Tertiary Disk Filters at the Kitchener WWTP

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The Kitchener Wastewater Treatment Plant (WWTP) is a conventional secondary treatment facility in the Region of Waterloo (Region) that has a rated capacity of 123 MLD and discharges to the Grand River. The Region has been undertaking a 10-year capital upgrades program at the Kitchener WWTP in the order of $320 million. Upgrades to the facility have been initiated to improve performance, effluent quality and reliability of the plant, and a key component of these upgrades is a new tertiary treatment facility.

A thorough review of tertiary treatment technologies was undertaken with the goal of improving the removal of total suspended solids (TSS) and total phosphorous (TP). Cloth media disk filters were selected as the preferred alternative, primarily due to having the lowest capital and life cycle costs and low headloss, which avoided the need for intermediate pumping. The design parameters for the new tertiary filtration system were developed based on cloth disk filter technology and the effluent objectives were set at less than 5 mg/L for TSS and less than 0.2 mg/L for TP.

Disk filtration equipment can vary significantly between vendors, including equipment size and the number of units required, therefore, selection of the specific equipment model was required prior to completing the overall detailed design of the new facility. An equipment pre-selection process was initiated and included a pre-qualification of equipment and manufacturers, a pilot evaluation of the pre-qualified equipment at the Kitchener WWTP, and a pre-selection tender process.

Pilot study and equipment pre-selection

During the pre-qualification stage, manufacturers submitted proposals for the full-scale equipment requirements of the Kitchener WWTP tertiary facility, including model, number of units required, equipment size, filter surface area, and filter loading rates. Based on this proposal, they participated in a pilot program to confirm the performance and operational requirements of the proposed equipment. As an added benefit, operators were able to tour each pilot plant and observe the equipment and discuss operation and maintenance with supplier operators.

Four manufacturers were selected to participate in the two-week pilot program in September 2013. Samples were analyzed for TSS, TP, soluble phosphorous (SP), carbonaceous biochemical oxygen demand ($cBOD_5$) and UV transmittance. The following operating conditions were considered: average flow, peak flow, solids stress, and ferric chloride addition. Each filter performed as expected under normal conditions; however, some of the filters began to falter as the flow increased and upset conditions were introduced. Not all filters achieved the TSS objective during peak flow, solids stress, and ferric chloride addition conditions.

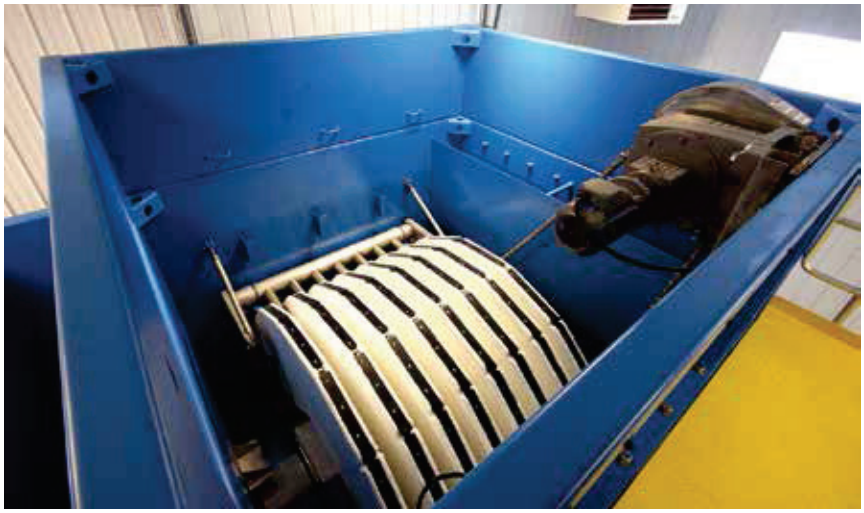
Results from the pilot study were used in the development of vendor design criteria for the pre-selection specifications. The peak hydraulic loading rates that could be treated during the pilot study were applied to the full-scale plant. The required backwash rate criteria and minimum filter surface area for the full-scale facility were adjusted based on the pilot study findings. Overall, the pilot findings confirmed similar hydraulic loading rates (i.e., peak hydraulic loading rate of 15 m/h on a submerged area basis) for each vendor when corrected to a total submerged or 'active' filtration area.

