

DairyWater Project: Investigation into IASBR system efficiency for treatment of dairy processing wastewater at pilot scale



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Overview

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Background

- Milk quotas abolished in 2015 – Expected to see 50% rise in milk production in Ireland by 2020
- Ireland is one of Europe's leaders in cows milk production (6,653 million litres per year – Central statistics office, 2016)
- Export of dairy ingredients and products is in excess of 3 billion per year (reached this in 2013)
- Increased production will have consequences to emissions and strict discharge parameters
- Need for innovative technologies to help reduce emissions and cost of treating wastewater
- Ireland uses up to 66% more water than some other countries per litre of milk produced
- IASBR may present such a solution to assisting energy cost and efficiency of water treatment

Intermittently Aerated Sequencing Batch Reactor (IASBR) technology

- New technology developed here at NUI Galway
- Similar to normal SBR systems – however intermittently aerated (cycles)
- As there is not a constant need for aeration in the system costs are greatly reduced – offers a more energy efficient and cost effective method for removal of organic matter and nutrients
- Previous PhD research (Henry, 2014) has exhibited that IASBR systems are more efficient than SBR systems for nitrogen and phosphorus removal if correctly operated
 - Showed IASBR can achieve enhanced denitrification and EBPR reactions
 - If optimised these processes would allow WWTPs to reduce complexity of water treatment, onsite space requirements and operational costs/energy consumption
 - IASBRs can be more easily modified to treat higher/lower strength wastewaters
- Biological phosphorus removal would also reduce cost of wastewater treatment, the lack of a need for expensive chemicals to remove the phosphorus = reduced cost to WWTP

Aim & Objectives

Aim: Investigate the potential for the IASBR technology as a viable option within the Irish dairy industry

Objectives:

1. Efficiency of the IASBR system for the treatment of dairy processing wastewater will be assessed
2. Wastewater produced from a dairy plant will be treated to lower the nitrogen, phosphorus and chemical oxygen demand (COD) content of the water
3. Nutrient removal efficiencies (nitrogen and phosphorus) will be monitored, as well as the operating cost and energy demand, to determine whether it is a more efficient and effective solution when compared to current technologies
4. Experimental research study will be performed at both laboratory and pilot-scale in order to prove the effective and efficient performance of the system

Lab-scale IASBR research

➤ Lab scale testing has commenced in this investigation to analyse nitrogen and phosphorus removal efficiencies from dairy wastewater

Lab Scale IASBR design

Working Volume	8 L
Cycle length	12 hours
Aeration rate	0.8 LPM
Fill & Draw volume	1 L
SRT	16 days – 250 mL mixed liquor removed per cycle



Average Composition of synthetic WW

COD (mg/L)	3513
Soluble COD (mg/L)	3307
NO ₃ -N (mg/L)	0
NO ₂ -N (mg/L)	0
NH ₄ -N (mg/L)	48.9
Total N (mg/L)	122.2
PO ₄ -P (mg/L)	25.4
Total P (mg/L)	51.9
pH	7.9

IASBR Operation at lab scale

1. IASBR cycle : 12 hours
2. 1 L pumped in at beginning
3. Continuously mixed for following 10 hours 40 minutes (intermittently aerated)
4. Allowed to settle for 80 minutes (unmixed)
5. 1 L pumped out at end
6. 250 mL mixed liquor removed as sludge waste once per cycle yielding a 16 day SRT



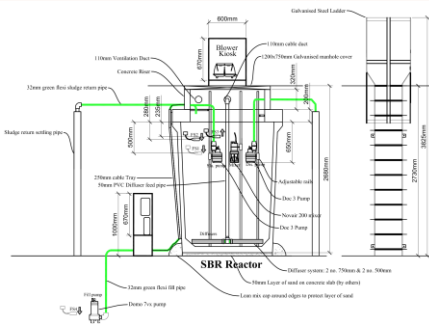
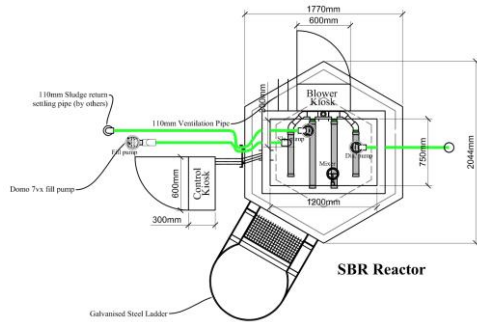
IASBR pilot scale design

➤ Lab scale operation strategy was used to set initial parameters and will be adjusted as necessary (will also use lab scale work to determine if change required)

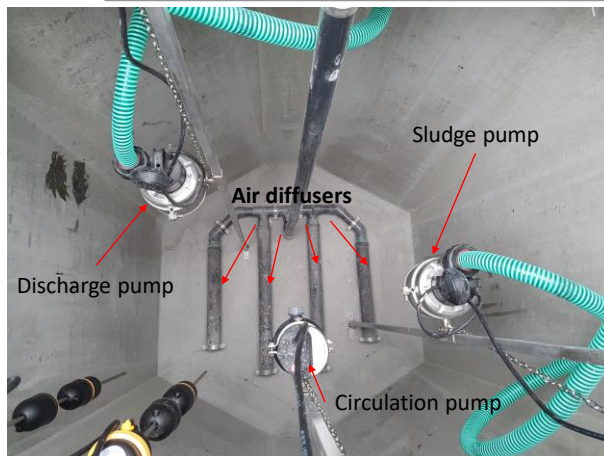
➤ Location: Aurivo Dairy Ingredients, Shannonside, Ballaghaderreen, Co Roscommon

