POLYMER MANAGEMENT AND TREATMENT ALARM USING THE IQ SENSOR SYSTEM ULTRASONIC TURBIDITY PROBE

Paper Presented by :

Alex Dupleix

Author:

Alex Dupleix, *Treatment Plant Manager,*

Warrnambool Cheese and Butter Factory Company

66th Annual Water Industry Engineers and Operators' Conference
Eastbank Centre - Shepparton
3 and 4 September, 2003

POLYMER MANAGEMENT AND TREATMENT ALARM USING THE IQ SENSOR SYSTEM ULTRASONIC TURBIDITY PROBE

Alex Dupleix, *Treatment Plant Manager*, Warrnambool Cheese & Butter Factory Company

ABSTRACT

The Warrnambool Cheese and Butter Factory wastewater treatment plant incorporates an induced air floatation system to remove suspended solids from the Anaerobic treated effluent. Failures in the floatation cell could lead to high levels of suspended solids being discharged, causing a negative impact on the operation of the South West Water Authority wastewater treatment plant at Thunder Point.

An alarm system needed to be in place to prevent discharge of high solids.

Turbidity was chosen as the alarm trigger because the clear background matrix could be detected by this method and ensures effective treatment occurs. Several systems were trialed unsuccessfully as the residual solids formed a scum on the detectors and on the surface of liquid cells.

The IQ Sensor Net system with an ultrasonic self cleaning turbidity probe, has recently been installed at the plant and has provided the answer to our problems. In fact, the trial was so successful we handed over the purchase order and said find another demonstration unit!

The operation of the probe has been very successful. The side of the probe builds up deposits but the 'measuring window" has stayed clean. The IQ Sensor Net system also has the advantage of connecting to our Citect automation control system.

The next aim is to use the turbidity probe to fine tune the chemical dose rates, thus optimising chemical use. The IQ Sensor Net system was also chosen for its simple expansion capability and its ability to control extra probes. An ammonia probe and a pH probe will be added in the near future.
The ph and ammonia levels are very important factors in the operation of the anaerobic Bulk Volume Fermenter and need to be monitored constantly.

1.0 INTRODUCTION

Warrnambool Cheese and Butter Factory is situated at the end of the Great Ocean road, 12 km east of Warrnambool. The plant is 15 km north of Childers cove and the bay of islands, two local features of the ship wrecked coast. The company at peak season processes three million litres of milk per day sourced from 600 farmers across south west Victoria and south east South Australia. Warrnambool Cheese and Butter factory's annual production is 34,000 tonnes of cheese, 24,000 tonnes of skim milk powder, as well as butter, whey protein concentrate and packaged milk etc.

The Warrnambool Cheese and Butter Factory Waste Water Treatment Plant originally consisted of an Equalization tank and anaerobic Bulk Volume Fermenter (BVF) Reactor. The system was designed by ADI, the Canadian company that perfected this type of technology. The plant was built by KME.

The function of the EQ tank is to equalize the pH and COD loading and has a 6 hour retention time. A secondary function allows for the separation of fat from the influent stream.
The function of the BVF reactor is to provide anaerobic treatment of the influent to reduce the COD load.

2.0 DESIGN CRITERIA

The plant processes two to three times the design waste load as shown in Table 1.

Table 1: ***Design criteria and current loadings***

Criteria	Original Design Spec's	Current Spec's
Flow Average	1.1 ML/Day	2.8 ML/Day
Flow Peak	1.7 ML/Day	3.5 ML/day
Average Daily Load	28,000 kg COD	70,000 kg COD
Peak Daily Load	46,000 kg COD	110,000 kg COD

3.0 PLANT PERFORMANCE

The plant is monitored daily by a NATA registered laboratory to guarantee optimal performance. BOD reductions of 98.5% are achieved.

WCBF have an after care agreement with ADI (ADI reviews operation data and provides technical support plus site visits.)

The plant was built in 1993. The original design included anaerobic SBR but because of the prohibitive cost it wasn't installed. The plant operated well at the design loads, but as the influent loads increased the levels of BOD and suspended solids in the treated effluent rose to the point where they where having a negative impact on South West Water's Warrnambool wastewater treatment plant at Thunder Point

A secondary treatment plant was required to meet the trade waste standards set by South West Water for Warrnambool Cheese and Butter Factory. Refer to Table 2 for loading percentages prior to secondary treatment plant installation.