Tertiary filtration design concept

Aqua-Aerobic Systems, Inc. was the successful vendor in the pre-selection and is supplying four 24-disk MegaDisk® units for this facility; the final detailed design of the tertiary filtration process and associated

FIGURE 1

Example MegaDisk installation (photo courtesy of Aqua-Aerobic Systems, Inc.)



building were designed around these filters. An example MegaDisk® installation is depicted in **Figure 1**. The tertiary filtration process consists of the following major system components:

- Four tertiary filters installed in concrete basins (1 additional basin for future filter)
- Four backwash pumps, which are also used removing solids that have settled at the bottom of the filter basin
- Tertiary filtration bypass gate

The filters are sized based on three duty, one standby. In practice, all four filters will normally run continuously, which minimizes system headloss and ensures continuous turnover of water within each filter cell. The filters are fully automated and are supplied power by a plant wide emergency backup power system. A rendering of the Kitchener WWTP tertiary filtration building is presented in **Figure 2.**

The specific needs and conditions of the Kitchener WWTP were considered in the design and are reflected in the final design concept, including reducing headloss, filter bypass provisions, and maintenance access improvements.

Headloss

The tertiary filtration process is being added into an existing plant with a fixed hydraulic grade line. Minimizing headloss was an important consideration to avoid the need for intermediate pumping. The maximum allowable headloss, including inlet, cloth media, and exit losses was 0.6 m.

The standard MegaDisk® design is based on influent finger weirs (for improved flow distribution) and a fixed bypass weir gate. Headloss was minimized in the filter design by elongating the filter influent finger weirs and providing modulating effluent weir gates. Through these modifications, tertiary filter system headlosses were minimized and gravity flow from the secondary clarifiers through tertiary filtration to the UV disinfection system could be maintained.

Filter bypass

The tertiary filter system is designed to hydraulically treat the peak daily flow and TSS loading without any bypassing; flows above the peak daily flow will bypass the tertiary filters and be combined with tertiary effluent and directed to UV disinfection. Designing the tertiary filter system on peak day (2.0 peak factor) rather than peak instantaneous flow (PIF) (3.5 peak factor) allowed for a reduction in the number of filters and the overall building size without impacting the plant's ability to achieve compliance objectives.

An actuated bypass weir gate is provided upstream of the tertiary filters and is the main bypass control mechanism. Normally, the bypass weir gate is in a fully-raised position and all flow undergoes tertiary filtration. At high water levels upstream of the filters, the weir gate modulates to maintain the upstream water level at a fixed set point to maximize filtration. Tertiary bypass flow receives full secondary treatment and blends with tertiary treated effluent upstream of UV disinfection.

Emergency fixed bypass weirs internal to the filters also allow for the bypass of PIF, should the bypass weir gate fail in the closed position.

Maintenance access

The filter basins are equipped with removable checkered plate covers, providing two main benefits: 1) minimizing humidity and the presence of filter flies in the building and 2) providing additional working space on the filter room floor, allowing for common wall filter construction and maintenance access from covered adjacent filters. Small inspection hatches are provided to allow for easy inspection of the filters.

An overhead crane has been provided for easy movement of equipment from the loading bay to the rest of the building.

The filter basins were enlarged slightly to allow use of a custom removable maintenance platform, which can be installed in the filter basin on a temporary basis using the crane, to improve the ease with which maintenance (e.g., filter media replacement) can be performed.

Conclusions

Tertiary disk filters were selected for the Kitchener WWTP upgrades due to lower capital and operating costs, small footprint and low headloss. By working closely with the filter vendor, custom modifications were incorporated to increase value to the Region through reduced overall headloss and improved building environment and maintenance access.

FIGURE 2

Kitchener WWTP tertiary filtration building interior