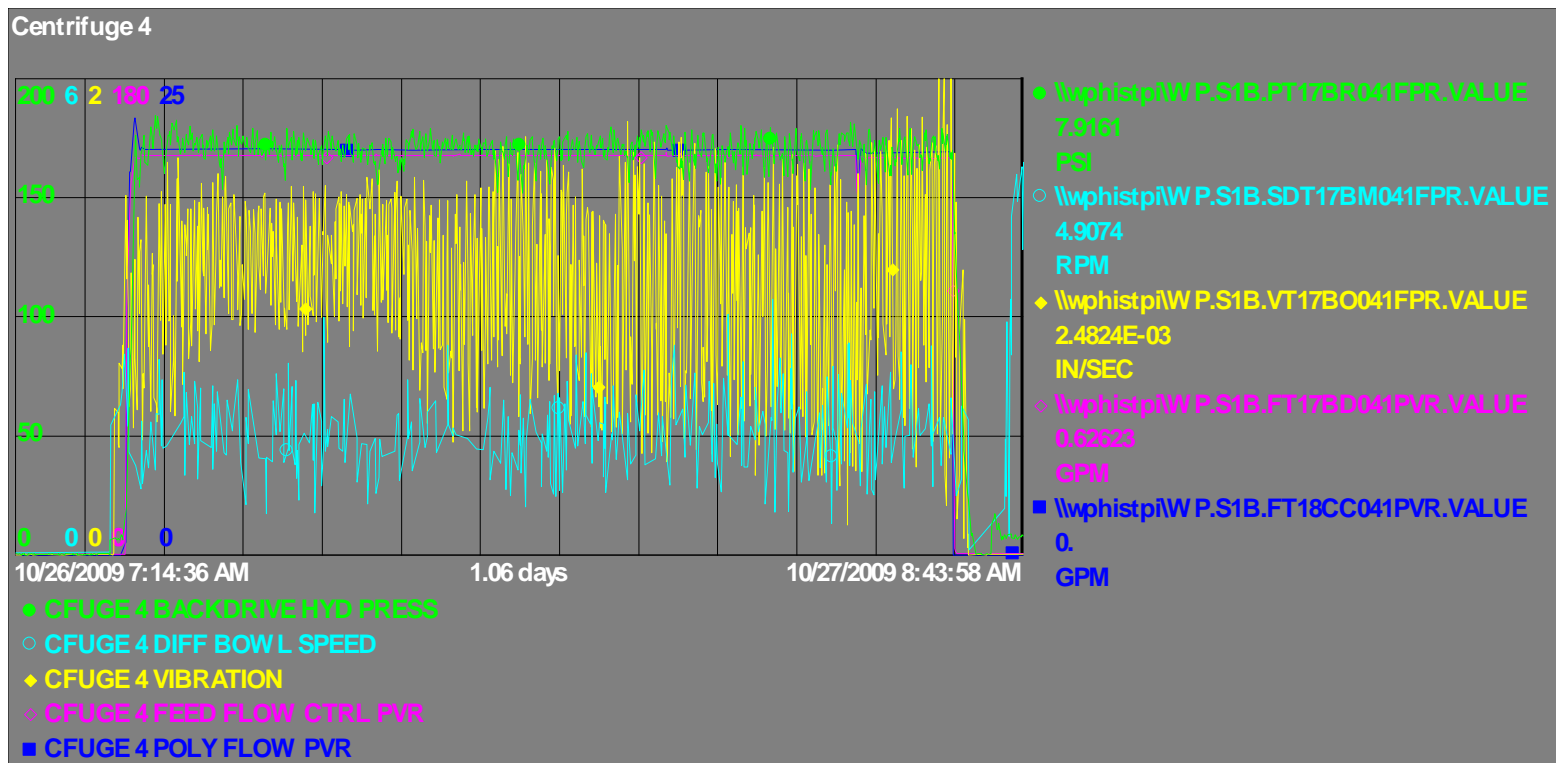
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| Dewatering Process Parameter | Process Limit | Process Consequence | Corresponding Centrifuge Problem |
|---------------------------------|-------------------------------------|---|---|
| Differential speed | 1.0 | <1.0 fails to remove enough solids. | Belts, motors |
| Feed flow | 180 gallons/min | >180 gpm overloads the centrifuge | Sludge feed pumps, controls |
| Polymer tank levels | Drop no more than ½ inch per batch. | Too much polymer makes the sludge too heavy. Not enough polymer doesn't remove enough solids. | Motorized valves, polymer transfer pump, flow meter, controls |
| Sludge cake % solids (lab data) | 25% - 29% | Too little solids – lose the batch. | Heavy sludge increases machine vibration levels. |

