Landfill Leachate Treatment Solutions – What Technologies are Working and How to Select the Best Solution

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Joseph G. Cleary, P.E., BCEE
HDR
Senior Vice President
Mahwah, New Jersey

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Outline

- Key Drivers
- Treatment Challenges
- Treatment Technologies
- Approach to Selection
- Case Studies
- Summary

Key Drivers

- High Operating Costs
- Increased Pressure from local POTW's
  - Ammonia/BOD/COD
  - Surcharges
  - Volume control or rejection
  - Variability in Characteristics
  - Impact on UV Systems
  - TDS/Chlorides
- Increasing Condensate/Leachate Extraction
  - Cell Development
  - Stormwater Management
  - On-Site Recirculation
- Disposal is becoming more stringent
- Future? Pharmaceuticals, Tritium, TDS, Nitrogen

Treatment Challenges

- **PRETREATMENT FOR POTW**
  - NH3-N/TKN, Chloride/TDS, BOD, TSS
- **FULL TREATMENT FOR DIRECT DISCHARGE – High degree of treatment needed:**
  - ~1 mg/L NH3-N
  - 10 to 15 mg/L BOD
  - 10 to 15 mg/L TSS
  - Metals
  - TDS
  - VOC, SVOC, Pesticides, Herbicides, PCBs and emerging contaminants.
  - Whole effluent toxicity (bioassay)

Leachate Characteristics	
Parameter	Typical Concentration (mg/L)
BOD	100 – 500
COD	250 – 1500
TSS	40 – 200
TKN	300 – 1200
Ammonia	200 – 1000
Total P	1 – 3
TDS	500 – 4000
Color (TCU)	500 – 1500

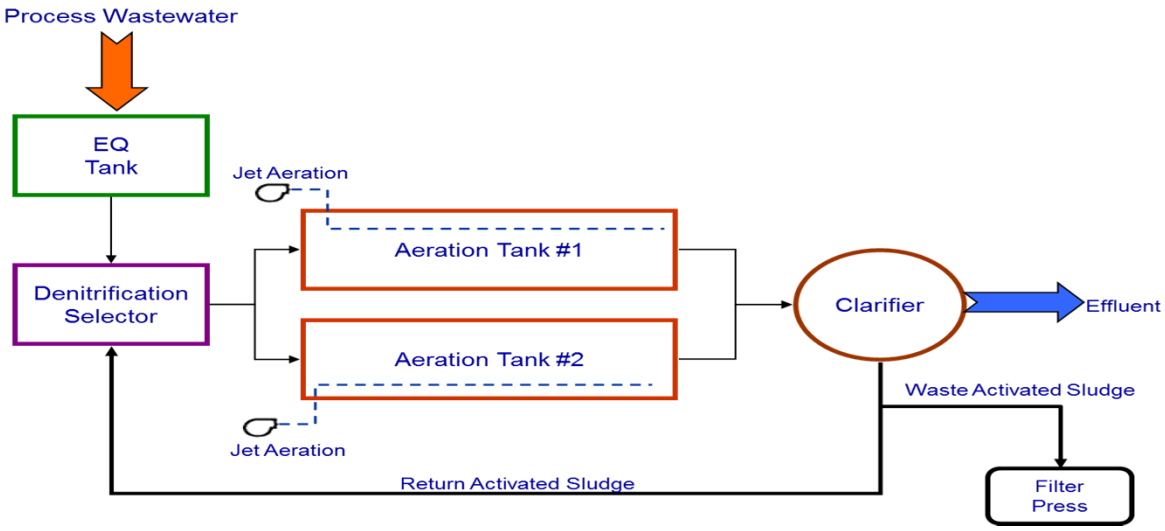
Leachate Technology Alternatives

- **BIOLOGICAL TREATMENT**
  - Activated Sludge
  - SBRs – Sequencing Batch Reactor
  - PACT
  - MBRs – Membrane Bioreactor
  - MBBR – Moving Bed Bioreactor
  - RBCs & Biofilter
  - Wetlands
  - Anaerobic Treatment
  - Anammox
- **PHYSICAL/CHEMICAL TREATMENT**
  - Reverse Osmosis
  - Ammonia Stripping
  - Vacuum Distillation
  - Nutrient Recovery
  - Evaporation
  - Breakpoint Chlorination
  - Chemical Oxidation

Activated Sludge Definition

- Gelatinous mass of microorganisms, zoogleal bacteria, protozoa& rotiters
- Biosolids floc produced with wastewater by growth of bacteria in presence of dissolved oxygen and recycled floc after settling.

