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Microalgae in Wastewater Treatment

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Introduction

The process of treating wastewater can be a costly subject, with engineers constantly trying to find ways to lower these expenses. Investigated within this poster is the advantages of introducing microalgae into wastewater treatment and the benefits and new challenges it brings. This poster will be comparing the conventional way of treating wastewater with algae to determine which system is more effective. The main focus will be on the symbiotic relationship between the algae and the bacteria as well as the aeration the algae provides allowing for a bypass of a costly aeration system.

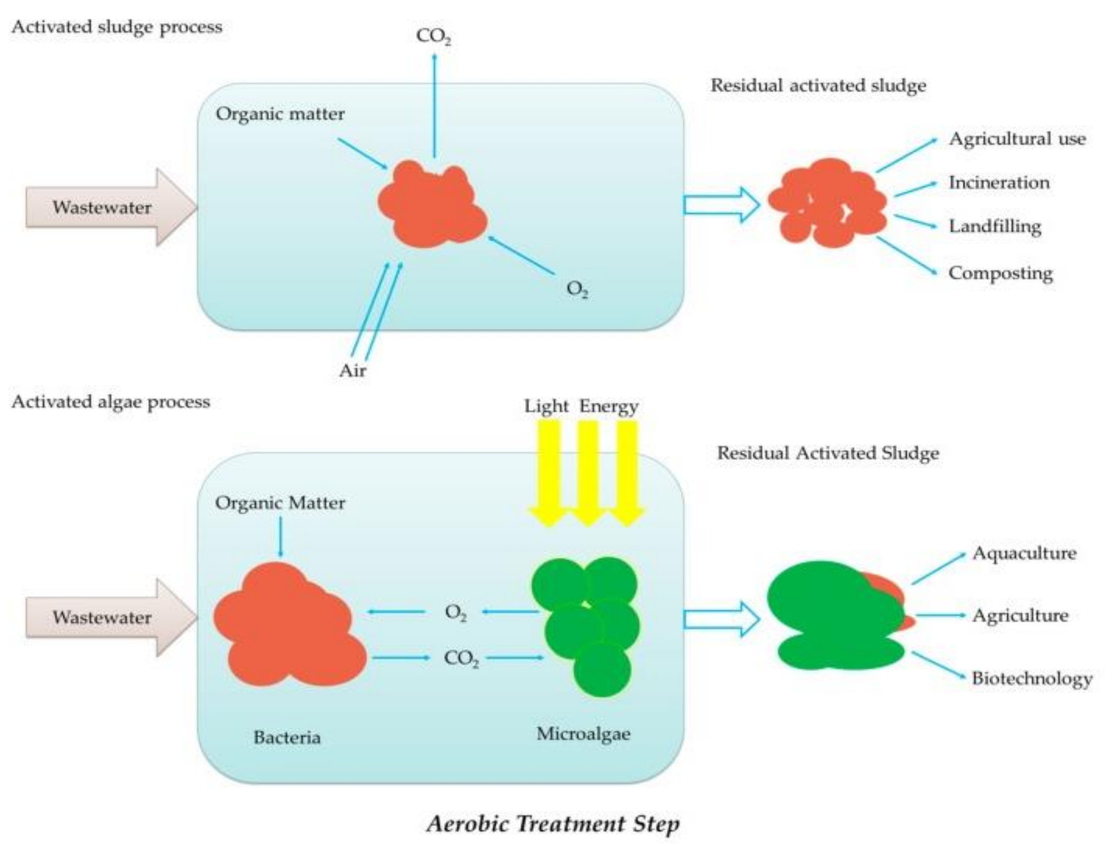

Figure 1: Activated Sludge with Algae (Amenorfenyo)

Treatment of various types of wastewater using physicochemical or biological (non-microalgal) approaches can be inefficient and energy-intensive. Figure 1 shows the basic mechanism differences between the two systems. Microalgae grows in bodies of water that contain the nutrients they require. They require nitrogen, phosphorus, and other trace elements for cell growth, and wastewaters are frequently contaminated with these elements (Passos).

Potential Impact Eco. Services

Immediate Effects:

- Less energy consumption.
- Better quality biomass.
- More opportunities for secondary products from wastewater treatment byproducts.

