

Centrifuge Camera Control Application Analysis

Objective:

- Examine the capability of the Cauty process camera to monitor / measure cake thickness during the filling process.
- Examine the capability of the Cauty process camera to monitor / measure level of any water that may be over standing on the cake during the washing process.
- Examine the capability of the Cauty process camera to monitor / detect when dewatering is complete and all over standing liquid has been filtered from the surface of the product.

Equipment / Method:

The objectives were attempted using a Cauty process camera / light combination unit and Cautyvision Client Software.

The cake thickness, and over standing water level were monitored / measured using the Cauty “Edge Tool” in the Cautyvision Client Software. The “Edge Tool” has the ability to track any edge based on the difference in colour / grayscale of 2 materials / components (centrifuge base plate and cake product). Initial Calibration Points were set up as 0mm (centrifuge drum wall) and 234mm (edge of base plate).

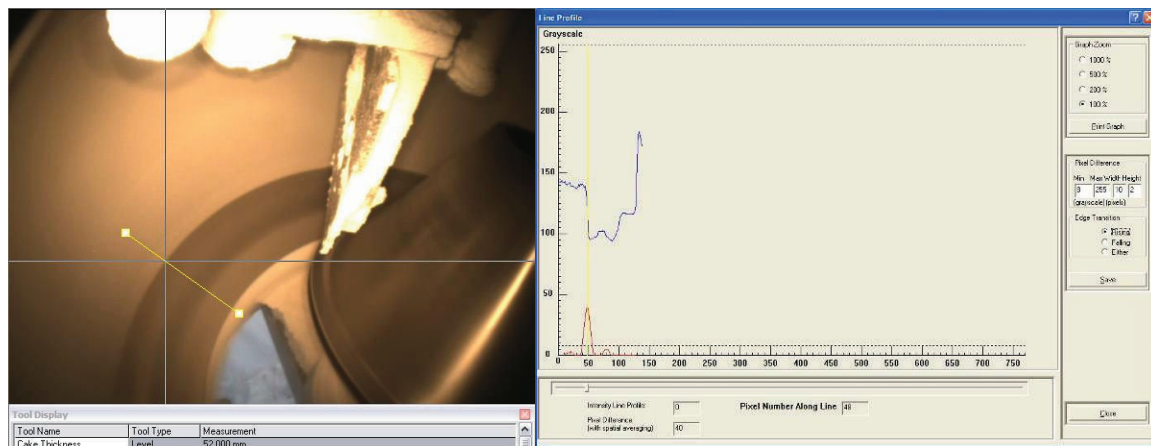


Figure 1: Edge Detection Software

The over standing liquid on the surface of the cake during washing and dewatering was detected using the “Intensity Tool”. The overall grayscale value is monitored within the intensity measurement zone, the concept being that when there is liquid present there will be a higher level of intensity due the liquid surface being more reflective than the cake surface.

Run 1

For Run 1 the process would be; filling phase 1, filling phase 2, washing, dewatering, with a stoppage between each phase of the process

Filling Process:

Fill 1 and Fill 2 were carried out, during which the thickness was monitored in Cantyvision. It was verified that the software was capable of tracking the edge (cake thickness) during the filling process.

After the filling process was carried out, a manual measurement of the cake was taken (52mm) which then became a third calibration point, for future runs.

