Performance of Residential Wastewater Treatment Technologies under New Stressing Conditions related to Lifestyle Changes

Summary of the conference presented by Roger Lacasse within the context of OOWA Annual Conference

Premier Tech Environnement

Performance of Residential Wastewater Treatment Technologies under New Stressing Conditions related to Lifestyle Changes

Roger Lacasse[1]

Over the past two decades, major changes in family lifestyles have been observed. People travel more, eat in restaurants more frequently and, in many families, both parents work outside the home. Based on information from Statistics Canada, in 1970, 31% of Canadian families had both parents working outside the home. In 1990, this percentage has risen to more than 70%. As well, the higher divorce rate also impacts house occupancy. In newly formed families, house occupancy may vary from week to week because of issues like shared custody.

These lifestyle changes all have an impact on wastewater flow patterns generated in houses not connected to the municipal sewer system. And now, intermittent and peak flows are not only generated in secondary or seasonal homes, but increasingly in permanent homes as well.

Although the existing testing protocols for technology certification (NSF, BNQ and EN in Europe) include stress tests, they do not reflect the new stressing conditions (intermittent flow, overload) related to lifestyle changes. For example, the NSF protocol does not provide for overloading or underloading periods (only design flow). As well, vacation stress (zero flow periods) is limited to eight days.

To test residential wastewater treatment technologies under conditions that better reflect the new lifestyles, in 2006, the international group Veolia Water developed a new testing protocol to compare and evaluate eight different treatment technologies on the CSTB (Building Scientific and Technical Center) testing platform located in Nantes, France. The new protocol is based on a 40-week testing period that includes the following steps:

- Four (4) weeks for system start-up (stabilization of biological process) at design flow rate
- Twelve (12) weeks at design flow rate
- Four (4) weeks at design flow rate from Monday to Thursday, and at 2 X design flow rate for the other 3 days. This condition reflects typical high occupancy during week-ends (frequent condition in secondary homes).
- Three (3) weeks at 2 X design flow rate (overloading conditions for high-occupancy conditions)
- Three (3) weeks at zero flow to simulate vacation
- Two (2) weeks at design flow rate from Monday to Thursday, and at 2 X design flow rate for the other 3 days
- Four (4) weeks at design flow rate;
- Two (2) weeks at 50% of design flow rate (low occupancy conditions)
- Six (6) weeks at design flow rate with 3 days of power failure (one every 2 weeks)

Phase 1 of this evaluation project began in February 2006 and was completed in November 2006. New testing phases are presently ongoing. The eight technologies tested were representative of the different treatment processes existing in the market:

[1] Roger Lacasse, Scientific and Technical Director, Premier Tech Environment, 1, ave Premier, Rivière-du-Loup, Québec Canada, G5R 6C1. lacr@premiertech.com

- Sand filter sized according to the French regulation;
- Reduced sand filter size using a gravelless distribution device (plastic channel with geotextile interior)
- Constructed wetland
- Zeolith filter
- Organic-based biofilter (Premier Tech Ecoflo® technology)
- Textile-based biofilter (Premier Tech Ecoflex™ technology);
- Aerobic treatment unit (ATU) (without fixed film)
- Aerobic treatment unit (ATU) with submerged fixed film media

The capacity of the tested systems corresponded to 5 - 6 inhabitant equivalents, and samples were collected twice a week to analyze for TSS, COD, $CBOD_5$, ammonia, pH at the system inlet (inlet of the septic tank), septic tank effluent and treatment unit effluent. Table 1 provides the raw wastewater characteristics at the inlet of the system showing that the wastewater used was representative of domestic application with low dilution. Table 2 provides a summary of the results (average ± standard deviation) obtained during Phase 1 of the evaluation project.