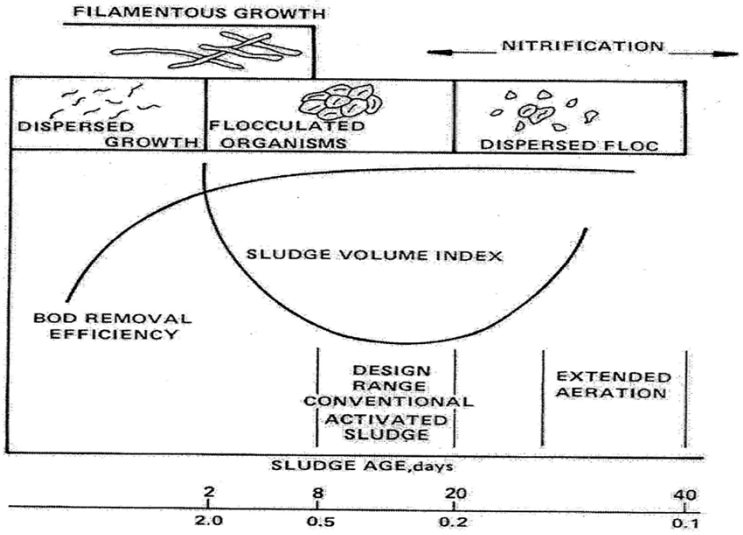
Activated Sludge – Process Flow Diagram



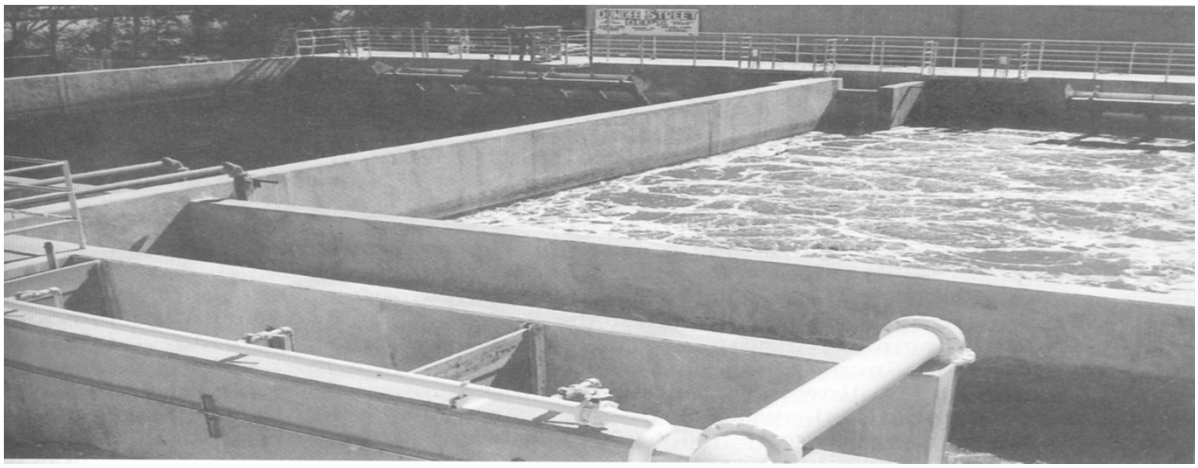
History and Key Milestones

- 1913 – Initial research in MA and UK
- 20s – First plant in US in MA
- 40s – NYC step feed plants
- 50s – 300 AS plants in US, Aerated Lagoons at Pulp and Paper Mills
- 60s – SBRs
- 70s – Pure Oxygen, PACT and Deep Shaft
- 80s – Thermophilic Aerobic and Selectors
- 90s – Membrane Bioreactors and Moving Bed Bioreactors
- 2000 to present – Sharon, Biomag, Nereda, Annamox
- 2014 forward – What's Next?