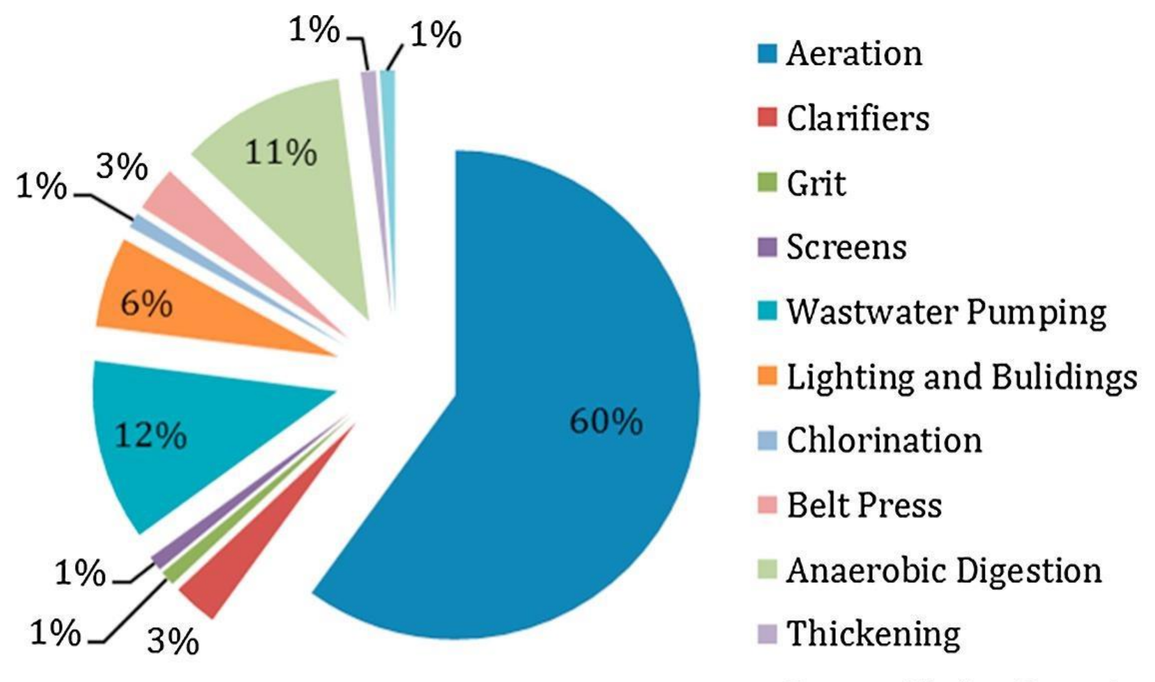

Figure 3: The proportion of energy use associated with different components of a CAS treatment system. (Gu)

From figure 3, one can see the breakdown of energy usage at a general wastewater treatment plant. By removing the need for aeration , energy use is reduced by 60%, saving both time and resources.

Similarly, another big portion of energy consumption is the anaerobic digestion process. Algae has a high lipid content, and because lipid content has the greatest influence on biomass production, it serves as a better co-feed than that of regular residual activated sludge (Flisberg). This will increase biogas production which can:

1. Decrease energy consumption in anerobic digestion process.
2. Increase ethanol production.
3. Increase return profit.

Process Description

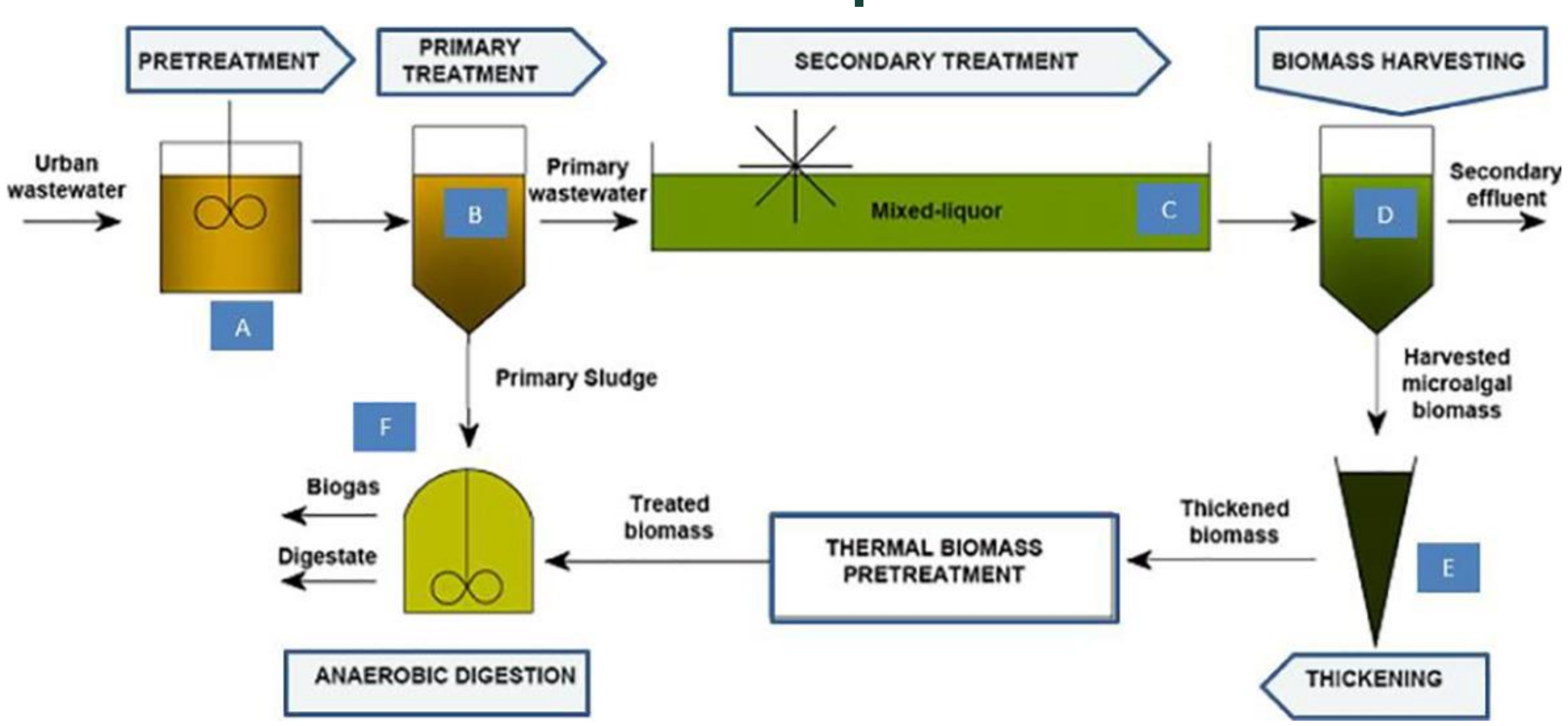

Figure 2: Wastewater Treatment with Algae (Passos)

Sensitive Unit

The availability of sunlight is crucial due to photosynthesis. Most mass-cultured microalgae systems are constructed as shallow raceways with a depth of 6 to 12 inches (15 to 30 cm), requiring significantly more space than traditional wastewater treatment oxidation ditches, which can be several feet deep (Kiepper). Too much light can cause photoinhibition, or a reduction in photosynthetic effectivity. Extreme temperatures and limited water or nutrient availability are additional factors that cause photoinhibition. Figure 4 shows the trend for photoinhibition, and one can see that excess light can vastly inhibit the photosynthetic O2 evolution level. Now at night, photosynthesis rates will be lower and protein synthesis of algae will consequently be lower as well. A balance must be found for this modified activated sludge system to work.

