Improvement to Passive Green Wastewater Treatment: Floaters Coupled with EMOH Technology

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***Abstract*—This paper enhances an existing wastewater treatment process that utilizes Typha domingensis (cattails) for secondary treatment by introducing a redesigned floater system and implementing Electromagnetic Oxygen and Hydrogen (EMOH) technology. The improved modular floater features an interlocking triangular design that adapts to spatial constraints while supporting twenty-eight planting holders per unit, increasing planting density and system flexibility. The EMOH system increases dissolved oxygen levels, promoting aerobic microbial activity that accelerates the breakdown of organic pollutants. Detailed infrastructure design and performance calculations are presented to demonstrate the system's scalability, structural stability, and improved treatment efficiency.**

Keywords— Wastewater Treatment, EMOH, Cattail Floaters

I. Introduction

Excessive wastewater discharge and nutrient-rich runoff contribute to algal blooms, oxygen depletion, and adverse effects on aquatic ecosystems. This study presents an innovative, sustainable approach to water treatment by integrating low-energy pumping components with Typha domingensis (Typha D.), commonly known as Southern Cattail. This system enhances natural purification processes to produce high-quality recycled water suitable for non-potable reuse or safe environmental discharge. Traditional mechanical and chemical wastewater treatment processes are often cost-prohibitive; therefore, implementing a green, cost-effective alternative such as Typha D. can significantly reduce treatment expenses while maintaining efficiency.

II. Impact & Importance

Traditional wastewater treatment systems often depend on high energy and chemicals that create burdens on the tail end of the treatment process. Their high cost and complexity also make them impractical for small/remote communities with limited access to services and utilities. Municipalities seek treatment methods that are both cost-effective and environmentally sustainable, without compromising local regulatory compliance. This improvement enhances the phytoremediation potential of Typha domingensis by increasing the number of cattails supported within the system. The addition of the Electromagnetic Oxygen and Hydrogen (EMOH) further helps elevate dissolved oxygen levels that will assist in plant growth.

This system designed by AquaSol is designed for scalability and ease of deployment across a variety of conditions. The system has been utilized in agricultural runoff zones, wastewater treatment, and industrial retention basins. Its low maintenance and reliance on locally available materials make it suited for decentralized developing regions. In the context of local efforts, it improves water access by aligning with broader sustainability goals, which reduce chemical dependency, lower energy consumption, and promote ecosystem restoration.

III. Approach

A. Floater Model

A floater model for a interconnecting system is used to support a larger number of cattails. Within the treatment Typha D. is a species requiring minimal environmental fluctuations to thrive. An interconnected set of holders are set in an array, this allows for stability and widespread reproduction. The floater system consists of a dense array of buoyant platforms made from high-density polyethylene (HDPE), supported by a closed-loop PVC pipe structure to ensure stability and longevity.

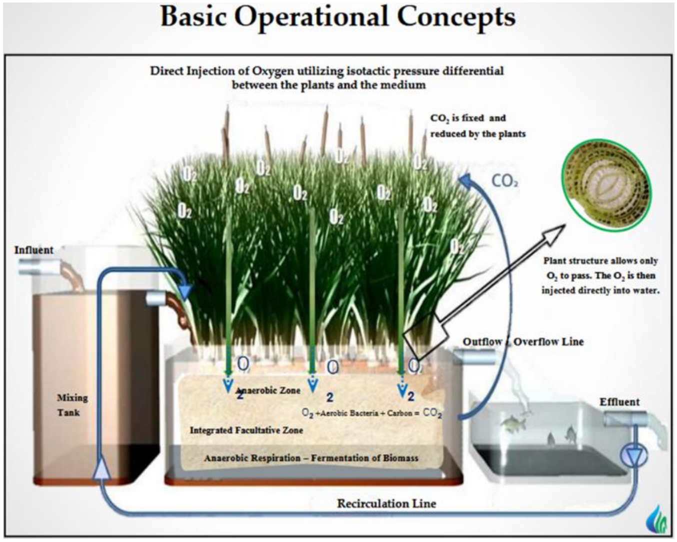

Fig 1. Basic operational concept of AquaSol's Cattail Water purification design

B. Electromagnetic Oxygen and Hydrogen

The Electromagnetic Oxygen and Hydrogen system operates by using electromagnetics and a venturi mechanism to dissolve additional oxygen into water. This is done by electromagnetism is harnessed to enhance the efficiency of electrolysis by influencing the movement and separation of gas bubbles. EMOH technology introduces oxygen in a more efficient unlike conventional aeration systems that require intensive mechanical components or high energy consumption. A standard 1.5-kilowatt pump is used to circulate thirty cubic meters of water per minute, optimizing oxygen distribution within the treatment area. Circulating water through in an oxygenation chamber and reintroducing it into the water system, this elevates DO levels throughout the water body. This creates an ideal aerobic condition for breakdown of organic pollutants, nitrogen compounds, and biological oxygen demand.