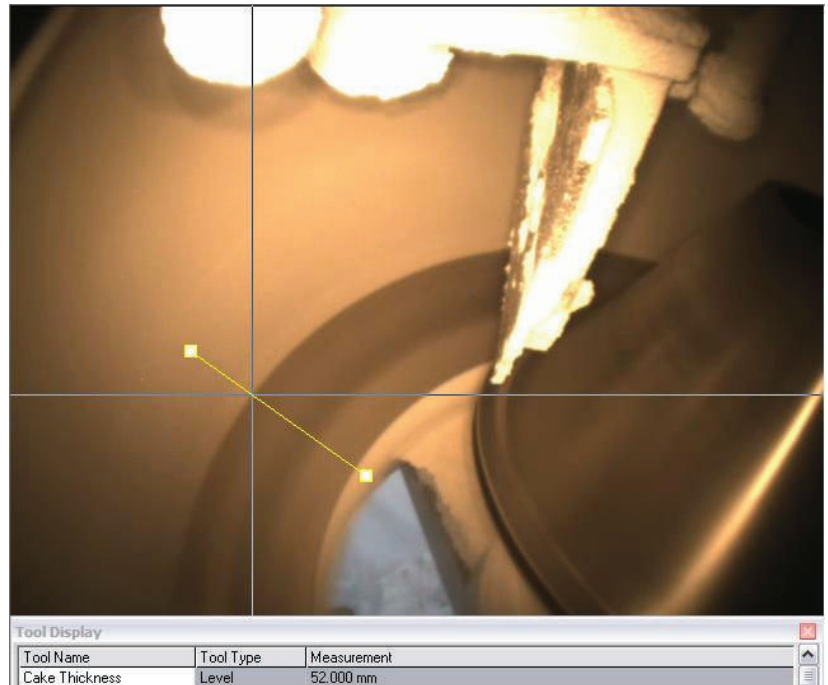
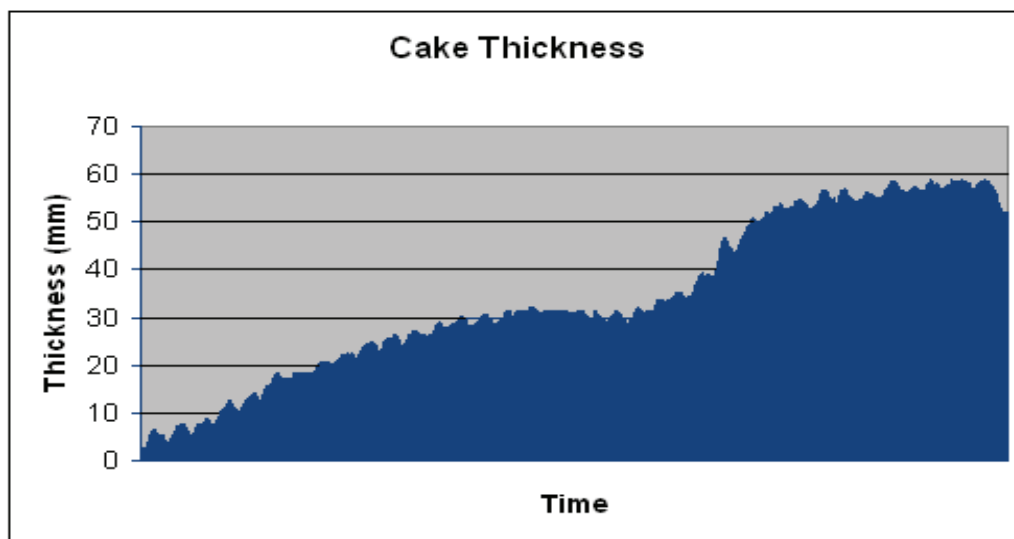


Figure 2: End of Fill Process

The fill process was graphed so the cake thickness could be monitored throughout the process. Note the area of consistent thickness measured at approximately the half way point. This is due to there being a break between the 2 stages of filling, and the data from 2 separate output files being combined to produce one graph.



Graph 1: Run 1 Fill Thickness During Process

Washing Process:

The washing process was carried out with deliberate over loading to monitor the effect of over standing liquid on the measurement, and to verify if the software was capable of tracking the wash water edge.

Figure 3 shows the washing process. It was observed that the software had the capability to track the edge of the wash water on the centrifuge base plate. It was also the case that the level of the wash water on the cake was larger than had been expected. The measurements taken by the software, were visually verified by images which showed the edge of the wash water significantly closer to the edge of the centrifuge base plate than expected (figure 3).



Figure 3: Washing Process

Dewatering Process:

The cake thickness was monitored throughout the dewatering process video, and initially it was expected that the final cake thickness would be back in the region of the 52mm as seen at the end of the filling process.

However, the software showed an increased thickness in cake by 13mm. Manual measurements were not taken at this point as the cake had been scraped from the centrifuge. This would be done in later runs.