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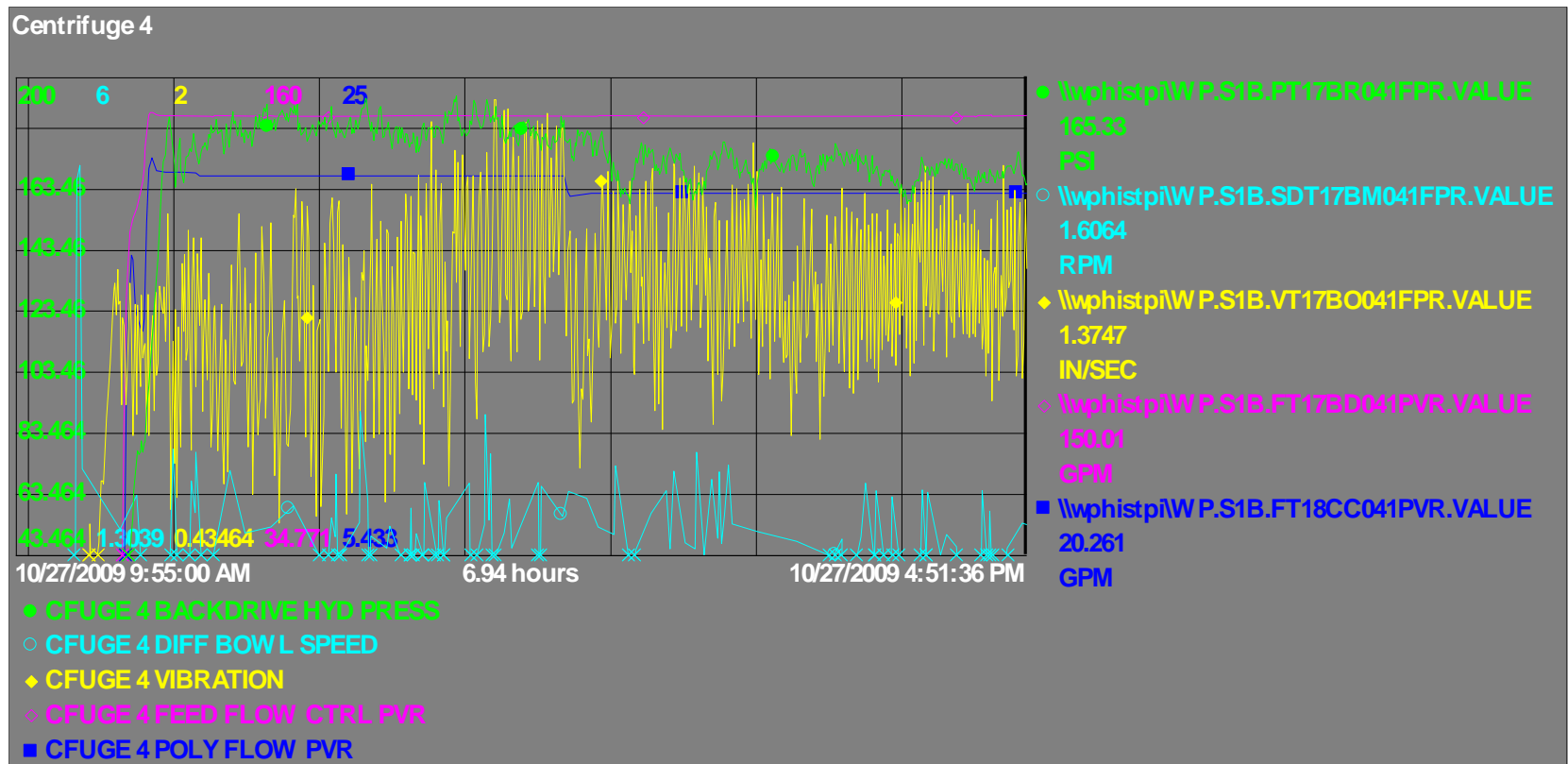
Fortunately, the centrifuges also have vibration monitoring systems. In this case, machine data alerted the Process Analyst to a process problem.