Table 2: ***Factory discharge as a percentage of South West Water's intake load.***

Flow	BOD	Suspended Solids
20%	15%	30%

During 1997 an investigation was made into four alternative treatment options:

1) A facultative lagoon
2) A lagoon style SBR
3) A chemically assisted clarifier
4) An air flotation cell

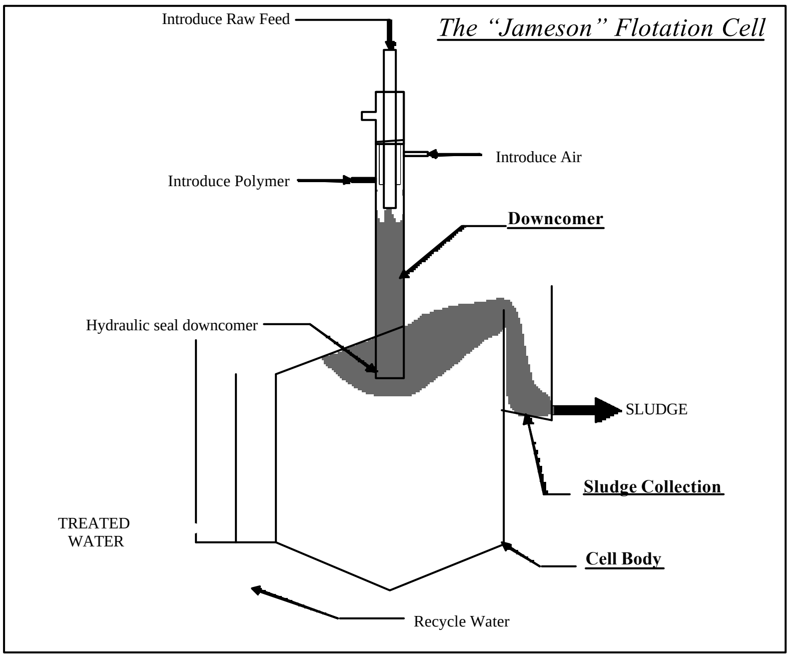
The following year the trade waste bill reached 1.5 million dollars and a decision was made to install an air flotation cell. The air flotation cell was the preferred process because it had the best capacity to remove the suspended solids. The high suspended solids in the treated effluent were having the greatest influence on the trade waste charges.

4.0 THE JETFLOTE INDUCED AIR FLOTATION CELL (IAF)

The Jetflote Induced Air Flotation cell was chosen because of its proven ability in the dairy industry and simple design.

The heart of the Jetflote plant is the Jameson Flotation cell which incorporates a vertical column of liquid known as a down comer. The down comer pipe has a flow rate 1.5 times the through put of the plant. A small air bleed at the top of the down comer allows air bubbles to be incorporated into the column of liquid. The bubbles may be visualized as a stream of marbles moving down the column. Polymer is also injected at the top of the column, allowing the solids to flocculate and incorporate the air bubbles. The flocculation process is completed in the column. The base of the column discharges the flocculated solids below the surface of the sludge separation tank. The sludge is skimmed off to a holding lagoon, while the clear treated effluent is discharged through a third cell. Refer to Figure 1.

Figure 1: ***The Jameson flotation cell***



The plant was commissioned in May 2000 and operates continuously 24 hrs a day, 7 days per week.

The foot print of the plant is small, allowing the plant to be built off site and delivered skid based on a regular transport. However, the plant has a short residence time which means a failure can rapidly result in poor quality effluent. For example, a failure with the polymer dosing system could lead to high levels of BOD and suspended solids in the treated effluent. This would result in an increased trade waste bill, and may have a negative impact on the South West Water treatment plant operation.

Table 3 sets out the hypothetical charges based on actual data from the 2000-2001 year.

Table 3: *Hypothetical trade waste charges*

Waste streams	Cost per Year $
Untreated raw Influent	56,000,000
BVF reactor treated effluent	4,500,000
IAF floatation plant treated effluent	309,000

Based on the average figures, poor performance by the IAF has the potential to cost $11,000 per day.

[($4,500,000- $309,000)/365days =$11,000]

Potential peak season costs could be close to $20,000 per day.

