Small Wastewater Treatment Systems

By Michael Albanese, P.Eng.

H2FLOW EQUIPMENT INC.

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Why do you need one?

- Typical Reasons
  - Environmental Regulations
  - New Development
  - Failing Septic Systems
  - Cost of Sewers & Pumping to Closest Municipality
  - Centralized Operations may be costly
  - Politics
  - Autonomy
  - Keeping the Water
  - Reuse
What are you looking for?

A low cost, highly efficient wastewater treatment system capable of consistently producing:

- <5-10 mg/L BOD
- <5-10 mg/L TSS
- <0.5-2 mg/L NH3
- <0.1-0.5 mg/L TP
- <200 FColi / 100ml

.... with minimal electrical cost, high degree of automation, low operator attention and minimal sludge production !!!!

(I WILL ORDER ONE OF THOSE, THANKS VERY MUCH....)
Definitions

• On-Site systems for 0 to 5m³/day and can be up to 20 m³/day
• A small wastewater plant is usually referred to flows between 10 to 300 m³/day but can range up to 3800 m³/day
• We will focus on 20m to 300m³/day range

5th Wheel Truck Stop WWTP – Dorchester, ON – 45m³/day SBR
What is a Package Plant?

• Term “package plant” is loosely used
• Industry definition is a transportable plant that comes pre-assembled ready for plug and play, made in steel or pre-cast tankage
• Sometimes this term is also used to refer to small pre-engineered plants which are poured in place concrete. Should be referred to as Pre-Engineered plants
Package & Pre-Engineered Plants

PACKAGE PLANT
(usually up to 200m³/day)
Steel or Pre-cast Tanks

PRE-ENGINEERED PLANT
(usually up to 3800m³/day)
Poured In Place Concrete Tanks
Package & Pre-Engineered Plants

PACKAGE PLANT
(usually up to 200m³/day)
Steel or Pre-cast Tanks

PRE-ENGINEERED PLANT
(usually up to 3800m³/day)
Poured In Place Concrete Tanks

Photo Courtesy of Eimco Water Inc.
Types of Small Plants

Most Common Biological Processes:

- Extended Aeration
- RBC (Rotating Biological Contactor)
- SBR (Sequencing Batch Reactor)
- ISAM (Modified SBR)
- MBR (Membrane Bio Reactor)
- Others (Contact Stabilization, Lagoon) not discussed as they are not common or no longer marketed
Extended Aeration

- Rectangular up to 400 m³/d
- Concentric Design > 400 m³/d
- Very popular up to recent years
- Usually Consists of:
  - Aeration Tank (outboard)
  - Clarifier (internal tank)

PLUS
- Aerobic Digester
- Disinfection
- Equalization Chamber
- Tertiary Filters
- Continuous Flow Discharge
- Declined in popularity as better processes went on the market

Photo Courtesy of Permastore Ltd.
Extended Aeration

Sample Plan Layout

- Influent
- Aerobic Digester
- Equalization Chamber
- Tertiary Filters
- Disinfection
- Effluent

Clarifier
Aeration Tank
Rotating Biological Contactor

- Declined in popularity due to mechanical issues and low effluent quality
- Usually Consists of:
  - Primary Tank
  - Rotating Disk
  - Secondary Clarifier

PLUS
- Aerobic Digester
- Disinfection Chamber
- Tertiary Filters

- Continuous Flow Discharge
- Needs to be covered
- Low operator attention
Rotating Biological Contactor

Sample Plan Layout
Sequencing Batch Reactor

- Modified Exended Air Process
- Mostly Rectangular
- Batch Discharge
- Various Variations
- Usually Consists of:
  - Selector Tanks
  - Upstream Equalization Tank or Two Tanks in series
  - Tank for React/ Settle/ Decant

PLUS
- Aerobic Digester
- Post Equalization Chamber
- Disinfection
- Tertiary Filters
Sequencing Batch Reactor

