Practical Problem Solving on Membrane Filtration
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Abstract
In November 2009 Tooheys commissioned a new automated twin stream cross flow filtration process. Whilst numerous controls and process improvements had occurred over several years, no investigations or improvements had specifically targeted extract loss across the system. In 2014 the Tooheys brewing department committed to reducing extract loss across all brewing processes. Filtration was identified as a large area of extract loss which was not readily visible as most of the system was hard piped to drain. Up until this point extract losses had been calculated using assumed values supplied to the department during the commissioning phase. Due to the large area to be investigated and the numerous potential loss points involved, careful consideration was given to the methods and strategy to be used for the problem solving exercise. Tooheys problem solving tools all utilise the Manufacturing excellence (MEX) principles and the DMAIC (Define, Measure, Analyse, Implement and Control) process. This presentation details the two methods deployed and the outcomes achieved. It also details the role of plant operators in achieving those outcomes.

Process
A team of 8 people consisting of a brewer, process owner, engineers and operators was assembled to examine extract loss and identify issues across the filtration process. Due to the limited understanding of the actual losses and the extent of the problem, a “Kaizen blitz” method was adopted. The “blitz” approach was decided upon as it focused on achievable goals in a short time frame, in this case 1 week, as well as highlighting areas of greater complexity. It was decided from the outset to allow the operators to “drive” the process, since they interacted with the plant on a daily basis.

An overview of the entire filtration process was drawn up showing all major process units and flow paths. The start-up and shutdown sequence was mapped out and broken down into 4 stages. Operators then identified any potential loss points within each of the stages, as well as discussing any issues or anomalies they had encountered whilst running the plant on a daily basis.

Using standard MEX tools (DMAIC’s), fishbones and 5 why’s, and by adhering to the “blitz” principle of only targeting high impact and achievable goals, the team were able to identify loss points that could be easily measured and analysed.

The second project was a profit improvement project (PIP) and this was used to measure extract loss within the membranes, as the measure and analyse phases were complex and time consuming. The project was again led by an operator, being myself, and supported by an engineer (Insa Errey). To measure the residual liquid in the filter after emptying, we used an empty IRC connected directly to the drains. This process was repeated multiple times on all filters over five days. Whilst volumes varied from filter to filter, in all cases the volume was far greater than had been anticipated. (An average of 1.2hl).

Analysis of the measurement data was then presented to a group of 5 filtration operators for their input and opinions. Using the fish bone map and 5 why process, four areas were identified for investigation and improvement. CO2 supply pressure. Low level switch (LSL) functionality and location. Liquid and gas separation. Step timers values.

Results
"Blitz method": The following improvements and modifications were achieved in five days. Other than team members labour costs, no capital outlay was required. All drain points were identified and labelled. Drain valve timings were optimised. A visual check of all drains during start-up and shutdown sequence occurs once per week as operator’s standard work. All lines used in the sequence were laser measured and their volumes recalculated. Significant variations were found between the actual volume and the value used by the sequence. In consultation with the supplier, the centrifuge maximum discharge time was increased resulting in fewer discharges per production run. As the filtration process utilises high gravity storage beer, conductivity set points were optimised to allow for some carryover of de-aerated liquor into the system. The above modifications resulted in a calculated saving of 115 tonnes of extract per annum.

Membrane emptying PIP: Several weeks of trials were undertaken to analyse the impacts of the identified target areas. Only when one area had been optimised were trials conducted on another area. The trials all took place during normal production runs and had no impact on productivity or quality. The timed steps of the emptying process were optimised by using a turbidity meter directly downstream of the membrane filters. The CO2 supply pressure was optimised using the same turbidity meter. The pressure was reduced by 10kpa increments and the presence of foam (high turbidity) was monitored. This pressure reduction also minimised the liquid/gas separation that appeared to be occurring within the pipework. Testing confirmed that the low level switch was being activated whilst liquid was still present within the filter. In consultation with the engineer we concurred that the probe was not suitably located, being in the centre of a 180° bend. We relocated the probe on one filter block only to a more suitable location. With optimisations and modifications complete we then re-measured the residual liquid within the modified filter. This demonstrated a 1hl reduction of residual liquid (only 0.25hl was recovered). The modifications were then applied to the 5 other filter blocks. By calculating the number of brand changes and CIP’s (emptying sequence of membranes) per annum and applying a loss of 0.25hl we estimate an extract saving of 96.3 tonnes per annum.

Summary
Although the examples presented utilised the Manufacturing excellence (MEX) tools and principles, any structured problem solving techniques could be applied using a similar format to both the “blitz” and process improvement methods.

The “blitz” method is an ideal tool for troubleshooting a common issue across a large process area, and is also useful as a “first up” problem solving tool in areas where no problem solving has occurred in the past. It targets the “low hanging fruit” whilst identifying areas where a more detailed investigation may be required. Its strict time schedule delivers results almost immediately.

The process improvement method (PIP), whilst more complex than the “blitz”, allows for a more thorough investigation of an area. By utilising the DMAIC strategy (Define, Measure, Analyse, Implement and Control), a problem can be correctly defined and its possible causes identified. This strategy is extremely beneficial in situations where multiple root causes are contributing to the problem.

Whilst many people may be familiar with MEX and other structured problem solving techniques, what was unique to the examples presented, was the role of the plant operator/technician in achieving the outcomes presented. Often an operator’s participation in structured problem solving is limited to a consultative role and they are only utilised in the early stages of the process. Allowing operators to lead and drive problem solving projects utilises their intimate knowledge of the plant. The variations and anomalies they often observe in their daily operations are usually indicators of an underlying cause. Allowing them to follow through on these observations can often lead to a rapid identification of a root cause, or the identification of a cause not considered. They also have the advantage of being able to test and analyse in real time and under real conditions.

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