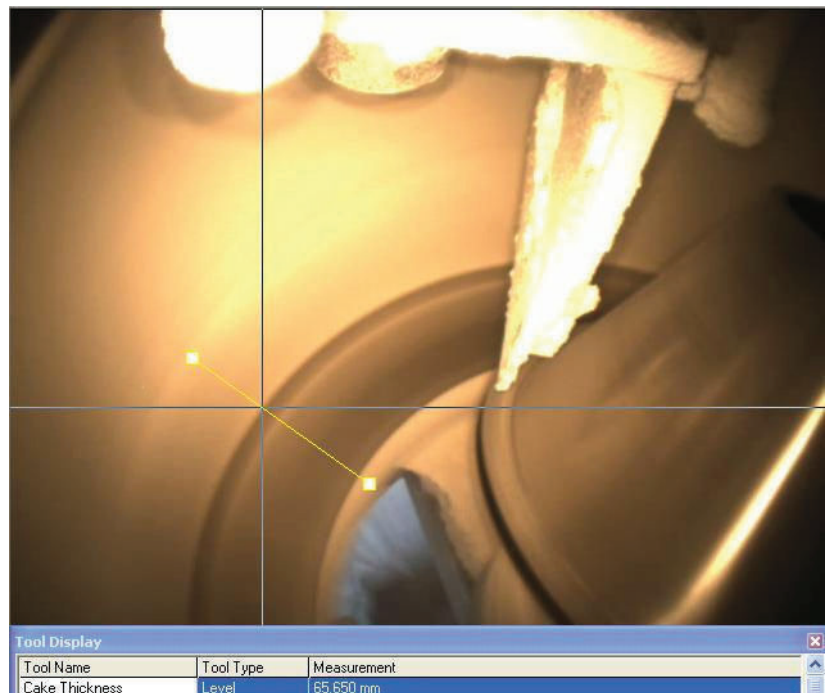


Figure 4: Dewatering Process

For run 1 there was a break between washing and dewatering, so continuous analysis on the wall intensity could not be done to see if there was a measureable drop in intensity. This was to be done in later runs. However the static scans carried out on figure 5 showed a difference in measurement of 245 during washing versus 238 after dewatering indicating the potential for this type of measurement. There is however the question whether the light is reflecting from liquid on the surface of the cake, or liquid which is in the air being sprayed onto the cake.

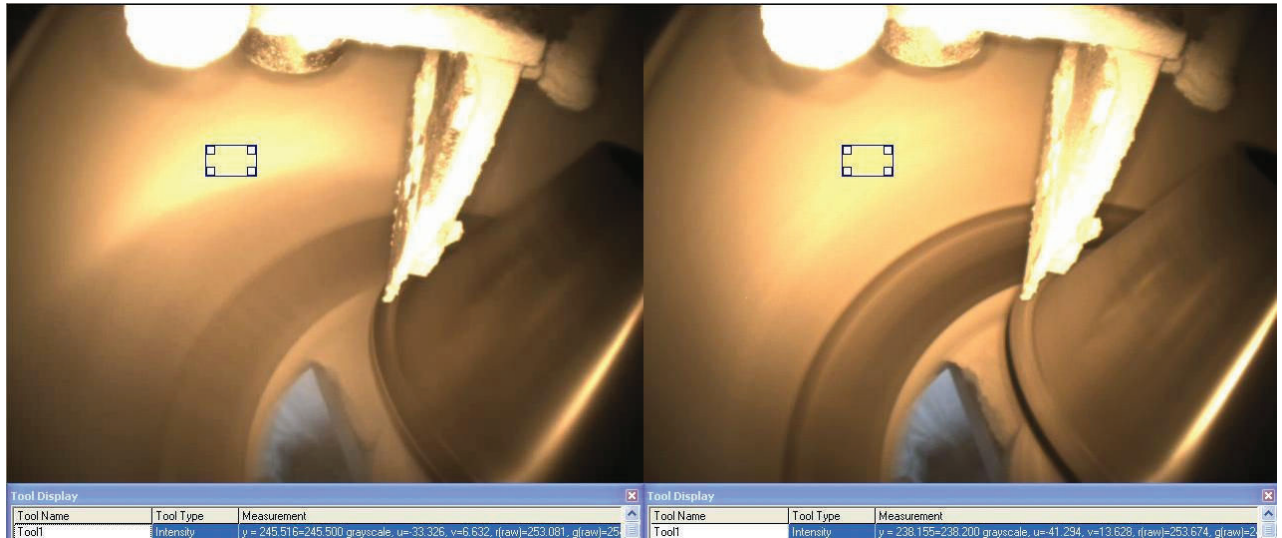


Figure 5: Intensity Measurements During Washing and Dewatering

Run 2

At the beginning of Run 2, some adjustments were made to the camera image to try to increase the white balance of the image, in an attempt to make it easier for edge tracking. For Run 2 the process would be; filling phase 1, filling phase 2, washing, dewatering, with a stoppage between each phase of the process

Filling Process:

At the end of the fill process, the software measured a thickness of 61.10mm.