Table 1 Raw Wastewater Characteristics

Parameters	**TSS (mg/L)**	**$CBOD_5$ (mg/L)**	**TKN (mg/L)**
Average	313	313	75
Standard deviation	216	114	13

Table 2 Treated effluent characteristics during Phase 1

Technology	**TSS (mg/L)**	**$CBOD_5$ (mg/L)**
Ecoflo® Biofilter	7 ± 3	5 ± 3
Sand filter	7 ± 6	6 ± 4
Ecoflex™ Biofilter	13 ± 11	8 ± 3
Zeolith Filter	14 ± 9	11 ± 5
Reduced sand filter size with gravelless distribution system	15 ± 10	13 ± 9
Aerobic treatment system with submerged fixed film	16 ± 12	19 ± 9
Aerobic treatment unit without fixed film media*	40 ± 30	45 ± 33
Constructed wetland**	36 ± 10	60 ± 23

* Sludge removal was required after the first 6 months of the operation period.
** The initial system has been replaced by a new version of constructed wetland (monitoring is ongoing)

An analysis of the results provided above show that, on average, the Ecoflo® Biofilter obtained better results with treated effluent concentrations of 7 and 5 mg/L for TSS and $CBOD_5$ respectively, and low variation (standard deviation of 3 mg/L). Average results with sand filter effluent were also below 10 mg/L for TSS and $CBOD_5$ but with more variation, although the sand filter area was 2 to 3 times larger than the Ecoflo® Biofilter. It is important to note that the installed sand filter was under drained, and results will likely be different if the sand filter is not drained before treated effluent infiltration into native soil. Three other filter technologies achieved average performance, below 15 mg/L for TSS and $CBOD_5$ but with more variation, especially with a reduced sand filter size. It is interesting to note that the five first technologies use filtering media. Results obtained with aerobic treatment units indicated higher average effluent concentrations and high variation. For an aerobic treatment unit with submerged fixed film media, effluent concentrations were in line with the secondary treatment level (TSS = 25 mg/l and BOD_5 = 30 mg/L), but the performance of an aerobic treatment unit without fixed film media was very low. In both cases, the treated effluent concentrations were highly variable.

To illustrate the effectiveness of a biofiltration process like the Ecoflo® technology under new stressing conditions related to lifestyle changes, Figure 1 provides a comparison of treated TSS effluent concentrations from an Ecoflo® system with effluent produced by an aerobic treatment unit that uses submerged fixed film media. Under all conditions tested, the results clearly show the high performance stability of the Biofilter compared to the aerobic unit with submerged fixed film media. Three different testing periods are of particular significance: 12 weeks are required to stabilize the aerobic treatment unit with submerged fixed film media and high TSS effluent concentrations related to overloading (high occupancy conditions) or a power failure. These results showed that aerobic treatment units with submerged fixed film media are not well suited for intermittent flow conditions observed in secondary or seasonal homes and in an increasing number of permanent homes. These high variations of effluent quality will clog the native soil and, in the short term, significantly reduce the life of the infiltration zone.

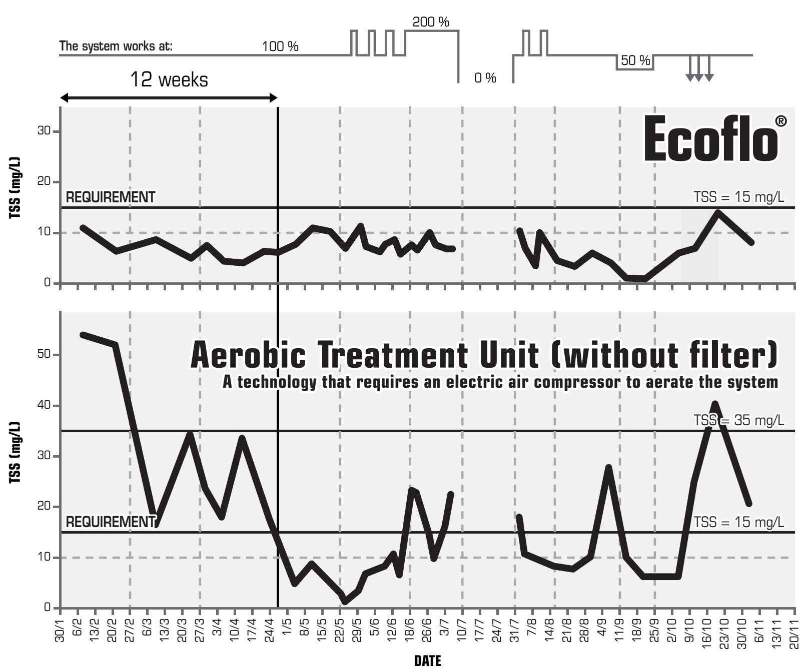

Figure 1 Comparison of the Performance of the Ecoflo® Biofilter and the Aerobic Treatment Unit (ATU) with Submerged Fixed Film Media