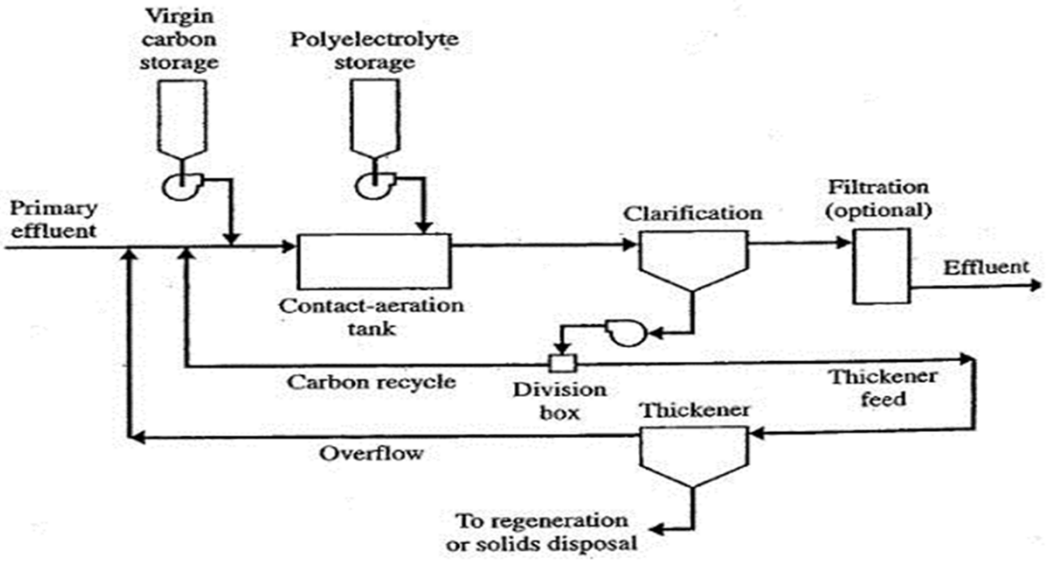
Flocculation & Settling Characteristics of Activated Sludge as Related to Organic Loading



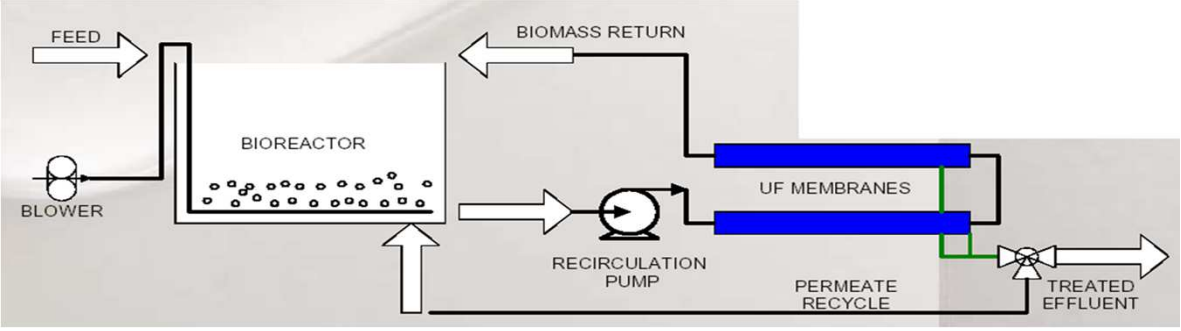
Sequencing Batch Reactor
(Freshkills, NY; RI; & Grows, PA)



