GENERAL OVERVIEW OF WASTEWATER TREATMENT PROCESS WITH SPECIAL FOCUS ON SECONDARY TREATMENT METHOD

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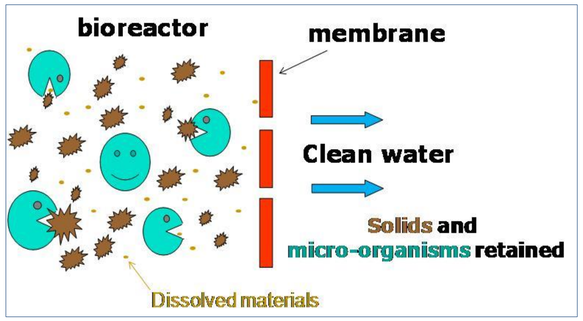
Introduction and Motivation

Municipal wastewater treatment plants are designed to influence the metabolic abilities of microorganisms to remove contaminants such as organic carbon, phosphorus and ammonia from influent sewage. These microorganisms also take part in the activated sludge system which acts as the active biological component of the treated influent. Under aerobic conditions; nitrifying microorganisms oxidize ammonia to nitrate. Under anaerobic conditions, denitrifying bacteria can reduce nitrate to gaseous forms of nitrogen (nitrous oxide and dinitrogen gas) ultimately reducing nitrogen concentrations in the wastewater.

Current sewage treatment systems use separate reactors for different microorganisms. This project aims to investigate a more convenient, cheaper and greener approach to the bio-chemical process of wastewater treatment.



Research Objectives

- Discover modification methods for the existing microbial population that can remove both nitrogen and phosphorus from sewage wastewater and activated sludge;
- Investigate the performance of the new strain of microbe to quantify pollutant removal efficiency, identify stable metabolites, calculate the mass balance, and estimate the bio-chemical degradation pathway;
- Determine the microbial community structure, the active metabolic pathways and the prevalence of recognized contaminants;
- Identify any unclassified complexities associated with introducing new microbial population to water treatment plant;
- Examine possible areas where treated activated sludge can be better used (most activated sludge is dumped in the landfill after treatment).

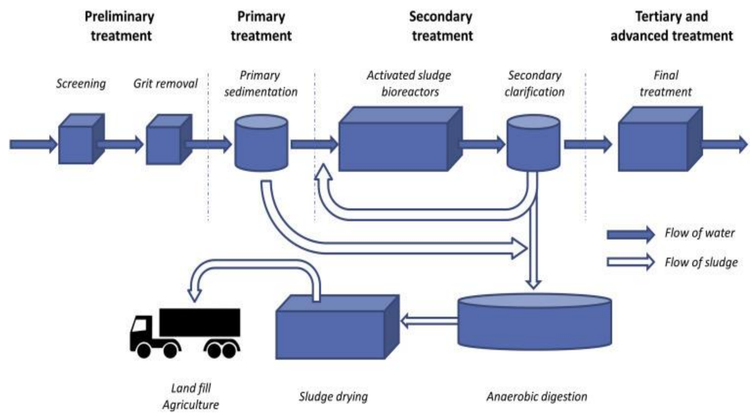
Methodology

1. **Wastewater Treatment**: Processes vary according to the need and type of contaminants. In general, a wastewater treatment plant tails four processes to treat contaminants:

- **Preliminary Treatment**: It is a physical process and involves removal of large pieces of garbage from influent wastewater.
- **Primary Treatment**: It is also a physical process. It involves removal of floating and settleable solids through sedimentation. Primary sludge removed after this process is pumped for further processing;
- **Secondary Treatment:** Bio-chemical process. Here, (aerobic) microorganisms breakdown and consume organic contaminants in wastewater. The secondary sludge is removed for further processing;
- **Tertiary Treatment**: It is a Physio-chemical process where Chlorine, Ozone, UV radiation or even photocatalyst (in advanced case) is introduced into the semi treated wastewater to kill harmful disease-causing organisms and/or breakdown the stubborn organic pollutants before releasing effluent into local waterways.