This centrifuge tripped out on high vibration levels (yellow line).



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After restarting the centrifuge, the Process Analyst noticed that the centrifuge vibration levels (yellow) were creeping up again. She responded by decreasing polymer feed and increasing the scroll speed to get the solids out faster. The result was that the back drive pressure dropped and vibration decreased.



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WTD facilities are frequently near or upwind of populated areas, whether commercial or residential. Controlling odors from wastewater handling facilities is a constant challenge.

Overall results of our 2009 Good Neighbor survey showed that 64 percent of people felt the treatment plants were good neighbors, while 28 percent didn't know. Nearly 83 percent of respondents said they did not experience any negative impacts that could be related to the operation of a nearby treatment plant. Among those who did, the most common complaint was odor.

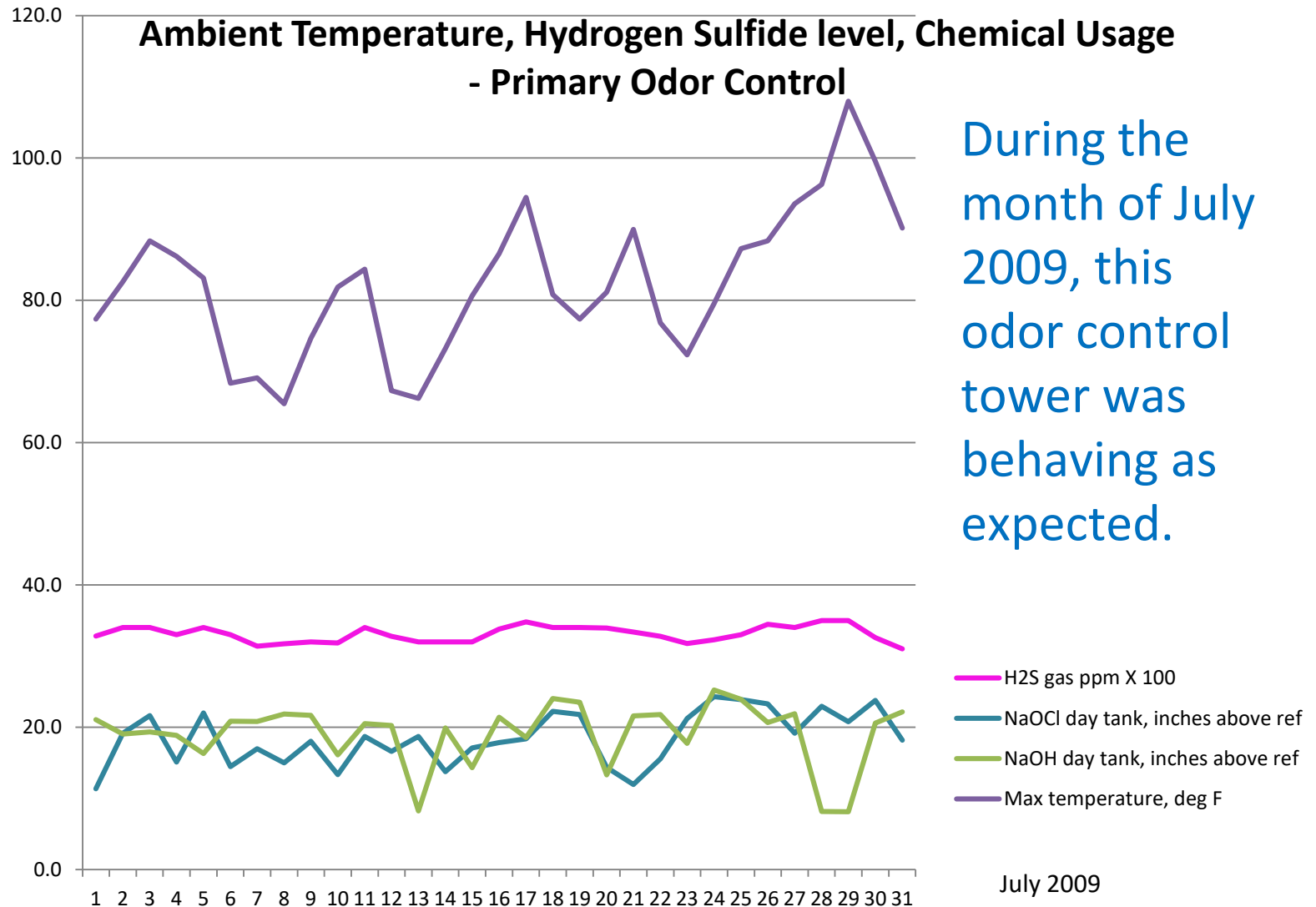
The characteristic “rotten egg” odor associated with wastewater treatment facilities is caused by naturally occurring bacteria that strip chemically bound oxygen from compounds that also contain sulfur. The end product is hydrogen sulfide gas, or H₂S.