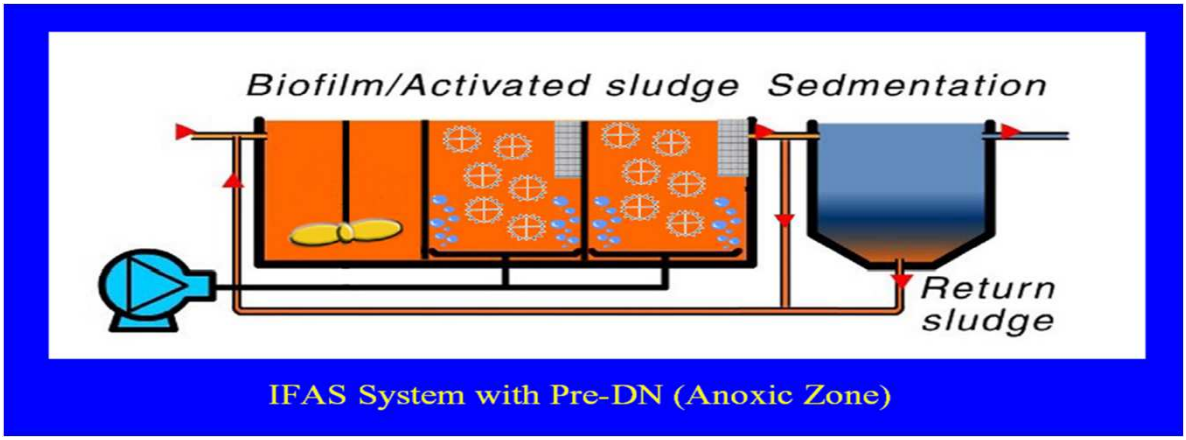
PACT Wastewater Treatment System



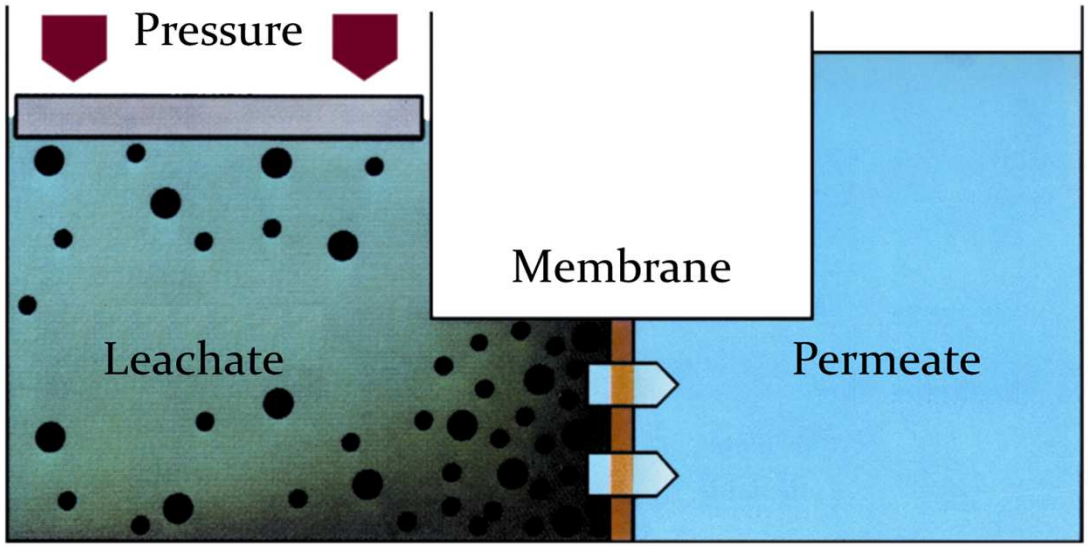
Membrane Bioreactor



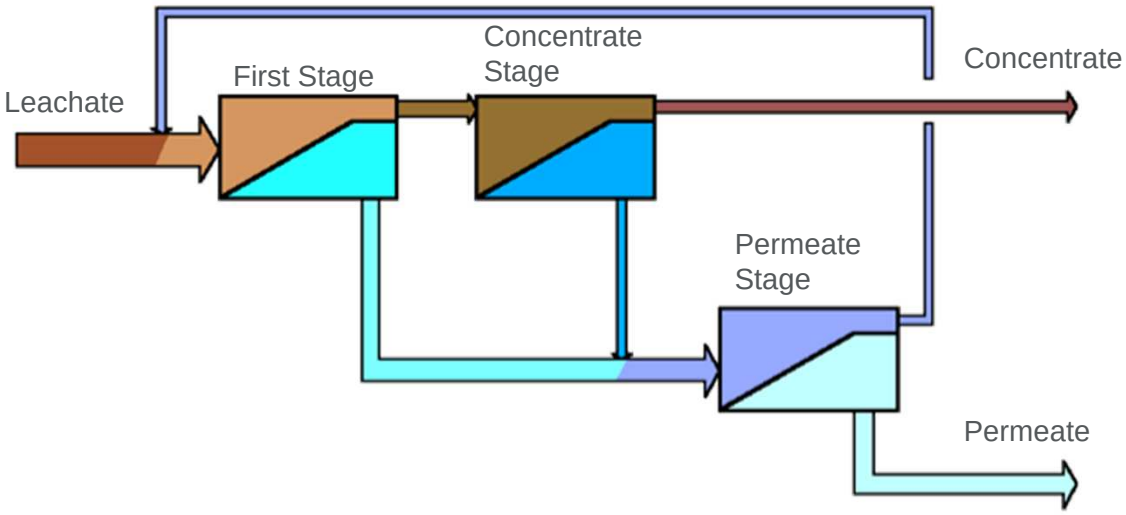
Fixed Film Technology



Reverse Osmosis

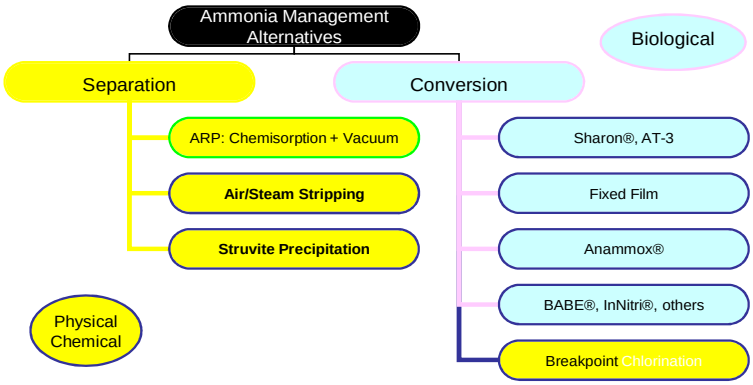


How does Rochem Treat Leachate?



Ammonia Recovery (ARP)

ARP is Physical/Chemical Separation / Recovery



How to Select the Best Solution – Comparison of Treatment Alternatives

- Identify contaminants of concern and treatment objectives
- Prepare evaluation criteria scoring matrix
- List advantages and disadvantages of each alternative
- Develop capital and operating screening costs for each alternative
- Compare non-cost criteria for each alternative based on a ranking system developed with team (performance, reliability, footprint, operator skill, adaptability…)
- Project Team meeting for review and selection of appropriate treatment system for conceptual design
- Discuss need for treatability and pilot study

Importance and Value of Treatability Studies

- Confirm that a design will work in lab first
- Gain more confidence in design and operation
- Troubleshoot performance issues