4 manual measurements were taken from the centrifuge at 90° to one another. The 4 measurements were 60mm, 63mm, 60mm and 58mm, the average of which is 60.25mm.

The measurement taken by the software correlates very favourably with the manual measurements taken, indicating it is a viable method for cake detection

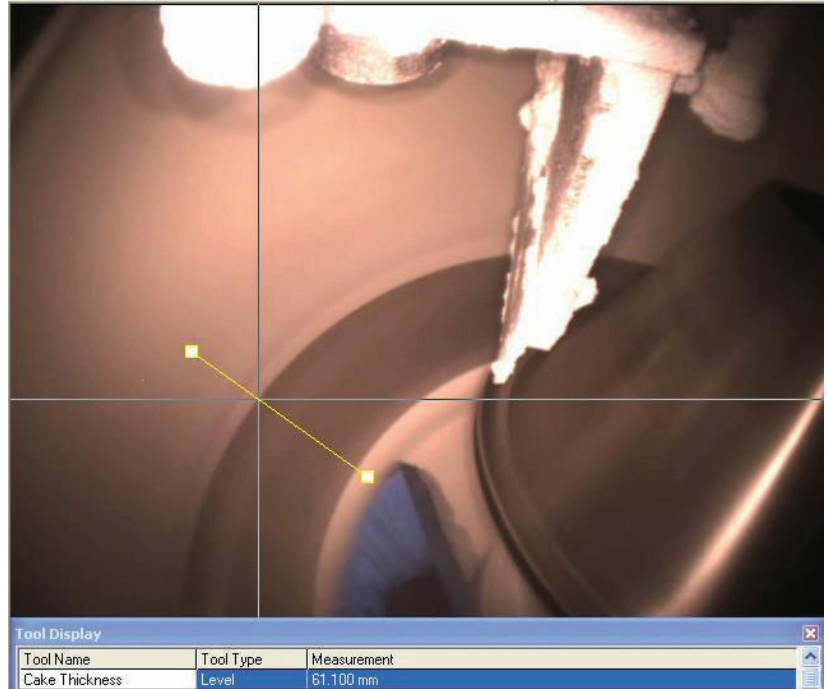
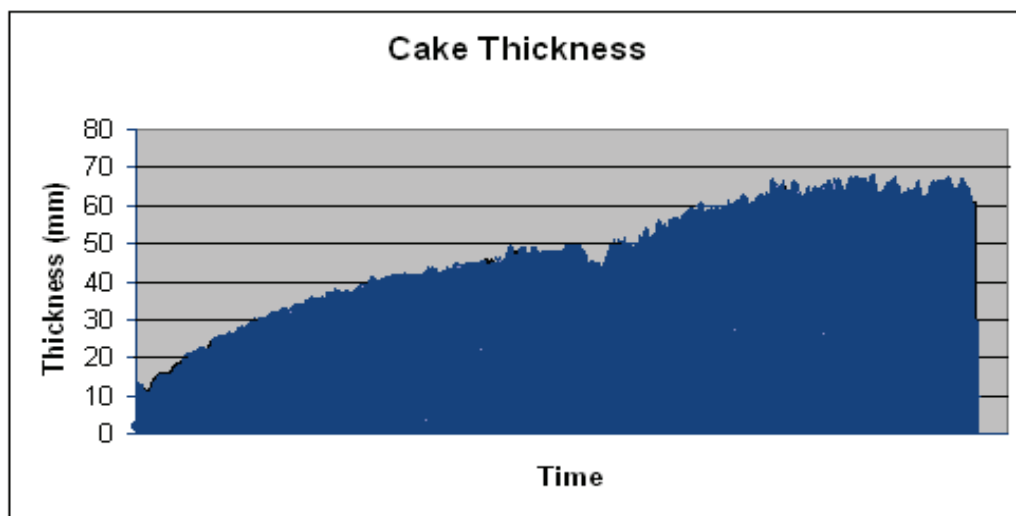


Figure 6: End of Fill Process

The fill process was graphed so the cake thickness could be monitored throughout the process.



Graph 2: Run 2 Fill Thickness During Process

Washing Process:

The washing process for Run 2 was again carried out with deliberate over loading to monitor the effect of over standing liquid on the measurement, and to verify if the software was capable of tracking the wash water edge.