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Odor control scrubbers are used to remove this gas and other odorous compounds before it's discharged to the air. Many of our scrubbers use chemicals so chemical storage and transfer equipment needs to be monitored. In this case, we're using chemical tank levels to troubleshoot increased levels of H₂S.

| Odor Control | | | | |
|---------------------|---------------------------|--------------------------|--|-------------------------------------|
| Ambient Temperature | Hydrogen Sulfide gas, ppm | Scrubber Chemical levels | Problem indicators | Possible problems |
| High | Increase | Decrease | Insufficient decrease in chemical levels | Transfer pumps, sensors, set points |
| Low | Decrease | Little decrease | Larger decrease than expected | Valves, sensors, set points |

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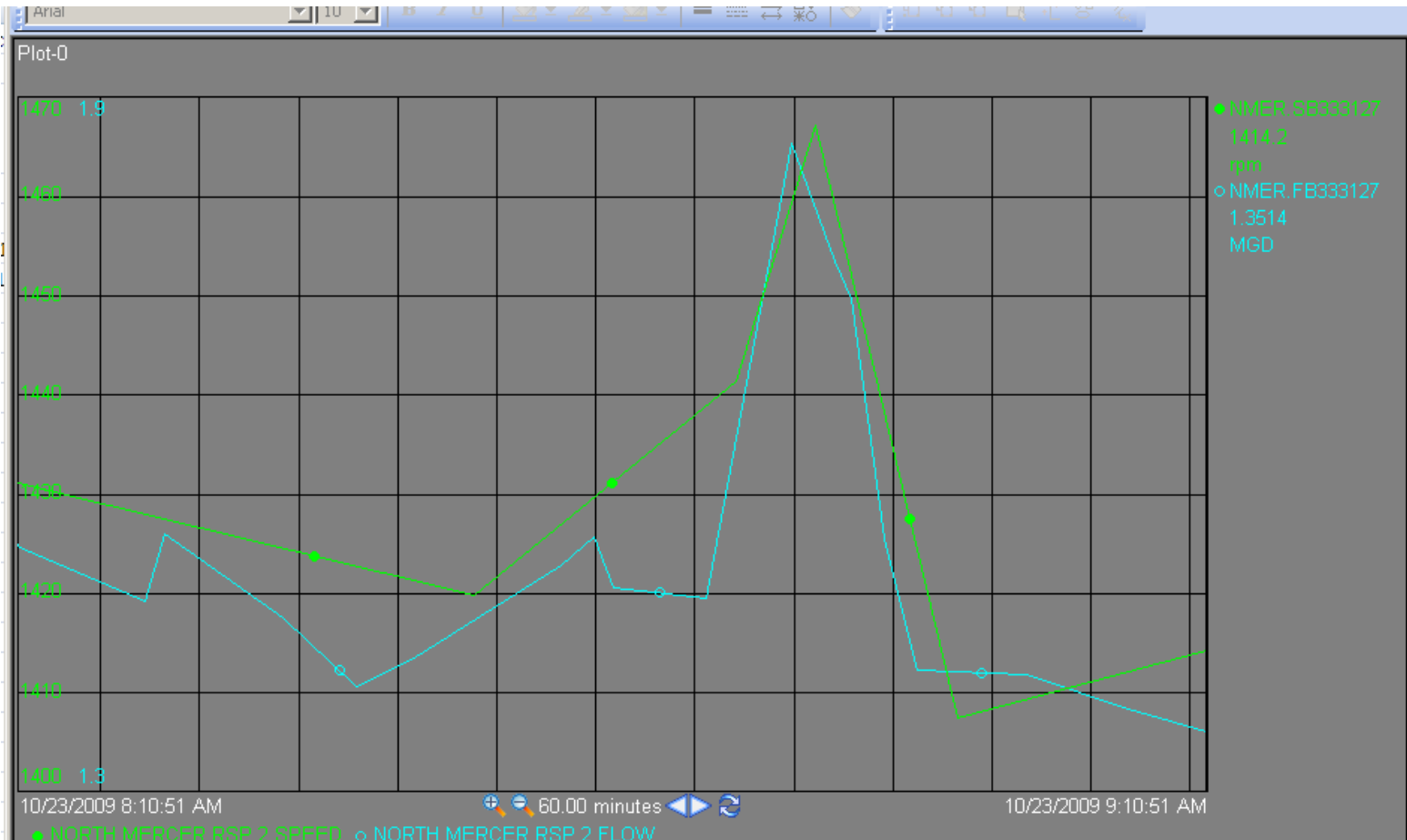
Wastewater handling pumps often become clogged with rags and other materials. If the pumps are allowed to continue running in that condition, the motors can burn out.