SBR Steps: Fill, React, Settle, Decant & Idle
Sequencing Batch Reactor

Single Train Layout

- Influent
- Equalization Chamber
- SBR
- Post Equalization Chamber
- Tertiary Filters
- Disinfection
- Effluent
- Optional Selector Tank
Sequencing Batch Reactor

Dual Train Layout

Sequencing Batch Reactor (SBR)

Influent

Optional Selector Tank

Post Equalization

Disinfection

Tertiary Filters

Aerobic Digester

Effluent
Modified Sequencing Batch Reactor (ISAM)

- Rectangular
- Batch Discharge with Fill, Interact, Settle, Decant
- Usually Consists of:
  - Anaerobic Trash Trap Tanks
  - Equalization Tank
  - React/ Settle/ Decant Tank
PLUS
  - Post Equalization Chamber
  - Disinfection
  - Tertiary Filters
- Low sludge production
Modified Sequencing Batch Reactor (ISAM)

Sample Plan Layout
Membrane Bio Reactor

- Mostly Rectangular
- Continuous Discharge
- Various Variations
  - Selector / Anoxic Zone
  - Aeration Zone
  - Membranes as Clarifier

PLUS
- Aerobic Digester
- Disinfection

- NO Tertiary Filters
- Smallest Footprint
- Some MBR models can thicken sludge
Membrane Bio Reactor

38 m³/day Footprint Based on EIMCO WATER / KUBOTA MBR
Design Issues

• Large fluctuations in flow and BOD loads
  - (watch your pump sizing!)
• Effluent Limits may determine which technology
• External Loads like Septage – this is high BOD load – we need to design for it
• Sludge Production and Disposal - usually removed by vac truck, but if you can produce less that reduces frequency
• Odour considerations if neighbours are nearby
• Pretreatment; Screening, Grinding or Trash Trap
• Downstream processes; Filters and Disinfection
Large fluctuations in loads

Hydraulic shock loads and large variation in flows from small communities are accentuated by the use of oversized pumps where wastewater is pumped.

Example: Based on per capita unit flow, you determine you need a 30m³/day plant for a community.

Smallest sewage pump (2”) is rated for 120 lpm @20ft head

When pump is on it equates to 173m³/d ! (about 6 times ADF). Designing for 8-10 is not uncommon, by using equalization tanks.
Pretreatment

- Fine screening is recommended (and is a must for MBR)
- Grinding can be adequate for SBR, ExAir, RBC
- Trash trap works well for SBR, ExAir
- Grit removal may be required but for small systems it is typically not included or use Trash trap
- Size for Instantaneous Peak Flow not ADF

Channel Grinder – Photo Courtesy of Franklin Miller Corp.
Pretreatment – Screening

• If screening, then fine screening is recommended (6mm openings)
• 2 or 3mm if going with MBR
• Removes grease balls!
• Screw Screen popular choice
• Will have to dispose of removed screened material
• Bagger Unit can help with odours and housekeeping
• Can be located outdoors (no building) but must equip screening unit with heat tracing and insulation.

Screw Screen – Photo Courtesy of Parkson Corp.
Tertiary Filters

- Pressure filter type or Continuous Backwash Type
- Not needed for MBR
- Size for Instantaneous Peak Flow not ADF
- Watch Volume of Backwash!
Disinfection

• UV or Chlorine are typical
• With Chlorine, Dechlorination is needed more and more
• UV is simple, no chemicals, less operator attendance
• Can be inside or outside building
• Size for Instantaneous Peak Flow
This presentation was mainly an overview of available technologies for small wastewater treatment plants, plus considerations and general design issues associated with them. In conclusion:

Select your treatment system process based on:

- Capital cost
- Operational costs
- Site Conditions (Temperature)
- Effluent criteria
- Sludge production
- Footprint
- References
- Support
THANK YOU VERY MUCH!

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Any questions?

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