Figure 7 shows the washing process. It was observed that the software had the capability to track the edge of the wash water on the centrifuge base plate. It was however noted that the edge was not tracked as easily with the newer camera settings, as the wash spray made it difficult to threshold on the wash edge.

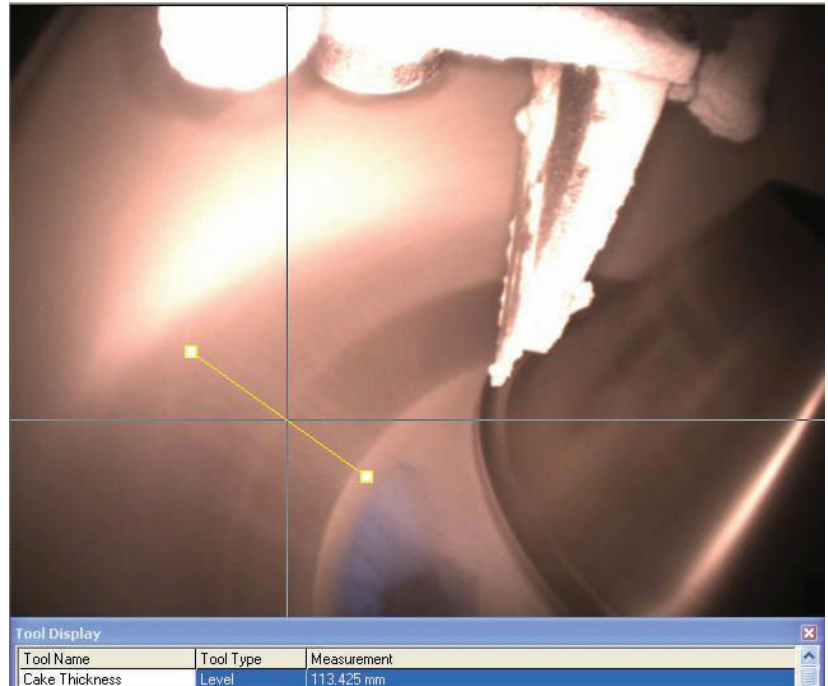


Figure 8: Washing Process

Dewatering Process:

The cake thickness was monitored throughout the dewatering process video. Before the results of Run 1, it would have been expected that the final cake thickness would be back in the region of the 61.1mm as seen at the end of the filling process. However, after monitoring Run 1 it was investigated if the cake thickness had actually increased during washing & dewatering (perhaps due to settling out of product).

The camera software showed a reading of 65.6mm after the dewatering, indicating that it had noted an increase in cake thickness. Manual measurements were taken at 4 points in the centrifuge at 90° to each other. These measurements were 63mm, 65mm, 65mm and 68mm, the average of which is 65.5mm.

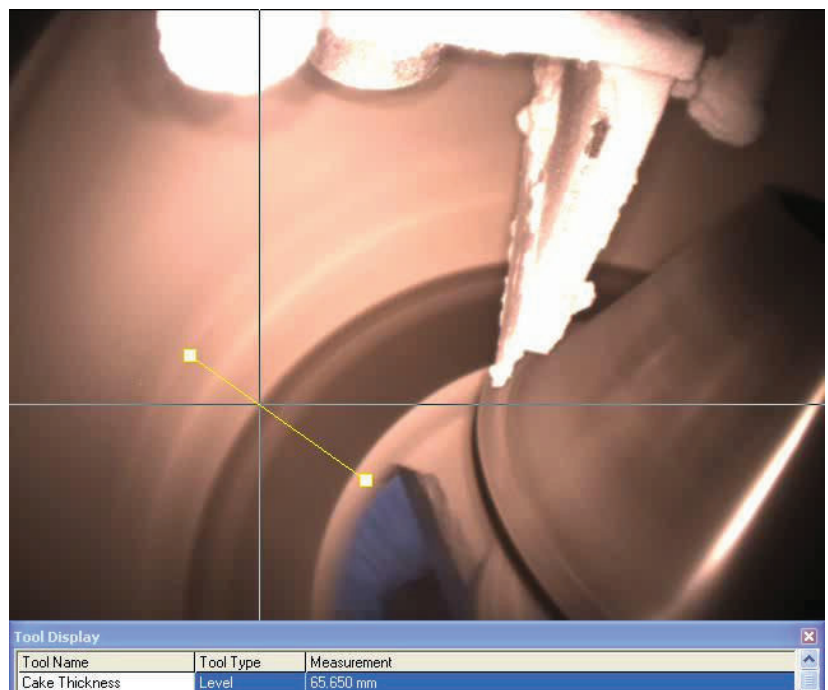


Figure 9: End of Dewatering Process

This compares very favourably to the measurements taken by the camera, further indicating its ability to be used for measuring cake thickness.