One of the advantages of the EMOH system is in its low energy requirements when compared to traditional aeration technologies such as surface agitators or bubble diffusers. EMOH enables a more uniform dissolved oxygen (DO) distribution, preventing hypoxic zones that typically reduce treatment efficiency. The enhanced aerobic environment supports faster organic decomposition and suppresses anaerobic, odor-producing processes, resulting in cleaner, more stable effluent. Experimental findings support these benefits one study showed that electromagnetic hydrolysis significantly increased DO concentrations in small ponds, confirming its potential as a low-energy oxygenation strategy for decentralized water treatment applications [6].

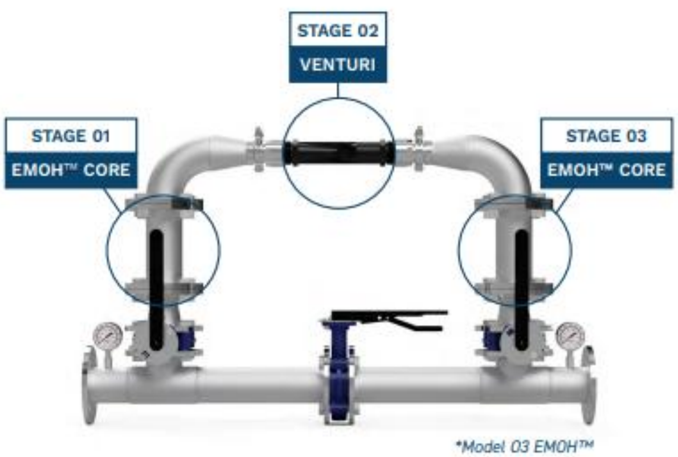

Fig 2. Aequion Water Technologies, "EMOH system schematic"

The effectiveness of EMOH is amplified when used in conjunction with a phytoremediation system such as the Typha domingensis. The cattails naturally oxygenate through the rhizosphere throughout the roots, the EMOH system supplements this by saturating the upper portion of the ponds with oxygen. This dual-source oxygenation accelerates microbial metabolism at the root zone, promoting higher nutrient uptake by plants and faster contaminant degradation. Moreover, EMOH's ability to operate in shallow or stagnant waters makes it highly compatible with floating wetland systems, ensuring consistent oxygen levels. This synergy enhances the treatment performance of the cattails beyond what it could achieve independently..

C. Scalability

AquaSol, an American company specializing in Typha D. based natural water treatment systems, constructs scalable facilities with capacities ranging from 900 to 20,000 cubic meters per day. AquaSol projects have been successfully implemented across Europe, Africa, and the Americas, adhering to traditional wastewater treatment stages (primary, secondary, tertiary). The Typha D., or Southern Cattail, has been known to treat water. Studies show that Typha D. can remove up to 90% of chemical oxygen demand, total nitrogen, biological oxygen demand, and phosphorus [1].

Each project is customized according to influent characteristics and local regulatory requirements. Initially, wastewater enters a mixing tank where it is diluted using recycled freshwater from the system's effluent discharge. Following dilution, the water is pumped into the first treatment pond and subsequently flows into the second pond. The recycled water maintains flow dynamics in the first pond through pipelines that divert effluent water directly, guiding sequential water flow through pond one, then pond two, and finally into pond three. The overall detention time within the system is approximately eight days, maintaining a daily input and output volume of 945 cubic meters.

Fig 3. The original floater design with sixteen holders available

IV. Methodology

A. Origninal Floater Design

The initial floater model featured a hexagonal design with an area of 2,619 cm², fabricated from 10 mm thick HDPE. The

