Liquid Trees: A Novel Approach for Air Pollution Mitigation

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ABSTRACT

Air pollution is regarded as a menace that deteriorates the quality of life for urban residents. Deforestation resulting from urbanization has reduced the absorption of greenhouse gases and pollutants by trees. Consequently, the concept of the "Liquid Tree" has emerged in recent scientific research. The "Liquid Tree" is a photo-bioreactor designed in Serbia, housing green microalgae capable of capturing and sequestering carbon dioxide from the atmosphere. It conducts photosynthesis to release pure oxygen, thereby enhancing air quality. In addition to air purification, it treats wastewater and promotes greenery in densely populated urban areas. This popular article summarizes the operational principles and potential applications of the Liquid Tree.

INTRODUCTION

Trees are widely recognized for mitigating the effects of air pollution and climate change by absorbing carbon dioxide from the atmosphere and converting it into oxygen. Additionally, trees are effective at capturing particulates, thereby contributing to cleaner air. However, in densely populated urban areas, trees face limitations due to the presence of buildings and a scarcity of space and nutrient-rich soil necessary for their growth. Furthermore, the robust and expansive root systems of trees can potentially cause damage to buildings and concrete pavements. Additionally, the release

of pollen from trees can lead to seasonal allergies among the residents. Given these challenges, there arose a need to explore alternatives that could provide similar environmental benefits as trees. This led to the development of photobioreactors.

Liquid Tree

The "Liquid Tree," often referred to as "LIQUID 3," is a new ingenious solution containing freshwater microalgae. It is an innovative photobioreactor containing microscopic fibers from plant cell walls, known as cellulose nanofibers. It has been introduced in Serbia to address the issue of air pollution. Photobioreactors are closed fermentation tanks containing numerous small photosynthetic organisms collected within a carefully controlled system that enables precise management of their growth. These algae absorb carbon dioxide from the environment, carry out photosynthesis, and release oxygen, offering an effective solution to air quality concerns.

Dr. Ivan Spasojevic exploited the Liquid Tree photobioreactor from the University of Belgrade. In 2020, Serbia attained the unenviable distinction of having the highest number of pollution-related facilities in Europe. This alarming situation prompted the development of the photobioreactor concept as a response to pressing environmental concerns.

Working mechanism:

The photobioreactor is equipped with a 600-liter water chamber housing a multitude of single-celled freshwater algae (Castim, 2021). These algae are native to ponds and lakes, making them resilient to both high and low-temperature stress, allowing them to thrive even during the winter season. Their primary function is the absorption of carbon dioxide from the atmosphere, conducting photosynthesis, and subsequently producing pure oxygen. After a month and a half, the biomass of the algae is harvested, and the water is replenished with added minerals. The harvested biomass serves a dual purpose, as it is employed as a fertilizer for crops and plants.

Furthermore, the “Liquid 3” has a solar panel on the top using dead biomass of algae, that captures solar energy, converting it into electricity, which is then used to power a pump responsible for introducing air into the tank through small perforations (Kriegar, 2022). This electrical supply also enables the tank to emit light, facilitating year-round, uninterrupted photosynthesis by the microalgae, even during the winter months when sunlight is less abundant.

In addition, this tank acts as a bench, the solar panel includes charging capabilities for mobile phones and provides light during the night.

Fig.: The View of the Liquid Tree installed in the Public Place of Belgrade, Serbia (Source: Singh and Dake, 2023)

Tree vs liquid tree:

The microalgae within the bioreactor possess the ability to replicate and replace the carbon dioxide absorption equivalent to that of two ten-year-old trees or a lawn spanning an area of 200 square meters. Notably, microalgae demonstrate a photosynthesis-based carbon dioxide binding efficiency that is 10 to 50

times higher than that of trees, as demonstrated in a study by Singh and Dake in 2023.

Furthermore, in situations where pollution levels are exceptionally elevated, trees often struggle to survive, whereas microalgae exhibit remarkable resilience, effectively continuing their air purification efforts. These algae exhibit resistance to heavy metals and can purify a substantial volume of air, ranging from 300 to 3000 cubic meters, as indicated by research conducted by Krieger (2022). Liquid 3 acts as an alternative to hedges, where there is not enough space to grow a woody plant. It can be installed anywhere around the city including parks, malls, cinema halls, and even multi-storeyed buildings.

Given their capacity to thrive in cold conditions, microalgae remain operational during the winter months when deciduous trees shed their leaves, resulting in reduced carbon binding efficiency. Unlike natural trees, Liquid Trees are impervious to insect pests and diseases, and they entail cost-effective and straightforward maintenance.

Uses of Liquid Tree:

1. **Reduction in Carbon Dioxide Emissions:** Liquid Trees can capture and sequester carbon dioxide from the atmosphere, playing a pivotal role in mitigating the greenhouse effect and addressing climate change.

2. **Improved Air Quality:** Through the absorption of carbon dioxide and other pollutants from the atmosphere, along with the release of pure oxygen, Liquid Trees contribute to enhancing air quality, making it healthier for inhalation.

3. **Wastewater Treatment**: When wastewater is passed through a photobioreactor, the contained algae act as filters to remove pollutants such as nitrogen, phosphorus, contaminants, and organic matter.

4. **Medicinal Applications:** Various microorganisms, including algae, can produce bioactive compounds with significant applications in the field of medicine. Cultivating such algae in a controlled bioreactor environment facilitates the extraction of these bioactive compounds, as compared to their growth in natural habitats.

5. **Spacecraft Utilization:** Photobioreactors hold the potential to be employed for carbon dioxide removal and oxygen generation within spacecraft. Additionally, they offer the possibility of cultivating green salads to support astronauts' dietary needs.

6. **Promotion of Urban Greenery:** Liquid Trees contribute to enhancing the greenery in concrete urban environments, providing an aesthetically pleasing effect to urban landscapes.

Future Strategies

Liquid tree is a very innovative approach for combating air pollution by reducing carbon emissions and improving air quality. In India, due to rapid urbanization, the greenery is declining day by day which has a significant effect on the environment and public health. This liquid may prove to be an effective solution for India as 22 out of 30 most polluted cities in the World fall in India (Saxena, 2023). By adopting this technology India may improve the quality of life of the citizens and make cities more livable. The liquid tree with the potential to sequester carbon dioxide, release pure oxygen, and purify the atmosphere represents a promising solution that marries nature and technology.

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