

Titre: Aerated lagoons sludge characteristics, distribution and
Title: accumulation rate

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Date: 2022

Type: Communication de conférence / Conference or Workshop Item

Référence: Dehghani Tafti, A. R., Mortier, C., Boulanger, C., Vanrolleghem, P. A., & Comeau, Y.
Citation: (novembre 2022). Aerated lagoons sludge characteristics, distribution and
accumulation rate [Communication écrite]. 36e Symposium de l'Est du Canada
sur la recherche sur la qualité de l'eau, Québec, Québec (3 pages).
<https://publications.polymtl.ca/61699/>

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Version: Version finale avant publication / Accepted version
Révisé par les pairs / Refereed

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Document issued by the official publisher

Nom de la conférence: 36e Symposium de l'Est du Canada sur la recherche sur la qualité de
Conference Name: l'eau

Date et lieu: 2022-11-04, Québec, Québec
Date and Location:

Maison d'édition: Canadian Association for Water Quality (ACQE)
Publisher:

URL officiel:
Official URL:

Mention légale:
Legal notice:

Aerated lagoons sludge characteristics, distribution and accumulation rate

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Abstract:

In Quebec, aerated lagoons (ALs) are a popular method of wastewater treatment, accounting for around 67 percent of all wastewater treatment plants. ALs' performance is significantly affected by the accumulation of sludge into the lagoon's sediment. Since there is only limited information available on AL sludge, the main objective of this study is to determine sludge characteristics, its distribution along the AL, its accumulation rates and the rates of the three most significant transformation processes in the sludge layer: compression, anaerobic degradation and resuspension.

The Le Gardeur aerated lagoon in the city of Repentigny was selected for this study. Samples were taken in April 2022, following melting of the ice cover, before temperature had risen which provokes sludge hydrolysis, digestion and biogas-induced resuspension, and before the post-winter seasonal increase in aeration rate. Both composite and grab sludge samples were taken. For the composite samples, five samples of identical volume were collected from various locations at the bottom of the AL and homogenized to obtain a composite sample for each lagoon. Grab samples were taken from nine different locations in each lagoon. The volume of sludge accumulated in each lagoon was

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measured by Echo-tech H₂O, Nordikeau (QC, Canada) using a broad-spectrum sonar attached to a boat equipped with a high-precision GPS.

The results showed that there was a non-uniform distribution of accumulated sludge in the lagoons. The largest accumulated sludge was observed on the inlet and outlet slopes of each lagoon. From August to April, which is the main sludge accumulation period, the average per capita rate of sludge accumulation in the first and fourth lagoon were 0.36 and 0.26 m³ per 1000 persons per day compared to 0.09 and 0.04 for lagoons 2 and 3, respectively. For the 2 sampling methods, the total solids content in lagoons 1 and 3 was about 8% and 10%, respectively. In lagoons 2 and 4, the total solids content in the grab samples were 11% and 13%, respectively, which was about 3% above the composite sample results. The fraction of volatile over total solids (TVS/TS) was nearly the same for the 2 sampling methods. The TVS/TS ratio for the first three lagoons was about 50% compared to 35% for the last lagoon. In lagoons 2 and 3, the ratio of TVS/TS is almost the same for all zones. At the entrance zone of lagoons 1 and 4, the TVS/TS ratio was lower than in other areas, which could be explained by the fact that much of the inorganic matter like sand and grit settle near the inlet of the first lagoon, while for lagoon 4, inorganic precipitates are formed after injection of P-removing coagulant just upstream of lagoon 4.

It is concluded that the characteristics of AL sludge show good potential to evaluate sludge removal, treatment options, lagoon design and management. Future efforts to characterize AL sludge should include the collection of sediment core samples because the initial sludge characteristics measured in this study changed significantly both horizontally and vertically throughout the sludge layer.



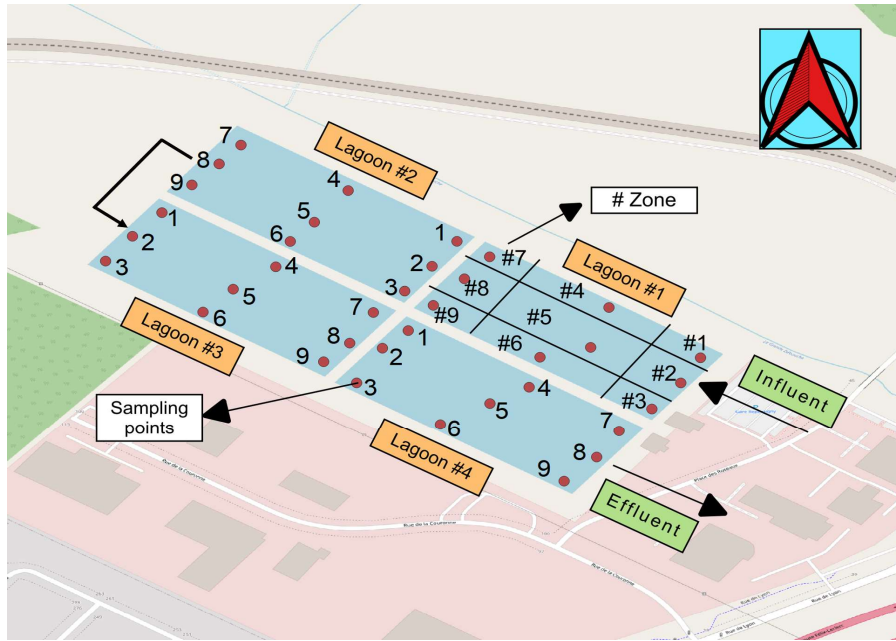


Figure: Le Gardeur aerated lagoon with different zones and sampling points

Table: Characteristics of sludge for 2 sampling methods

No. lagoon	Parameter	Unit	No. Zone										CS*
			1	2	3	4	5	6	7	8	9	Avg.	
1	Solids content	%	9.8	7.6	10.7	6.6	11.4	6.0	6.4		6.5	8.1	8.0
	TVS/TS	g/g	0.43	0.45	0.37	0.54	0.42	0.56	0.6		0.57	0.50	0.51
2	Solids content	%	9.8	14.1	12.8	9.8	9.1	8.1	9.4	10.7	10.7	10.5	7.7
	TVS/TS	g/g	0.52	0.40	0.43	0.51	0.48	0.50	0.46	0.49	0.45	0.47	0.51
3	Solids content	%	10.2	9.6	9.0	11.3	12.6	10.4	10.0	9.8	8.6	10.2	10.2
	TVS/TS	g/g	0.46	0.48	0.49	0.49	0.34	0.42	0.49	0.48	0.47	0.46	0.47
4	Solids content	%	13.5	22.6	13.2	12.7	14.2	13.9	12.2	8.3	4.4	12.8	9.8
	TVS/TS	g/g	0.36	0.24	0.36	0.30	0.30	0.29	0.32	0.35	0.39	0.33	0.34

*Composite Sampling