Some of our larger pumps have motors that cost tens of thousands of dollars, so it's important to check to see whether the pumps are beginning to clog.

The process parameter, pump flow, can be trended against motor speed. If the speed increases but the flow does not, the pump is either becoming clogged or there is another problem with the impeller.

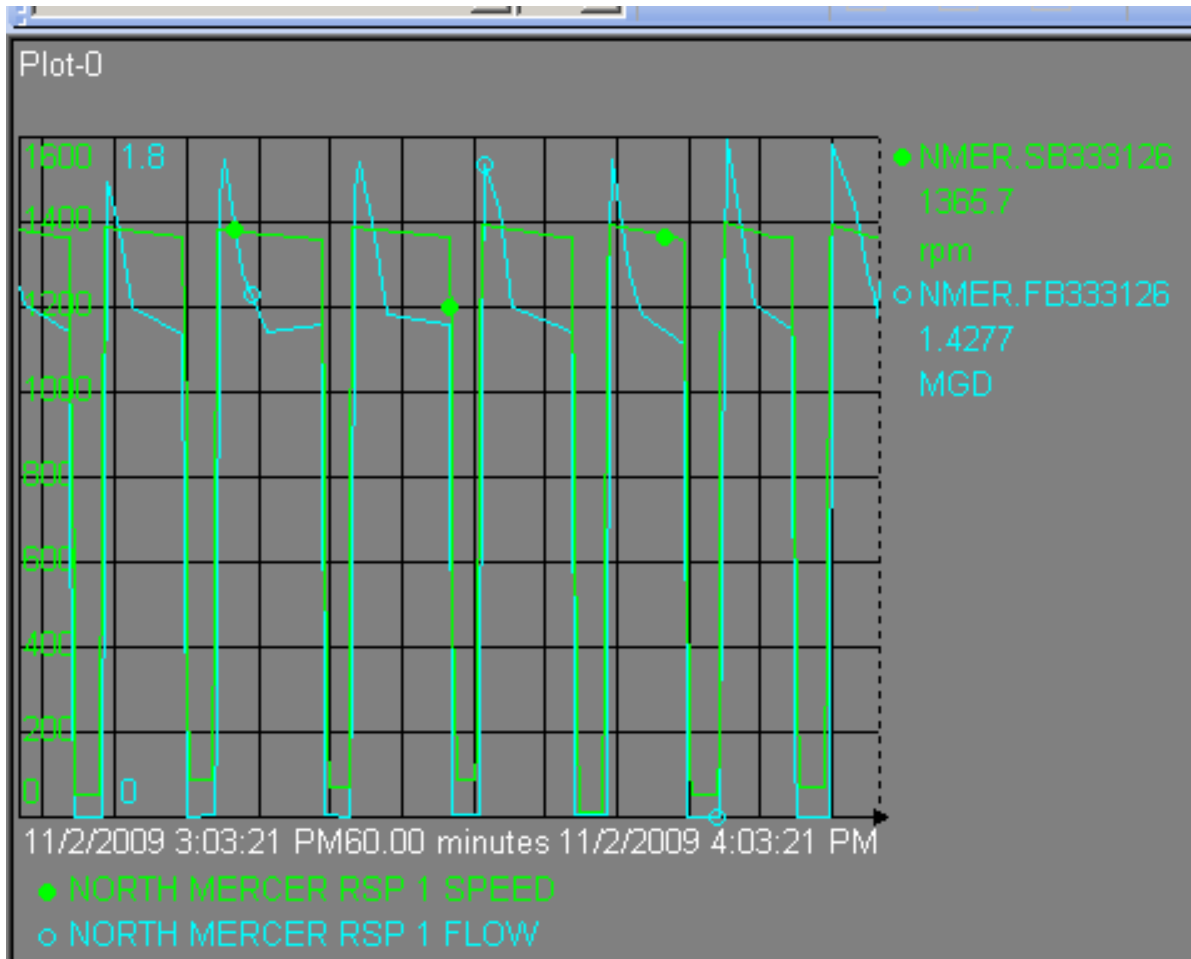
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North Mercer Pump Station, Pump 2 – flow and speed are generally tracking. Where the flows decrease, the pump is temporarily ragging up.