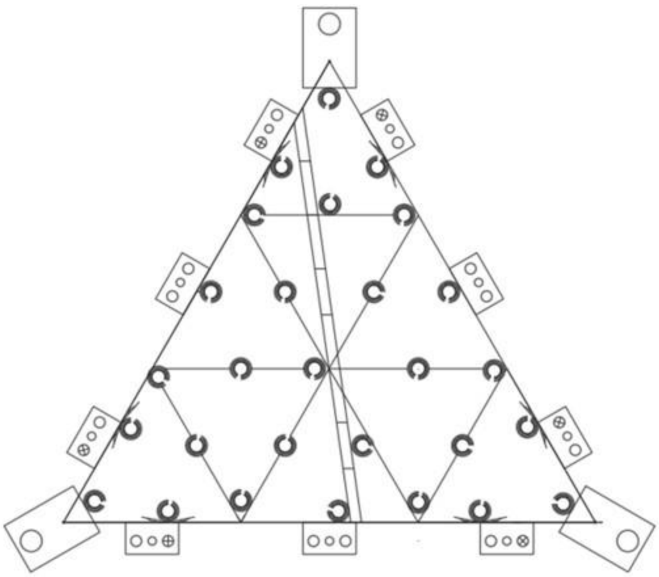

Fig 4. *The new design for the floaters that can hold twenty-eight holders*

floaters, capable of holding up to sixteen cattails, are interconnected to form a larger support structure. However, prolonged use led to structural degradation at the interconnection points, necessitating a more robust design. Over time, clips that secured the hexagonal floaters deteriorated and broke, leading to structural instability and decreased efficiency.

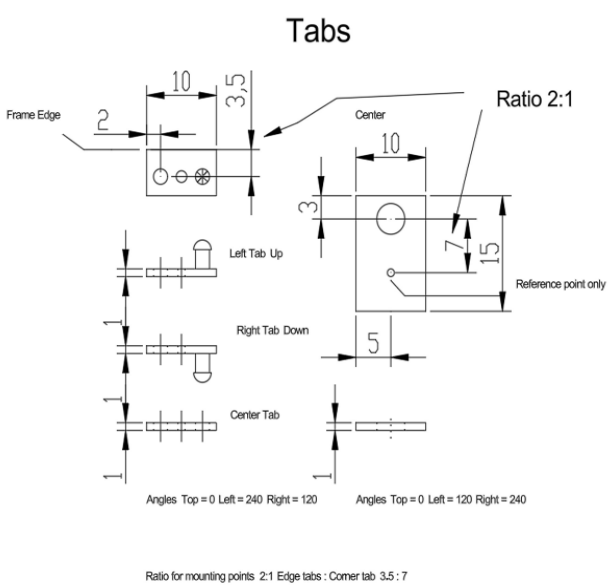

Fig 5. *The clip designs for interlocking the floaters*

This failure highlighted the necessity for a more resilient and modular design that would ensure prolonged durability while

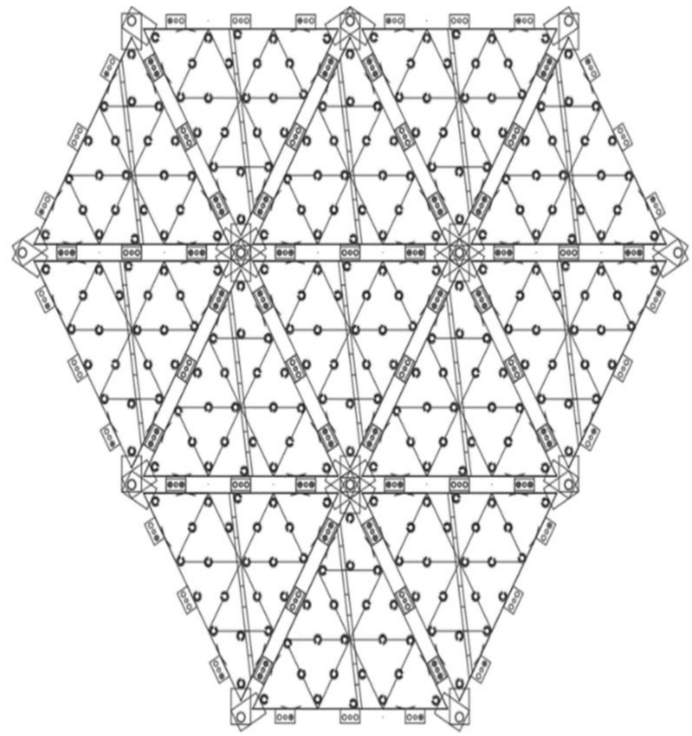

Fig 6. *The floater array once combined and brought together*

maintaining high cattail growth efficiency. Figure 3 illustrates the original floater design, highlighting its structural limitations.