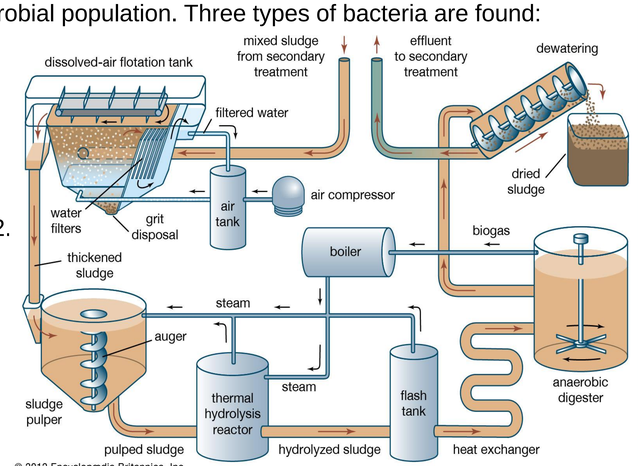
2. **Sludge Processing**:

- Sewage sludge is the remaining, semi-solid material that is left over after the cleaned-up water is discharged from WWTP.
- Sludge is thickened and treated with (anaerobic) microbes to get rid of possible harmful contaminants.



Microorganisms in Activated Sludge Treatment

- Bacteria, Fungi, Protozoa, and Rotifers compose the biological mass.
- Bacteria makes up almost 95% of the total microbial population. Three types of bacteria are found:
  - Aerobic
  - Anaerobic
  - Facultative
- Microorganisms consume and breakdown complex organic compounds and release CO2.



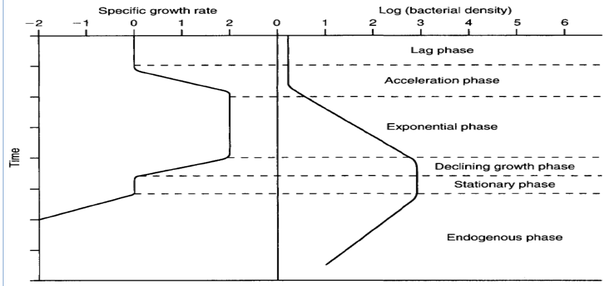
Microbial limitation:

- Larger microbes feed on smaller microbes; affecting mostly bacterial population;
- Most bacteria are not resistant to antibiotics in wastewater and activated sludge;
- Microorganisms also feed on their own protoplasm for cell metabolism- increasing pH (ammonia) toxic.

Biomass + Dissolved O_2 → CO_2 + H_2O + Ammonium Bicarbonate

Microorganism Limitation

- During the lag phase, bacteria adapt to the environment and produce enzymes to break the organic nutrients.
- During the accelerated growth phase, bacteria grow, reproduce and migrate for food.
- During the declining growth phase, bacteria slow their growth and reproduction due to less nutrients being available.
- Bacteria levels stay constant through the stationary phase
- More bacteria die during the death phase.
- Bacterial survival depends on availability of nutrients. In simple terms: Bacteria + Organics → New Bacteria + CO_2 + H_2O + Organics + Inorganics



- Bacterial Growth can be calculated by the MONOD equation for microbial growth:
- $\mu=(\lambda S)/(KS+S)$ Where,
  - μ is the specific growth rate coefficient;
  - λ is the maximum growth rate coefficient;
  - S is the concentration of limiting nutrient (BOD & COD);
  - and KS is the Monod coefficient .

Conclusion

The primary benefits of this project are:

- Modification method for existing microbial population. This will aid in cutting down the economic, physical and environmental strain for wastewater treatment.
- Increased treated sludge production can be beneficial to energy and agricultural production.
- Better performing microbial population can be beneficial to other areas of research and development.

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