Design Project – SIE 2024

STEIMER DS SA
Systèmes de pompage - Ingénierie - Installations

Optimisation des traitements de lixiviat

Supervisor : Christof Holliger

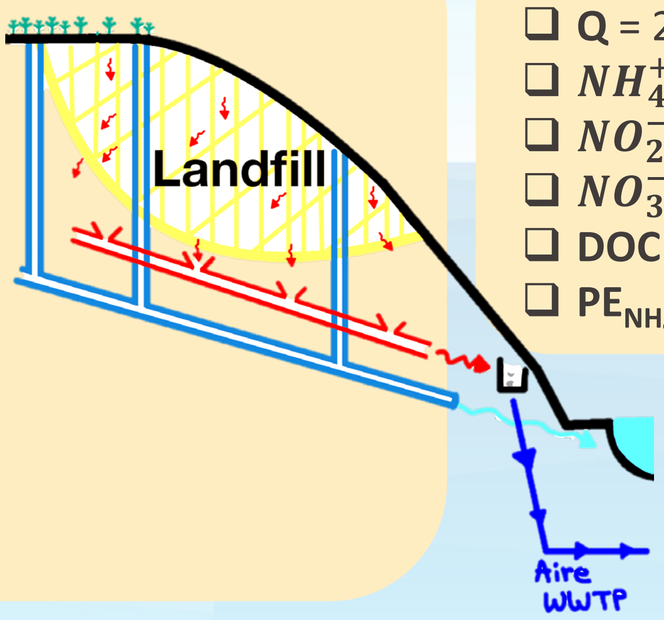
Students: Radu Nicolae, Luca Raviglione

Company: Alain Fuglister

"EVALUATE THE MOST ECONOMICALLY EFFICIENT AND PASSIVE TREATMENT METHODS ON-SITE FOR THE GRANDES-COMMUNES LANDFILL LEACHATE"

CONTEXT

Location: Lancy and Onex (GE)
Pipe system: Complex pipe system with separation of polluted and clear waters
Landfill: Municipal, old & closed, pH > 7.5, low biodegradability index, low content of heavy metals, high content of nitrogen and ammonium
Current treatment system: Pumping station, in the banks of the Rhone, directing water to Aïre WWTP, after filtration



DATA

High variability and uncertainty

- ❑ **Q** = 20-432 m^3/d
- ❑ NH_4^+ = 45.5-216 mg/L
- ❑ NO_2^- = 0.6-1.6 mg/L
- ❑ NO_3^- = 0.3-31.4 mg/L
- ❑ **DOC** = 24.4-34.4 mg/L
- ❑ PE_{NH4} = 631-1003

HYPOTHESIS

Obtained with an equalizer tank

- ❑ **Q** = 72 m^3/d
- ❑ NH_4^+ = 80 mg/L
- ❑ NO_2^- = 1 mg/L
- ❑ NO_3^- = 30 mg/L
- ❑ **DOC** = 29 mg/L
- ❑ PE_{NH4} = 700

LEGISLATION

OSites*10 → ❑ NH_4^+ < 5 mg/L, ❑ NO_2^- < 1 mg/L ← **OEaux**

DATA

- ❑ Technical reports
- ❑ Monitoring campaigns
- ❑ Leachate analysis

ANALYSIS

- ❑ Literature review
- ❑ Detailed evaluation of Stripping, Struvite precipitation, Reed beds, SBR Anammox, MBBR Anammox.

CRITERIA

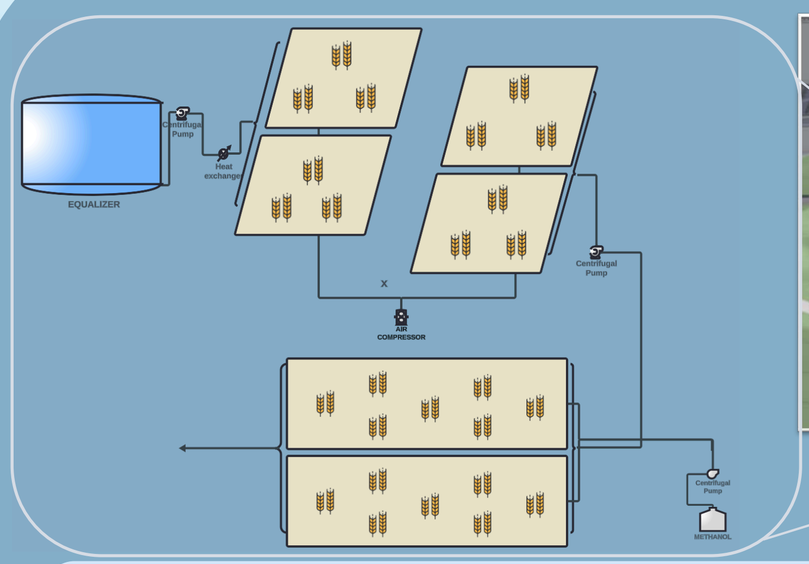
- ❑ Nitrogen recovery/removal
- ❑ Economic costs
- ❑ Efficiency
- ❑ Area required
- ❑ System passivity
- ❑ Consumables

PROPOSAL

- ❑ Aerated reed beds
- ❑ SBR Anammox

?