- Each test program is unique – need test plan
- Laboratory bench scale studies (i.e., biological and physical/chemical technologies)
- On-site pilot studies (i.e., MBR and RO systems)

Treatability Studies

- Treatability and/or pilot studies for technology demonstration and design criteria
  - Bench-scale studies at landfill or at treatability laboratory
  - Pilot studies, if necessary
  - Vendor studies for proprietary or unique technologies

Leachate is similar to some Industrial Wastewaters

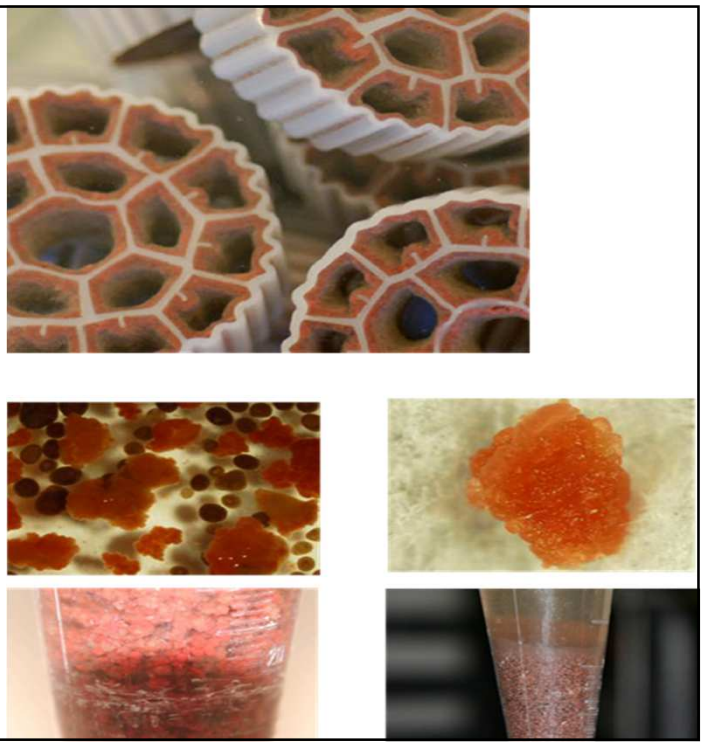
- Treatment options
  - Metals – oxidation and precipitation
  - BOD/COD and TKN – Biological (aerobic, anaerobic, nitrification, denitrification and variations)
  - Ammonia – Phys/Chem (steam stripping, vacuum distillation, air stripping, breakpoint chlorination, ion exchange)
  - Particulates – Sedimentation and filtration
  - Trace Organics & Pharmaceutical & Personal Care Products – PACT, GAC and Chemical Oxidation
- Process issues
  - Nitrification inhibition
  - Startup and operation
  - Chemical requirements
  - Sludge production and disposal
  - RO reject disposal
  - Loads can change overtime