For run 2 there was a break between washing and dewatering, so continuous analysis on the wall intensity could not be done to see if there was a measureable drop in intensity. This was to be done in later runs. However the static scans carried out on figure 10 showed a difference in measurement of 236 during washing versus 214 after dewatering indicating the potential for this type of measurement. There is however the question whether the light is reflecting from liquid on the surface of the cake, or liquid which is in the air being sprayed onto the cake.

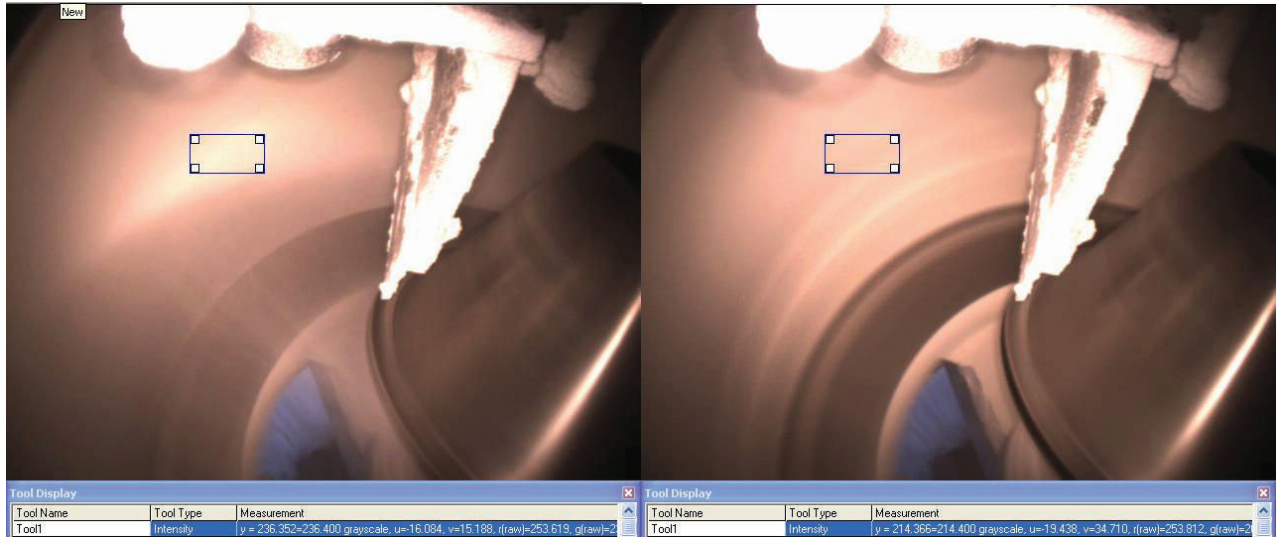


Figure 10: Intensity Measurements During Washing and Dewatering

Run 3

For Run 3, the camera settings were kept constant. For Run 3 the process would be; filling phase 1, filling phase 2, washing, dewatering, with a stoppage between each filling phase, but no stoppage between washing and dewatering (to investigate change in intensity during transition from one phase to another).

Filling Process:

At the end of the fill process, the software measured a thickness of 54.73mm.

4 manual measurements were taken from the centrifuge at 90° to one another. The 4 measurements were 55mm, 54mm, 53mm and 53mm, the average of which is 53.75mm.

The measurement taken by the software correlates very favourably with the manual measurements taken, indicating it is a viable method for cake detection