5.0 ALARM SYSTEM

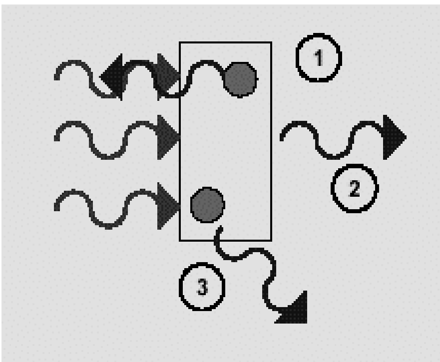
An alarm system is needed to alert the operator to poor quality effluent, enabling the plant to be shut down for repair. Turbidity was chosen as the alarm trigger, because the clarity of the back ground matrix could be detected by this principle.

5.1 Turbidity

The principle behind the decision to choose turbidity was that the clarity of the back ground matrix is proportional to the suspended solids in the treated effluent. The relationship provides a decrease in transparency of the liquid due to an increase in the presence of undissolved solids.

Turbidity is measured by producing a light beam from a tungsten lamp source. The beam of light is directed into the sample. A detector is then used to measure the intensity of the beam. The detector can be placed to read either the reflected or backscattered light, the transmitted light which has passed through the source, or light which has been deflected at a specific angle. See Figure 2.

Figure 2: *Light scattering and turbidity measurement*



1) Back scattering of light

2) Intensity of light passing unchanged through the samples

3) Intensity of scattered light in a special angle

5.2 Selection of the First Turbidity Meter

The original instrument utilized two sources and detectors, with the light beam passing through the liquid stream. The use of two sources and detectors enabled two simultaneous measurements providing better accuracy.
The unit was chosen for its accuracy, but it failed to cope with the application.

The Problems encountered were;

1) The large carry over particles affected the reading. To overcome the problem the treated effluent was piped directly from the centrifugal recycle pump. The action of the centrifugal pump provided a sample of uniform particle size.

2) Small particles were still attached to air. These particles floated to the surface in the sample weir adhering to each other eventually blocking the chamber and the delivery tube.

5.3 Selection of the Second Turbidity Meter

The second instrument worked on the 3rd principle (refer to Diagram 3), in which the light beam from the source is reflected or scattered from the sample surface at an angle to the detector. The measuring mechanism is housed in a light proof box to prevent stray light interfering with the result. Design advantages, which led to the instrument's selection were the large sample handling tubes, the bubble eliminator and the small sample detection surface which was assumed to be self cleaning. There was also provision to add a flush system to clear the sample chamber and detector surface of flocculated particles.

The second detector system worked initially but the next day there were problems.

1) The small particles collected in the piping and floated out in the surface well affecting light scatter and hence the result. A flush system was installed and a daily cleaning regime set up

2) Another problem was the temperature of the treated effluent, (32 degrees Celsius). At this temperature the light proof box filled with condensation that interfered with the integrity of the light beam.

Although we persisted with this unit, its operation was never consistent enough to be employed as a monitoring system. The concept of the quality alarm had again failed to convert to a working system.

We needed a system that did not involve the transfer or handling of a sample in any way at all.

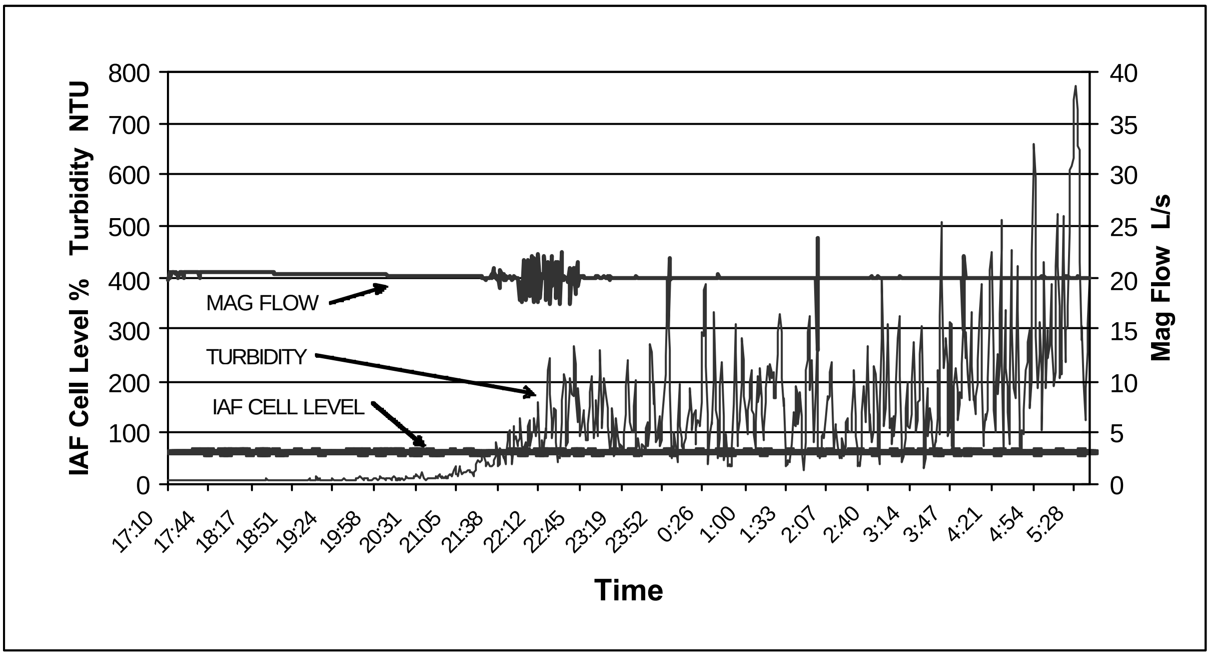
The obvious solution was to trial a probe style detection system. We began by inserting a bottle in the discharge cell of the IAF plant to act as a dummy probe. As we expected the small particles with their attached air bubbles adhered to the bottle coating it in a biological slime. It appeared that we had no way of achieving our alarm system.