What's Next for Activated Sludge Technologies

- Microbiology – Selecting Organisms
- Solids-Liquid Separation
- Technologies

Microbiology – Selecting Organisms

- Heterotrophic and Autotrophic bacteria
- Phosphorus removal bacteria
- Anammox bacteria
- Granules in Nerada
- Others

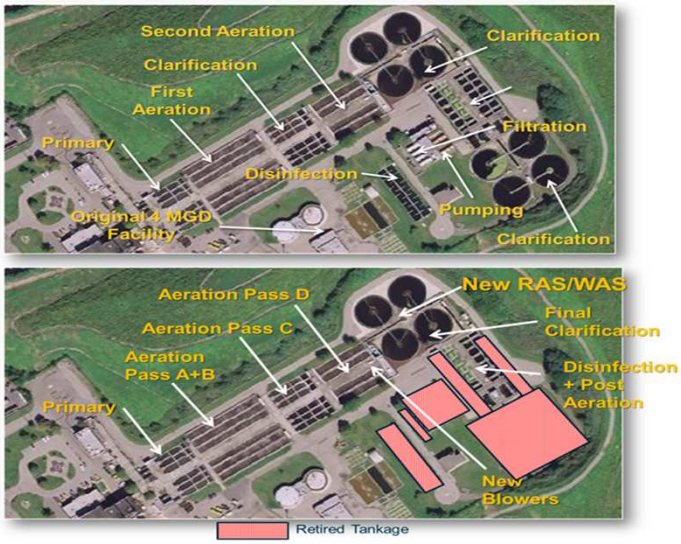


Solids – Liquid Separation

- Membrane Bioreactor
- BioMag
- Nereda

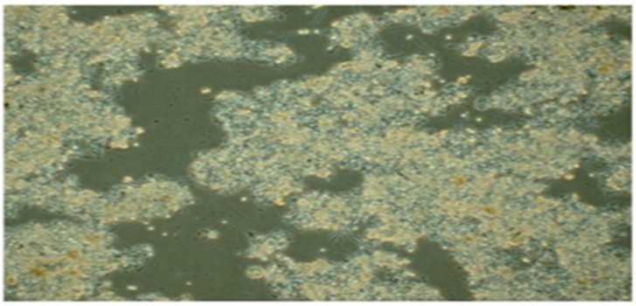
Technologies (New)

- BioMag
- Nereda - Granular Sludge
- Future?

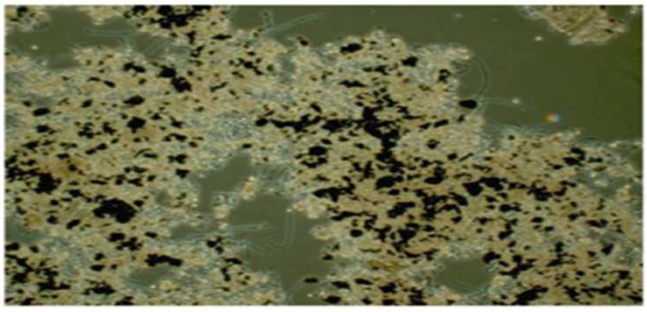


BIOMAG

- Uses magnetite as ballast to enhance settling rates
- Specific gravity 5.6
- Magnetically Retrievable (polish)
- Requires high energy mixing to maintain solids in suspension

