Tertiary Disk Filters at the Kitchener WWTP


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 (cBOD₅) 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...
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.