AERATED REED BEDS



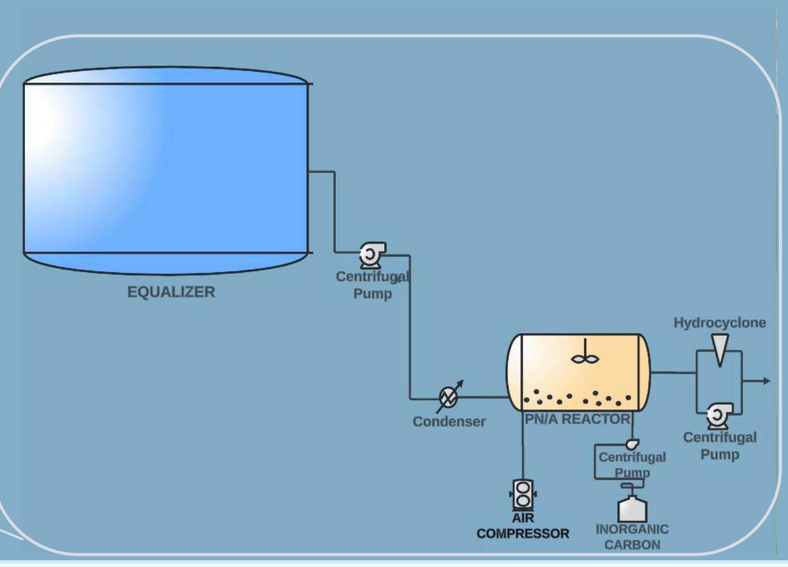
Volatilization, adsorption and uptake

$$NH_4^+ + 2O_2 \rightarrow NO_3^- + H_2O + 2H^+$$
$$6NO_3^- + 5CH_3OH + CO_2 \rightarrow 3N_2 + 6HCO_3^- + 2H^+$$

Proposed design and economic analysis

- ❑ **Area required:** 735-2345 m^2
- ❑ **Power consumption:** > 0.62 MWh/y
- ❑ **Chemicals:** > 4.5 t/y (CH_3OH)
- ❑ **Maintenance and control:** 172 h/y
- ❑ **Investment costs:** 2.5-4.5 MCHF
- ❑ **Running costs:** > 70'000 CHF/y

SBR ANAMMOX



Oxidation and biological consumption

$$NH_4^+ + 0.75\ O_2 + HCO_3^- \rightarrow 0.5\ NO_2^- + 0.5NH_4^+ + CO_2 + 1.5\ H_2O$$
$$NH_4^+ + 1.32\ NO_2^- \rightarrow 1.02\ N_2 + 0.26\ NO_3^-$$

Proposed design and economic analysis

- ❑ **Area required:** 270 m^2
- ❑ **Power consumption:** > 0.78 MWh/y
- ❑ **Chemicals:** > 7.3 t/y (HCO_3^-)
- ❑ **Maintenance and control:** 2950 h/y
- ❑ **Investment costs:** 2-3 MCHF
- ❑ **Running costs:** > 400'000 CHF/y

DISCUSSION

Aerated reed beds is the best option available in the market for the treatment of the Grandes-Communes leachate. Indeed, little maintenance, low running costs and, thanks to aeration, ammonium removal efficiency higher than 90%. The only drawbacks are the large area needed and the uncertainty, during winter, concerning the low environmental temperatures. **SBR Anammox** is really promising because of the process adaptability and the lower area required. However, **MBBR** could be a better option for the nitrogen load considered.

CONCLUSIONS

Given the costs, uncertainty of data, starting time and ammonium load, the recommendation is to maintain the **current pumping system.**

Sciences et ingénierie de l'environnement

References

S.Sri Shalini, K. Joseph, Nitrogen management landfill leachate: Application of SHARON, ANAMMOX and combined SHARON-ANAMMOX, 2012, DOI: 10.1016/j.wasman.2012.06.006

Geneva 3D Map, ge.ch/sitg/cartes/3d

Sinha, B., & Annachhatre, A. P., Partial nitrification—operational parameters and microorganisms involved, 2006, DOI: 10.1007/s11157-006-9116-x