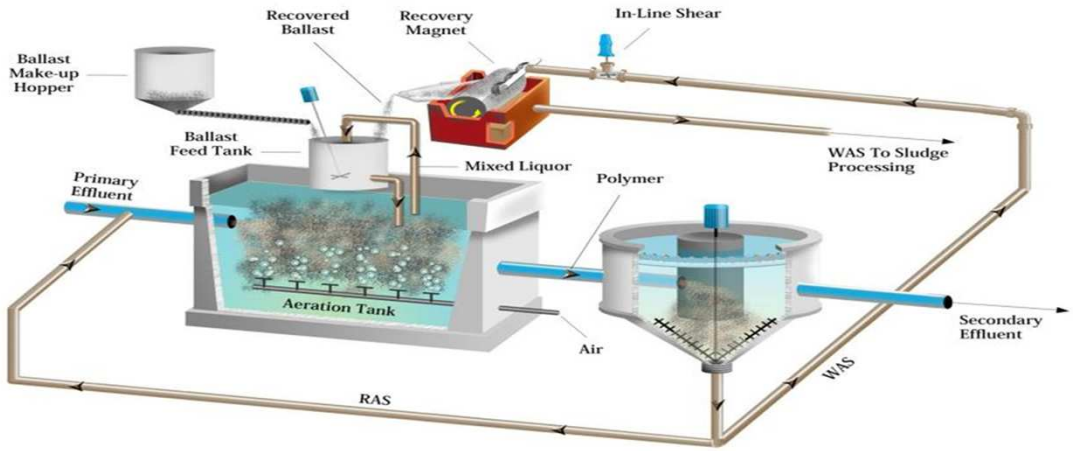


Flocs with no ballast settle slowly



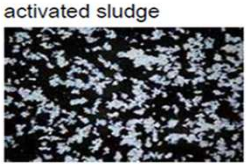
Ballasted flocs settle rapidly and reliably

BIOMAG



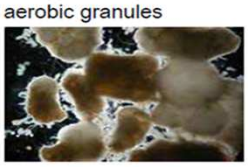
NEREDA

Instead of
activated sludge



use

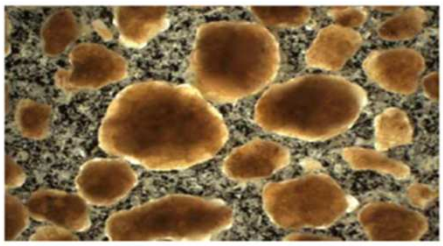
aerobic granules



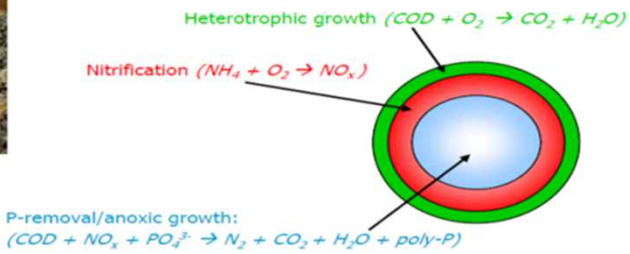
Aerobic granules

- Excellent settling properties
- Pure biomass, no support media required
- High biomass concentration
- Simultaneous extensive biological N- and P-removal
- Simple one-tank concept (no clarifiers)
- Small footprint
- Simple and easy operation
- Sustainable technology
- Low costs