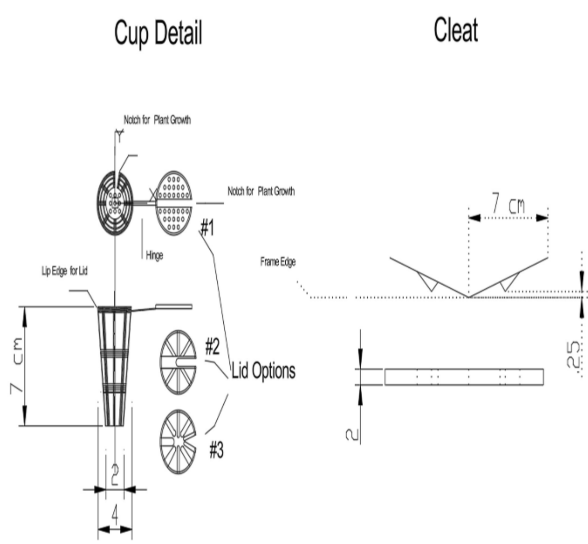

Fig 7. *The cup and cleat designs for interlocking the floaters*

B. *Improvement of Floater Design*

A revised triangular floater design was developed, featuring an equilateral structure with a side length of 100 cm. This configuration subdivides into nine smaller triangles--maximizing space utilization and increasing the overall area to 4,333 cm²—approximately 1.65 times larger than the hexagonal variant. The new design incorporates modular breakaway sections, allowing customization based on spatial constraints. If the entire floater is not needed, segments can be detached for an optimized fit. Three interlocking tabs are positioned on each 100 cm side of the floater, utilizing a combination of upper and lower face tabs to interconnect adjacent units securely, as shown in Figure 5.

To ensure stability, an additional plastic locking plate at each corner anchors floaters together using a central pin, allowing up to six floaters to interconnect. These floaters are secured within an outer PVC rectangular frame, enhancing buoyancy and maintaining position even under varying water conditions. The PVC frame is composed of 10 cm diameter pipes forming a closed-loop system that provides structural support and buoyancy for the floaters as the cattails mature.

Each floater accommodates twenty-eight planting cups, designed with side slits and bottom perforations to allow root expansion and water penetration. These cups are manufactured from polypropylene and feature three cap types to accommodate different growth stages of Typha D, as shown in Figure 7. The plants, ensuring optimal growth conditions. Using the buoyancy force formula: [2].

$$FV = \gamma h2dA - \gamma h1dA \uparrow \tag{1}$$

HDPE is the type of plastic used in calculations and holds atypical density ranging from .941 to .965 grams per cubic centimeter. This is assuming all conservative weights in measurements.

C. *Addition of EMOH*

The EMOH unit extracts water from surface sources, oxygenates it via electromagnetic and venturi-driven processes, and reinjects it into the treatment ponds. The system enhances aerobic conditions, supporting microbial activity, and promoting efficient organic matter decomposition. The applied hydraulic equations account for head loss and flow resistance within the PVC infrastructure. Figure 8 provides a schematic of the EMOH integration into the pond system. Calculations involving piping head and head loss are required, with the energy equation available in [3]

$$H_p + \left(\frac{P}{v} + \frac{V^2}{2g} + z_1\right) = \left(\frac{P}{v} + \frac{V^2}{2g} + z_2\right) + H_L$$