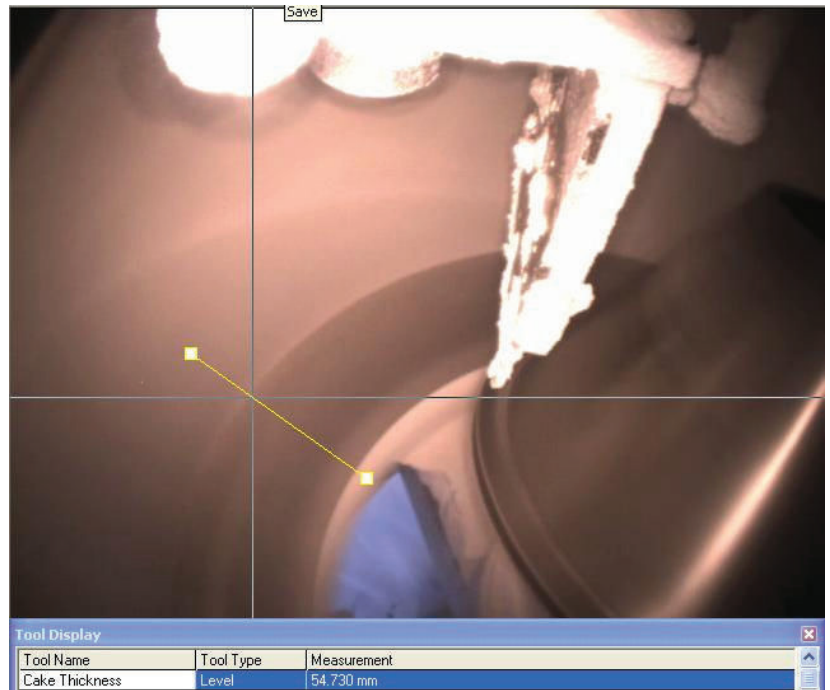
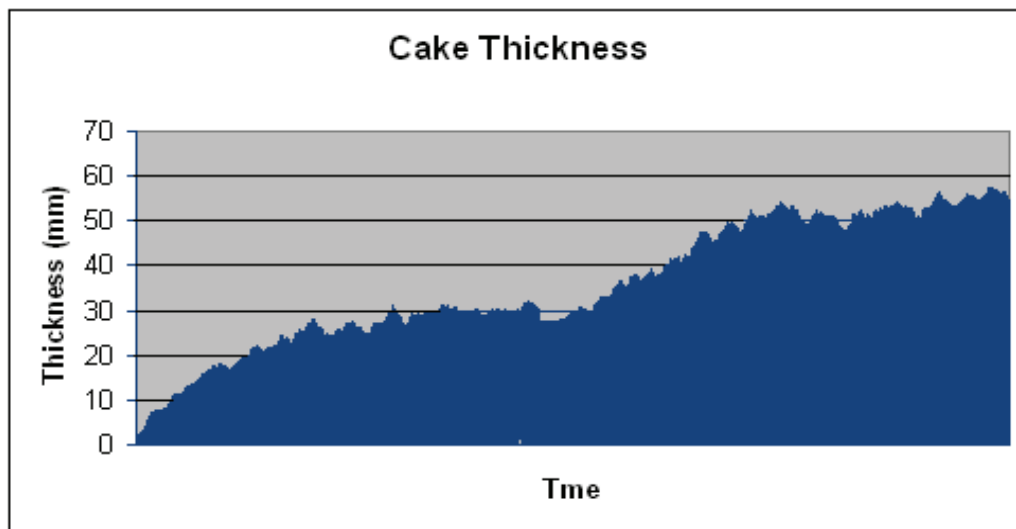


Figure 11: End of Fill Process

The fill process was graphed so the cake thickness could be monitored throughout the process.



Graph 3: Run 3 Fill Thickness During Process

Washing & Dewatering Process:

For Run 3 the washing and dewatering phase were done together in one run rather than having the break between the two phases as in previous runs. The washing phase was carried out with virtually no over standing water.