How to Make Granules

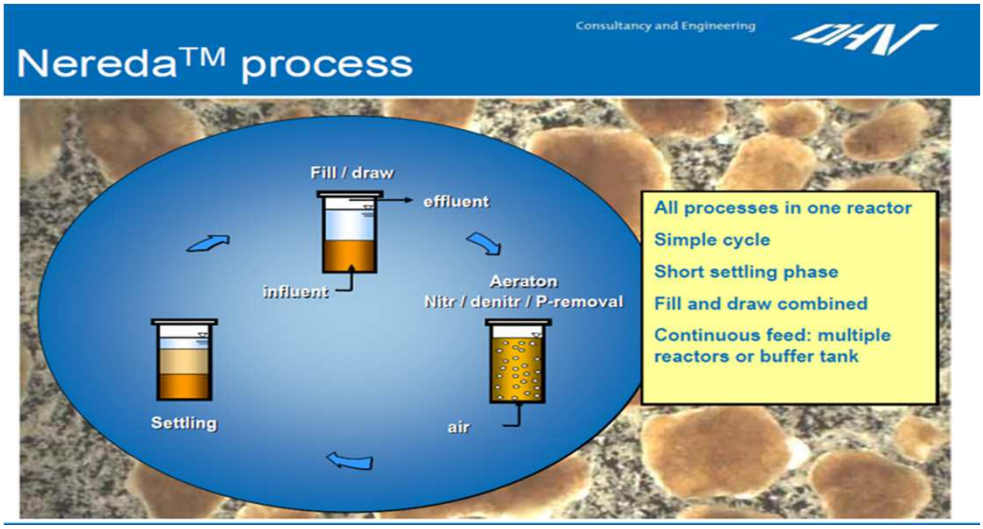


Selection mechanism:
settling pressure and/or short decant phase



Oxygen gradient in granule enables simultaneous COD, P and N-removal

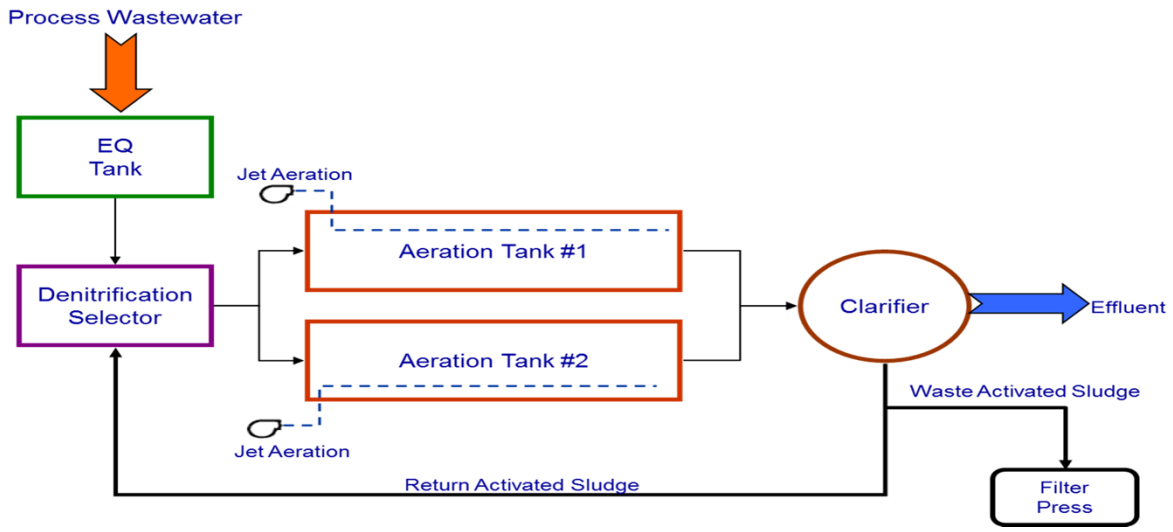
SBR Mode Operation



Case Studies for Landfill Leachate Treatment					
	AS	SBR	MBR	RO	Evaporation
Freshkills, Staten Island, NY		X			
Rhode Island		X			
GROWS in PA		X		X	
Seneca Meadows in NY				X	
Warren Township, NJ			X		
Cumberland County, NJ			X		
Monmouth County, NJ			X		
Barre, MA		X		X	
Gainsville, GA					
Sampson County, NC					X
Green Lane, Ontario, Canada	X				
McDougal, Ontario, Canada	X				
Merrick, Ontario, Canada		X			

Case Study Activated Sludge – MLE Process (Industrial)

Modified Ludzak Ettinger (MLE) Process



History of Plant

- 2003 – Design of New WWTP – used bench scale treatability and process calculations
- 2008 – Design of Upgrade Capacity using BIOWIN calibration to full scale data
- 2008 – Nitrification upset – bench scale work on inhibition, model on recovery time
- 2009 – Capacity study using BIOWIN and treatability
- 2013 – Evaluating upgrade of capacity and converting to MBR
- 2015 – What's Next?

Summary

- Leachate is unique, but similar to some industrial wastewaters
- There are a lot of technologies available to choose from
- Use the approach to select best solution and Vendor(s)
- Treatability testing provides value

Thank you

Joseph.Cleary@hdrinc.com

201-469-0579

Questions & Answers