5.4 The IQ Sensor Net System with Ultrasonic Self Cleaning Turbidity Probe

The answer came when reading an article in a water instrument supply company journal. The detector unit was a self cleaning probe using ultra sonic vibration to prevent accumulation of slime and mineral deposits over the detector lens. We contacted the company and arranged a trial. The trail was successful, so we purchased the installed the system.

The unit operated well, only occasionally requiring a wipe clean. After a few months of operation it was observed that biosolids were beginning to hang onto the probe surface, but the two sensor points stayed clean. The scum eventually began to interfere with the readings. A mineral layer had built up on the sides but the detector surface retained a shiny surface after wiping with a cloth. Figure 3 shows the deterioration in the readings due to the scum build up.

Figure 3: ***Effect of scum build up on probe***



The problem was overcome by adding an air purge to remove the build up. The air purge was controlled by the Citect. The Citect allows the frequency and the duration of the purge to be altered by the operator. The air purge could be controlled by the IQ Sensor Net system but I wanted to see it on the screen.

Figure 4: ***Probe cleaning using air purge***

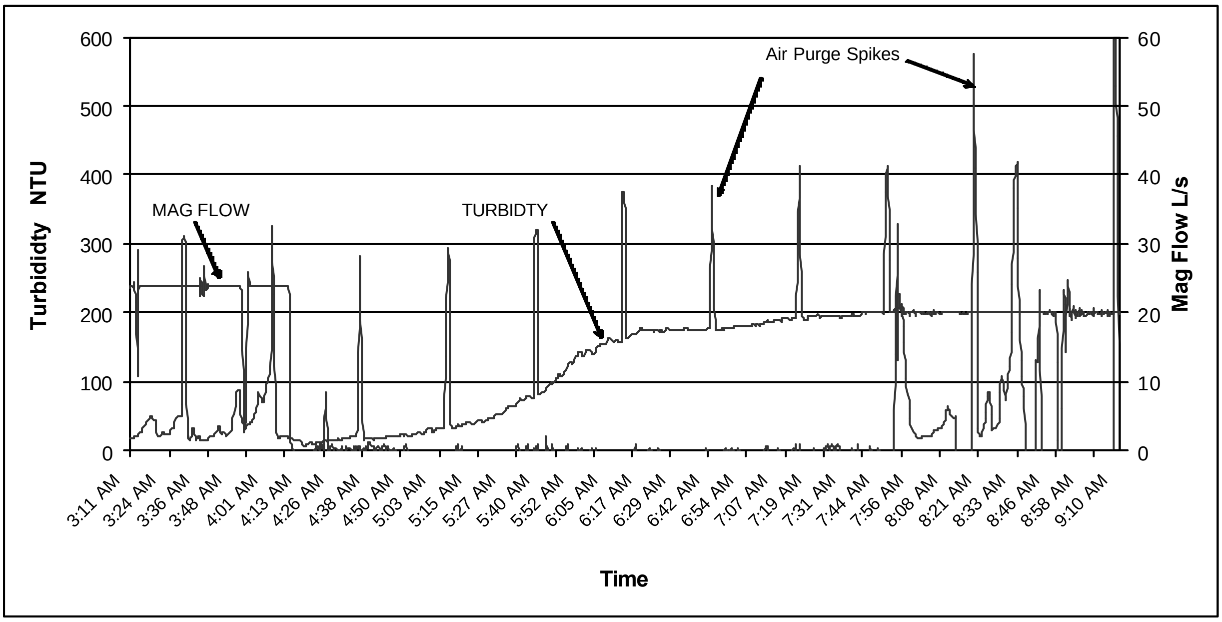


Figure 4 shows the spikes due to the air purge and also the increase in the turbidity reading during the plant shut down.