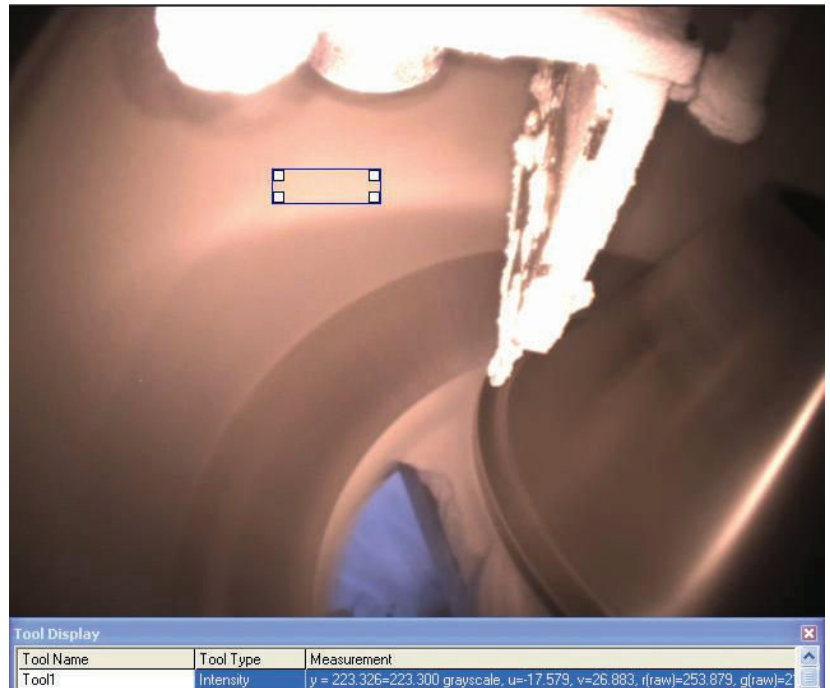
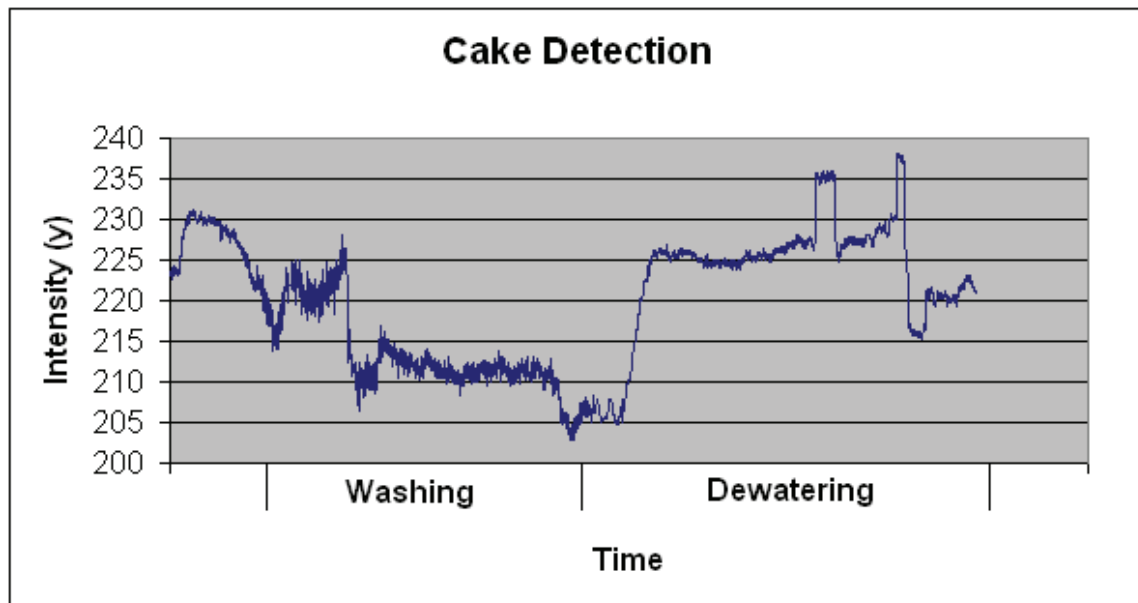


Figure 12: Washing / Dewatering Process

The washing and dewatering process was graphed so the intensity measurement could be monitored throughout the process. As can be seen in graph 4, there was significant variance in the measurement taken. The fact that the intensity measurement during washing was not higher than that during dewatering is possibly due to the fact that there was no over standing water on the surface of the cake. In Run 1 and 2, there was over standing water and the intensity measurements taken on static images (Figure 5 and 10), followed the expected trend.



Graph 4: Run 3 Intensity Measurement During Wash and Dewatering

Conclusions:

1. The Cauty process camera together with Cautyvision Client Software can be used to accurately measure the cake thickness during filling
2. The Cauty process camera together with Cautyvision Client Software can be used to accurately track the level of over standing water on the surface of the cake during the washing process.
3. The Cauty process camera together with Cautyvision Client Software showed potential of being able to detect over standing liquid versus cake. The static scans in Run 1 & 2 showed positive results whereas the continuous Run 3 produced some questions. However there was little or no over standing liquid in Run 3. Further testing is recommended on this.
4. The Cauty process camera provides an invaluable remote view into the centrifuge, helping to better understand the process from filling right through to scraping. It was noted during in scraping that it can be quite difficult to get the last of the product out of the centrifuge. This could be monitored from the control room using the camera rather than an operator having to go to the centrifuge to look through a sight glass.