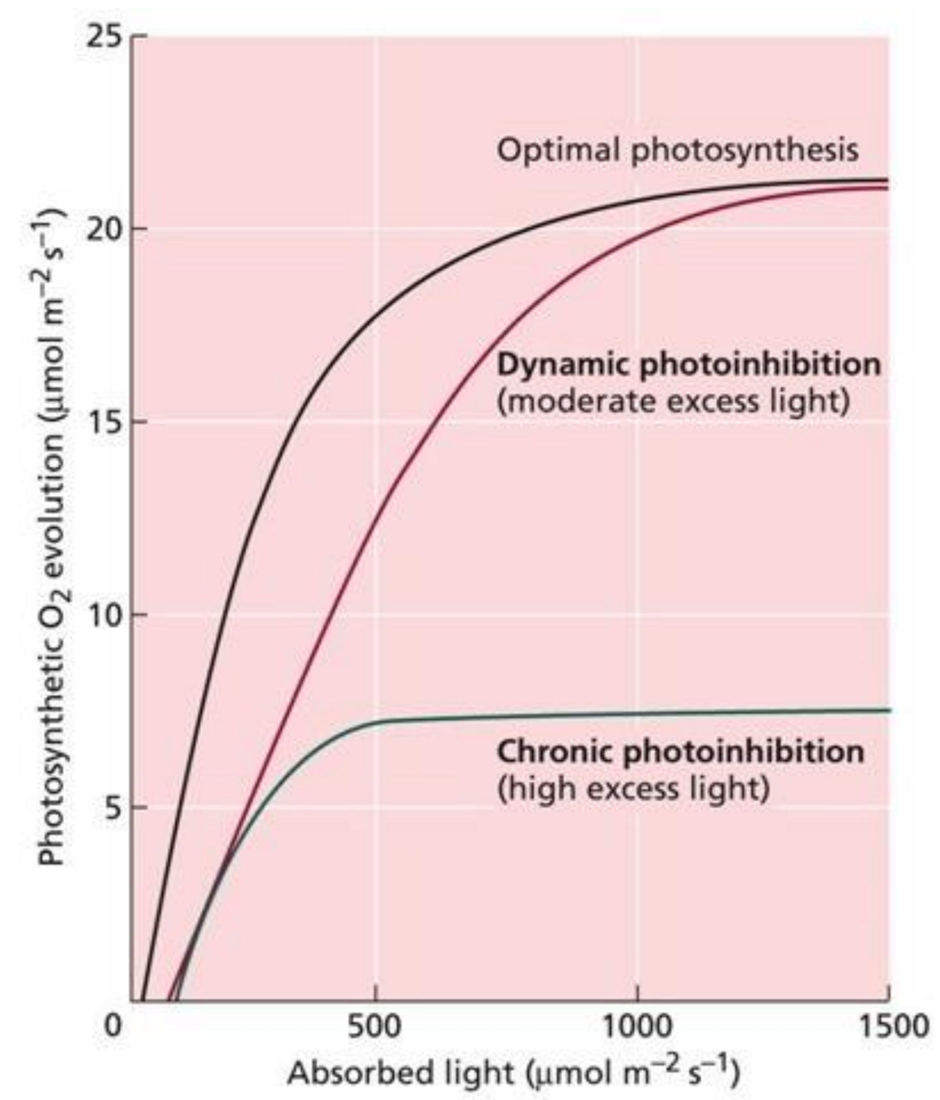

Figure 4: Photoinhibition with Light Exposure (Hicks)

One main issue is when it becomes night, meaning one must turn to alternative sources of light to fuel the photosynthesis process. Ideally, the treatment area would have access to natural sunlight to mitigate the need for constant artificial light. Doing this not only saves money, but also lessens the impact to the environment.

Possible Solutions for Not Enough/No Light:

- Artificial Light.
- Minimal Aeration Equipment.
- Alternate Wastewater Holding Tanks.

Possible Solutions for Too Much Light:

- Special glass to filter harmful light.
- Shades/Blinds that can decrease direct sunlight exposure time.
- It is also important to note that when night does come there is also usually a decrease in influent flow of wastewater into the treatment center due to decreased activity. This helps with “not enough light” by decreasing the amount of wastewater needing treatment.

Research

Hypothesis: Introducing algae into the activated WW (wastewater) system will replace the need for aeration equipment and its upkeep.

Tasks

- Collect WW samples and run BOD5 tests on them to find the required O2 saturation.
- Take the algae type and test its growth in WW samples.
- Have a control group with a miniature aeration device to mimic a normal activated sludge system.
- Monitor temp and O2 saturation levels over a set time period.
- Run numerous tests and compare results to find optimal conditions for the algae's O2 production.

Data analysis techniques

- Create oxygen sag curves and compare.
- Compile data and look for trends and patters that can lead to a conclusion.
- Compare all collected data to that of current activated sludge systems and review the original hypothesis.

Objectives

- Understand the required oxygen saturation level needed to treat the BOD of the WW.
- Find an algae species that works best with given conditions.
- Reveal if algae is able to produce enough oxygen while also treating the wastewater.

References

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