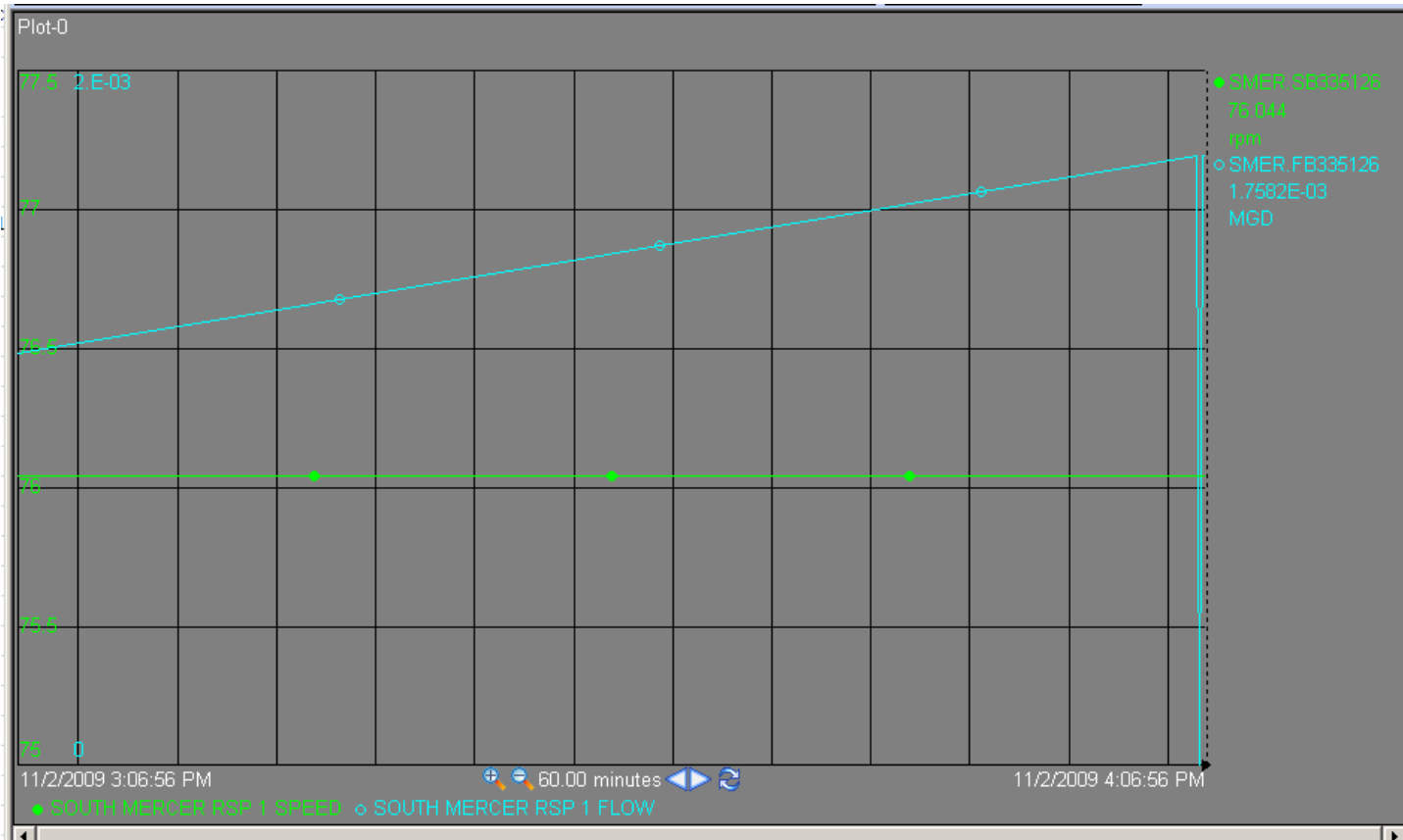
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North Mercer Pump Station, Pump 1 – flow and speed are not exactly tracking and the pump is cycling on and off about every 8 minutes.



