ENERGY LOSSES IN HYDRAULIC SYSTEMS OF WATER TREATMENT PLANTS.

An application to Vombverket in south Sweden.

By: Ivan Ssenozi; Supervised by: Prof. Magnus Larson, Tobias Persson, and Lars-Anders Fridström

Lund University, Department of building and environmental technology; Water resources engineering division. LTH

Figure 1-1: aerial view and layout of Vombverket

Sydvatten AB is a municipally owned company producing and supplying drinking water to about 900,000 inhabitants in southern Sweden through two water treatment plants (WTP), Ringsjöverket and Vombverket.

At Vombverket, the present capacity is somewhat reduced because of pressure losses in the pipe systems of the WTP. Parts of the WTP was built already in the 1950's and it was significantly expanded in the 1990's. In connection with the latter expansion, the transport of water through the WTP was extended before it is pumped to the main pipe system for distribution to the customers. This extension caused increased hydraulic losses in the system, resulting in reduced capacity. The WTP was typically not optimized for the new process design with regard to the hydraulic conditions, but substantial pressure losses were introduced through bends, valves, and other hydraulic components (figure 1-2).

The plant is sectioned into three filter buildings (FB1, FB2 and FB3), with FB3 being the newest one and accommodates the starting and ending parts of this study.

Figure 1-2: Inside view of filter building 2 showing the pipes and fittings; butterfly valve, flanged tees and bends.

The components in the layout as shown in figure 1-2, create a significant resistance to flow. An alternative to add a pump for overcoming the additional energy losses was to perform a detailed analysis of the flow and establish the location and properties of these losses. Such a study could form a basis for modifications of the hydraulic system that would reduce the losses and eliminate the need for pumping.

Figure 1-3: Mixing chamber, the starting point of the study.

The study begun with a literature review of energy losses in hydraulic systems of WTPs with focus on components present in Vombverket. A thorough investigation of the existing hydraulic system was performed based on available drawings and other additional information, and a comparison

made with the system before the expansion. The study started at the mixing chamber (figure 1-3) and ended at the chloramine dosing basin. Measurements of the pressure were carried out at selected points in the hydraulic system in order to quantify the losses occurring in the system.
Based on the knowledge established about the system and the measurement data obtained, the hydraulic system was schematized (figure 1-4), coming up with a simplified conceptual model involving the most important components that were expected to have an effect to the flow. Certain coefficient values were estimated from the collected data on pressure.

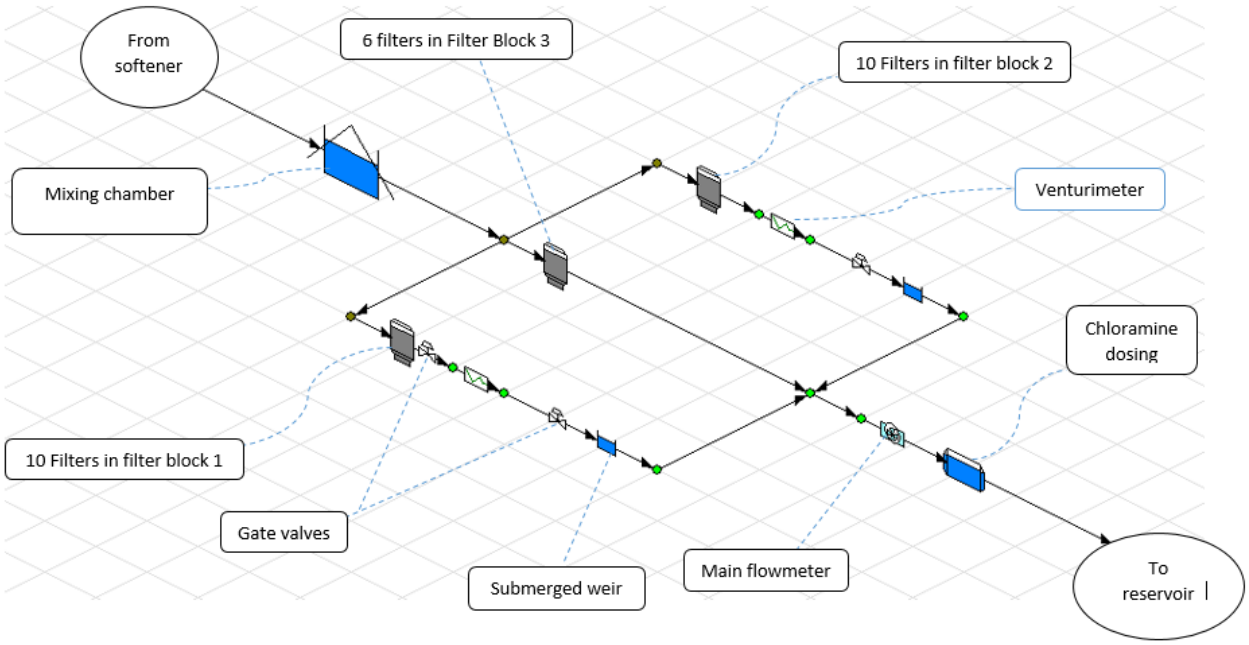

Figure 1-4: simple schematization of the hydraulic system at Vombverket

Using Pipe Flow Expert, a hydraulic model that had more details and effective description of the complex system was obtained. The model was calibrated, and validated using measured datasets from the plant.
The validated model was then modified to optimize its performance. Financial implications of each modification was done. This was in relation with the amount of water increment for a particular action taken.
There were two significant modifications recommended;

1. To remove specific components from the system like the Venturimeters, the submerged weirs, and one of the gate valves in filter block 1.
2. To directly connect the hydraulic system in filter block 1 and 2 to the reservoir shortening the water pathway, hence reducing the energy lost. With this option, the weirs would not be removed.