$$H_p = (z_2 - z_1) + H_L$$

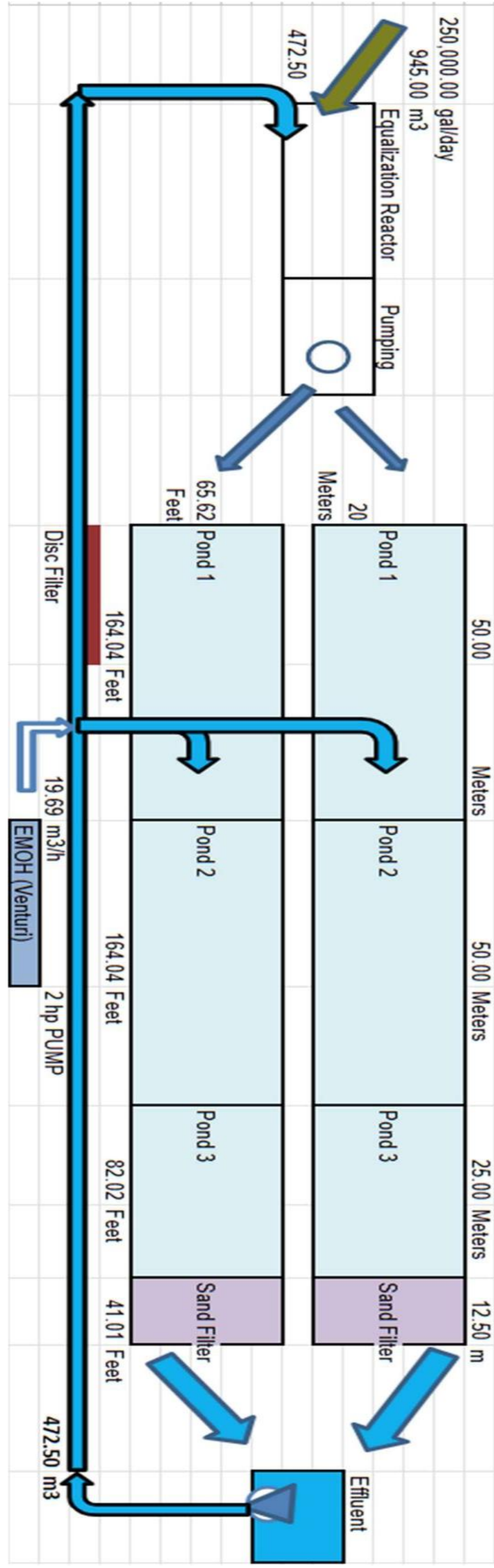

Fig 8. The placement of the EMOH unit within the treatment design plan

Reduced to:

$$H_L = h_{major} + h_{minor} + \Delta h + (z_2 - z_1) \qquad (2)$$

The pressure exerted on the system is equal at both ends of the pump. Thus, it does not affect the calculations. Similarly, velocity remains unaffected, as the pump is the sole influencing factor. PVC materials are used throughout calculations.

Introducing oxygen into the water body is a critical aspect of the water treatment process. Naturally, Typha D. already introduces oxygen into water bodies through their roots. The addition of the EMOH unit supplies excess oxygen, creating an aerobic system that works alongside the rhizome of the cattail. Establishing aerobic conditions initiates the nitrification process. The EMOH unit is designed to operate parallel to the surface water, directly interacting with the rhizome, while allowing the bottom layers to function anaerobically, thereby digesting accumulated sludge and waste. The ponds for both the first and second basins have a depth of 5 meters for the 945 cubic meters per day system. Allowing for enough room to harbor both. An additional benefit of elevated DO levels is enhanced cattail growth. Studies have demonstrated that maintaining optimal DO concentrations significantly improves plant growth, as evidenced in hydroponic lettuce cultures [4]. Similar advantages extend to trees and other hydroponically grown vegetation [5]. Although no direct studies confirm increased effectiveness specifically in cattails. It is self-evident that increased growth rates should correspondingly enhance root development. Improved root growth maximizes the effectiveness of Typha D. in removing nitrogen and phosphorus, and contributes positively to overall water quality.

V. Conclusion

The implementation of an enhanced floater system coupled with EMOH technology demonstrates significant improvements in water treatment efficiency. The increased dissolved oxygen levels stimulate Typha D. growth, reinforcing its capability to absorb excess nutrients and pollutants. The aerobic conditions facilitated by the EMOH unit contribute to the reduction of organic sludge, thereby improving overall water quality. The floater design is improved with interlocking and structural reinforcement. This guarantees longevity and scalability for various treatment applications. The combination of natural phytoremediation and advanced oxygenation technologies presents a sustainable, cost-effective alternative to traditional wastewater treatment. This approach offers practical applications in both industrial and municipal water treatment scenarios. The overall detention time within the system is approximately eight days, maintaining a daily input and output volume of 945 cubic meters, ensuring sustained treatment efficiency and compliance with environmental regulations.

VI. futurework

Future improvements will include the integration of an active sand filtration system to further refine water quality. Other future alterations include; in terms of quantitative data, water hardness (a measurement of dissolved calcium and magnesium ions). There is a goal to evaluate chlorination or ultraviolet (UV) sterilization options; these additional stages would aid in the possibility of potable water production. Of course further research and engineering would go towards incorporating post-treatment disinfection steps, to ensure compliance with safe drinking water standards. Ultimately, these future improvements broaden the system's applicability in both urban and rural context with an aim to make this a sustainable and efficient option to wastewater management.

However, it is important to note that it is necessary to conduct long-term studies, to collect tangible data and identify weak areas in need of improvement. For example, evaluation regarding the long term the durability and adaptability of the revised floater design under environmental and hydraulic loading conditions. Elements of interest like structural fatigue, UV exposure degradation, and anchoring performance during fluctuating water levels or storm events can lead to new solutions to aid in efficiency. Field data collected over time will validate design assumptions and overall system performance.

On that same note, when it comes to collecting data to validate system efficiency, a much needed improvement is the integration of peripheral sensors to track parameters of interest. These parameters may include the following:

- Dissolved oxygen (DO).
- Temperature
- Nutrient levels.
- Remote system diagnostics.
- Predictive maintenance alerts.
- Compliance reporting

Real-time monitoring of water quality parameters remotely can only add to the overall functionality and efficiency of this system as a competitive and sustainable option. .

Acknowledgment

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