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South Mercer Pump Station, Pump 1 – there is something wrong with the flow meter or transmitter.



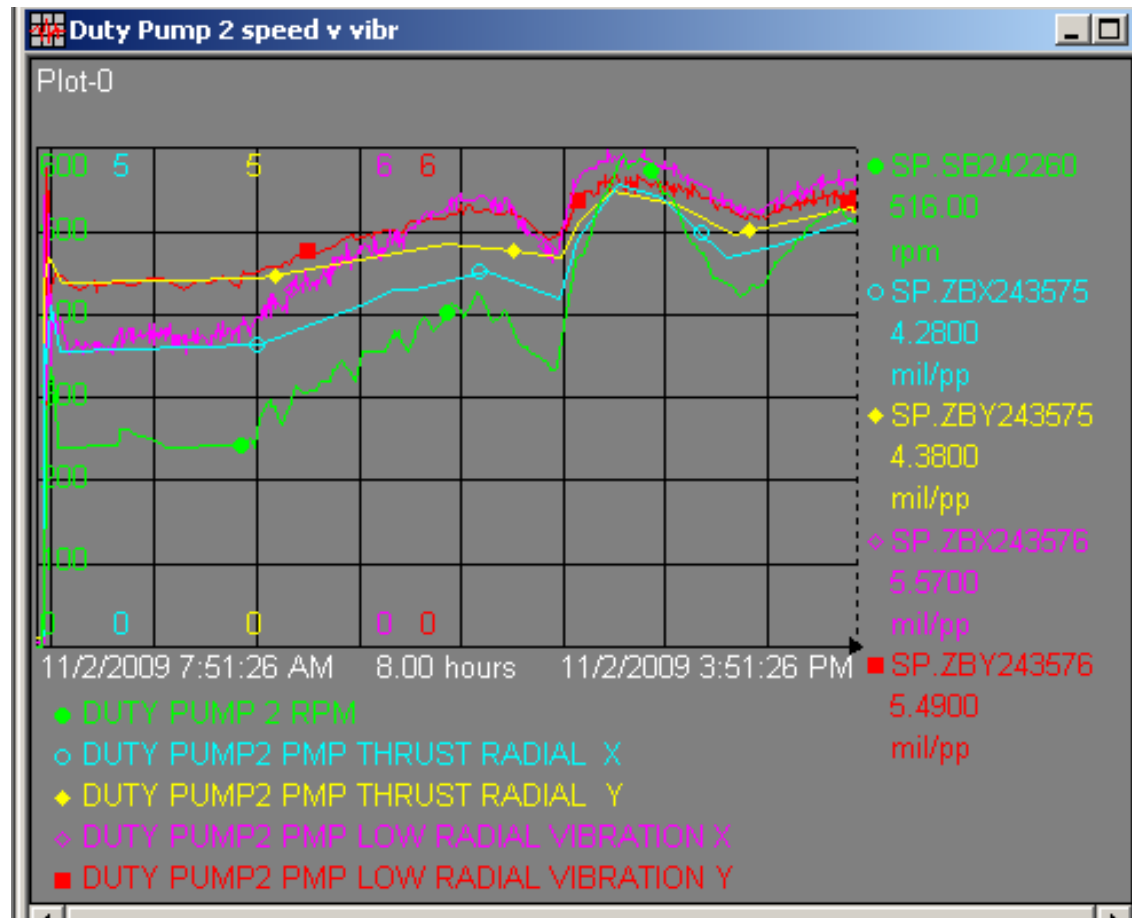
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PI is also useful for providing a visual indication when machine condition sensors may be malfunctioning.