Pilot Scale IASBR design

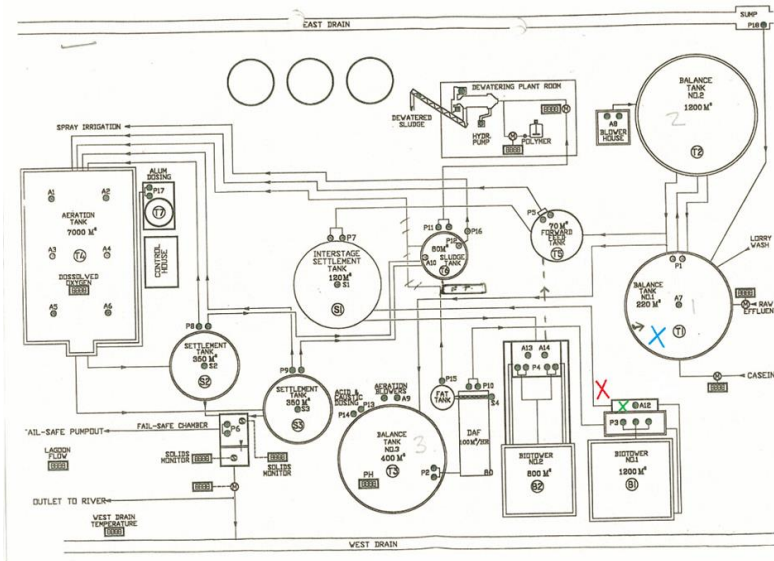
Working Volume	3000 L
Cycle length	12 hours
Fill & Discharge volume	375 L
HRT	4 days
SRT	16 days – 93.75 L removed per cycle



Pilot scale IASBR unit



IASBR pilot scale placement at Aurivo

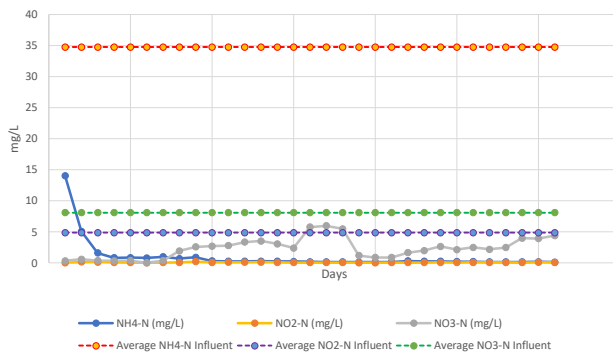


Pilot scale IASBR unit



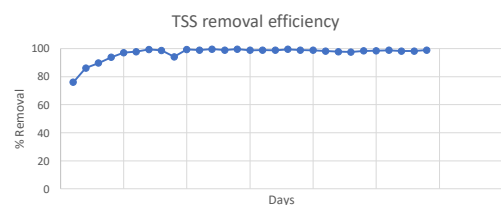
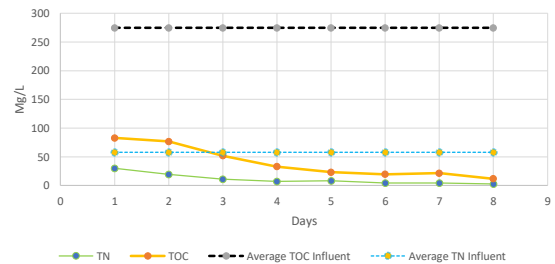
Pilot scale IASBR unit

Results: Pilot scale IASBR preliminary testing



$\text{PO}_4\text{-P}$ concentration never >0.05 mg/L (after day 9)

Aurivo Dairy Ingredients Licence Limits: TN = 15 mg/L,
 $\text{NH}_4\text{-N}$ = 0.5 mg/L, $\text{PO}_4\text{-P}$ = 1.6 mg/L, TP = 2 mg/L, SS = 30 mg/L



Conclusion

Preliminary testing has exhibited that the system has the capacity to remove the following from wastewater:

- Suspended solids
- Organic carbon
- Nitrogen ($\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, $\text{NO}_2\text{-N}$)
- Phosphorus ($\text{PO}_4\text{-P}$)
- Chemical oxygen demand

Biological system – more economical and sustainable wastewater treatment option

Technology can be easily scaled up for industrial use and easily retrofitted

Removal efficiencies are quite high and it demonstrates the potential performance of the system for the dairy industry

Future work

Lab scale	Continue tests using lab scale IASBR units and make changes to these units prior to pilot scale changes
Pilot scale	Travel to Aurivo to monitor pilot scale IASBR operation and collect samples comparing effluent characteristics to license limits Determine cost of running IASBR unit and cost of treatment
Amend system operation	Closely monitor discharge wastewater characteristics and amend system operation as required
DO monitoring	Bring portable DO probe to Aurivo to monitor DO concentration over an entire cycle to create a DO profile
DO control	Install a DO probe to maintain an upper threshold for DO concentration
Second auto sampler	Acquire second auto sampler and install at Aurivo. Full characterization of wastewater to be treated allowing calculation of removal efficiencies



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Thank you

Questions?

Would like to acknowledge the funding provided by the Department of Agriculture, Food and the Marine for the DairyWater project (Ref.: 13-F-507). For additional details: www.dairywater.ie

DairyWater project partners