The turbidity measurement is now at the stage where a reliable reading is being generated and an alarm set point can be put into the Citect. The turbidity probe has also helped us fine tune the polymer dosing rate, reducing the dose rate by several ppm. The adjustments are made manually at this stage.

A further trial was carried out where all the variables were fixed for example the surfactant dosing rate and the plant flow rate. The polymer dosing rate was then varied. The turbidity and dosing pump speed was recorded and the corresponding sample tested for suspended solids. The relationship shown in Figure 5 indicates that both over and under dosing can occur with a safe range showing the optimal dosing rate to be 6ppm.

Figure 5: ***Polymer dosing rate versus turbidity & suspended solids***

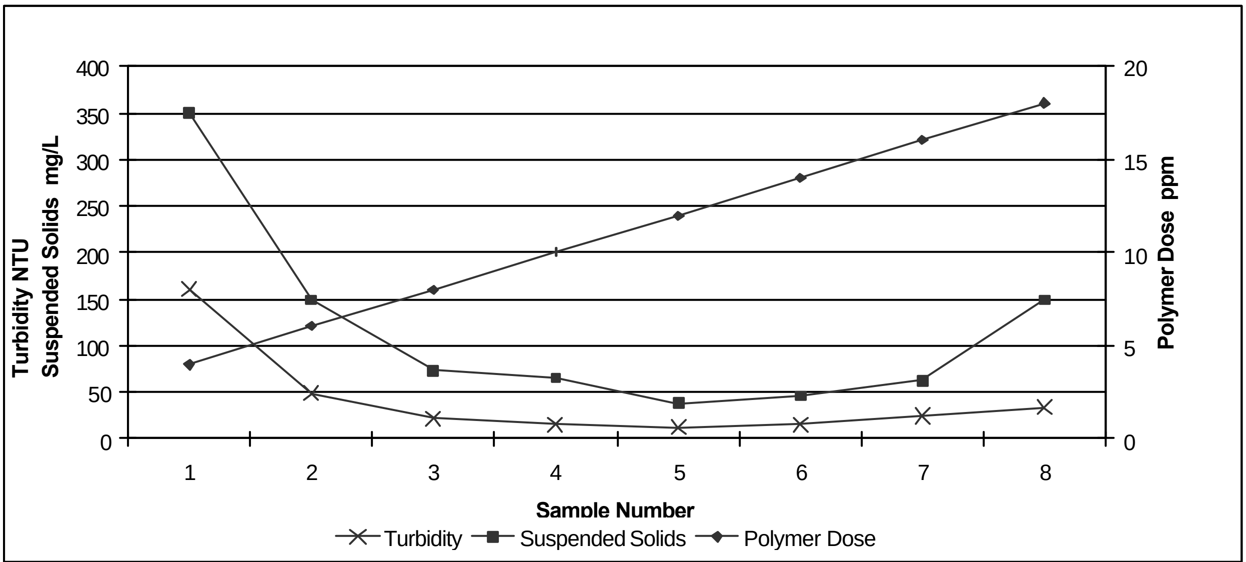


Figure 5 shows that it is possible to automate the dosing rate to obtain the lowest turbidity.

6.0 CONCLUSION

The process of realizing the original concept of an alarm system for the treated effluent quality has been a long and expensive one. But three turbidity meters later we have the alarm working. The next step is to automate the dosing set point using the turbidity probe. This should optimise polymer usage and save operating costs.

7.0 ACKNOWLEDGMENTS

Chris Conway	Environmental Group (Jetflote)	Technical
Phil Edwards	Merck	Technical
Paul Weir	WCBF	Electrical
Brooke Mellington	WCBF	Automation
Maurice King, Helen Dupleix		Proof reading