Comparing identical two pumps running side by side during the same time period allows us to see whether their vibration monitoring equipment is working.

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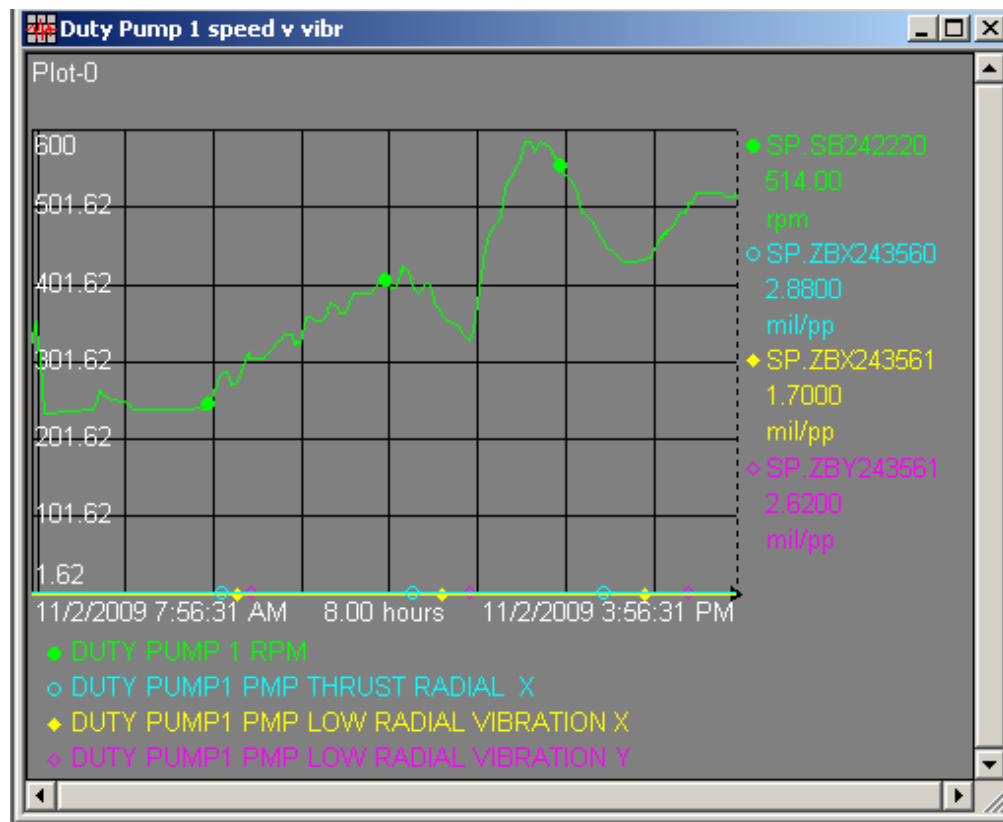
Speed and vibration are tracking in this example.
The speed is shown in green.



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On this pump, however, the vibration data appears to be nearly flat regardless of the wide fluctuations in speed.

This indicates a vibration monitoring system problem.



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Although we have limited machine condition monitoring instrumentation at this time, we are trying to mine our process data for hints about machine condition and performance, getting the most from our investment in PI.

We are currently drafting a pilot project to bring real time vibration data from two remote and problematic pump stations to the main control centers where it can be picked up by PI.

We hope this project will demonstrate the value of having direct machine monitoring data available to our maintenance staff so we can improve the efficiency and effectiveness of our operations.