ABSTRACT

The pulping and paper industry of South Africa relies on two primary raw materials; fibre and water. These materials are used in large quantities and the increasing water and wastewater tariffs have impacted heavily on the industry. A South African tissue mill therefore wishes to reduce its specific water consumption.

The aim of the research was to investigate the use of process simulation, water recycle, water reuse and the application of best practices to reduce the specific water consumption for the both the tissue machines at the mill.

Rather than looking at equipment changes pinch analysis was the approach used because it offers a more cost effective and long term solution. After a literature review the water cascade analysis approach proposed by Ng et al. (2007) was selected. This numerical method defines the pinch point clearly. Whilst graphical methods also define the pinch point, it is difficult to identify this point if the streams near the pinch point have similar contaminant concentrations.

A detailed material balance is required to carry out a water pinch. Examination of the mill's process flow diagram showed that insufficient information was available to complete the material balance with an accurate representation of the mill's processes.

Due to the large number of streams to be determined for each tissue machine as well as the large stream flows, physical sampling would have been impractical. Hence it was decided to combine the sampling and mass balance programming methods.

All flows where determined by back-calculation using mean production rates corresponding to the month during which samples were taken, to ensure data consistency. Statistical data analysis was performed to determine the degree of variance in the data so that all possible operating conditions were considered in the pinch analysis.

Then the water cascade analysis was performed to determine the pinch point which indicated where regeneration efforts should be focused.

Various scenarios where considered such that the true pinch point could be determined and also to compare the various regeneration configurations.

A rotary-disc filter was selected as the regeneration unit for tissue machine number one and a microfiltration unit for tissue machine number two. The network necessary to achieve the minimum targets calculated from the pinch was determined from the nearest neighbours algorithm proposed by Prakash and Shenoy (2005). Various network configurations were considered from a quality perspective.

It was determined that the specific water consumption could be reduced from 21 $m^3.ton^{-1}$ of tissue manufactured to 7 $m^3.ton^{-1}$ tissue manufactured (i.e. 66.67% reduction) on tissue machine number one and from 21 $m^3.ton^{-1}$ tissue manufactured to 8 $m^3.ton^{-1}$ tissue manufactured (i.e. 61.91% reduction) on tissue machine number two.

There is a corresponding reduction in wastewater flow to effluent plant treatment (ETP). There is no extra contaminant loading to the effluent treatment plant and as there is increased fibre recovery in the production process. Current chemical oxygen demand and biological oxygen demand control systems can still be utilised therefore there will be no appreciable accumulation in the system. The potential for energy savings is limited to heating of fresh water by the vacuum seal water as no other feasible temperature gradient exists.

Engineering and operational feasibility analyses need to be undertaken in conjunction with the factory management.