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OPPORTUNITIES AND CHALLENGES OF PLANT-MICROBIAL FUEL CELL USING

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Biotechnology using a microbial fuel cell (MFC) is one of the newest technologies for electricity production. Currently, generation of bioenergy via MFCs draws considerable attention [3] due to its green nature and the ability to simultaneously resolve the problem of waste management. In Ukraine, this issue is not studied enough, so it is a current and promising direction of technologies development for waste treatment and environment protection in general.

It should be noted that one of the varieties of MFC technology is PMFC. The PMFC utilizes root exudates and rhizodeposits secreted by plants in the rhizosphere region as a result of photosynthetic activity into bioelectricity using metabolic activities of microbial community residing in the rhizosphere region [4]. Moreover, PMFC could be suggested for solving technical challenges in the classical MFC like complete utilization of substrate by bacterial species.

However, more efforts remain to be done to apply PFPM to power generation, as well as to wastewater treatment or phytoremediation, due to some limitations, such as the high cost of running the system and low electricity density. This work is a sincere attempt to gather and interpret recent research results related to CFMP research in order to set a course for future aspects of technological progress.

The factors that can influence the PMFC performance on longer duration and enhance magnitude of voltage generated are plant species used in PMFC, operation parameters, electrodes materials, characteristics and properties of available wastewater, type of available microbial inoculum.

In [5] a number of missing aspects are highlighted that have not been investigated yet. Firstly, it is emphasized that the rate of photosynthesis is affected greatly by the atmospheric carbon dioxide concentration and hence it resultantly affects the performance of PMFC. Therefore, selection of plant with appropriate photosynthetic pathway is significant in the assessment of performance of PMFC for increasing electricity generation.

Another, essential aspect of PMFC is microbial diversity that occurs in the rhizosphere. Root exudates varies from plant to plant with respect to composition and concentration within and between species. Hence, abundance of microorganisms' colonies also varies according to the nutritional requirement, supporting medium and inoculum. There are some species which are reported to be useful in electricity generation using PMFC system including Geobacter sp. Ruminococcaceae sp., Desulfobulbus sp., Bacillus, Geothrix, Pseudomonas, Shewanella, Acid-oba [1] These species are recommended for use in PMFC applications to achieve larger magnitude of voltage.

It is worth mentioning that one of the milestones of PMFC is choosing electrode material and its configuration. PMFC electrodes must have certain surface characteristics such as a rough surface, excellent biological compatibility and effective electron transfer between the bacterial community and the electrode surface. Using highly efficient electrodes like platinum electrodes or platinum coated electrodes is not feasible because of high economic price. Therefore, its recommended to exploit graphite or carbon-based electrodes.

In addition, substrate salinity is reported to be one of the significant factors for performance assessment of MFC. It has been documented that, performance of MFC increases with the increase of substrate salinity till a specific extent. Beyond that extent, the ability of exoelectrogens to sustain higher concentration is absent, hence the performance of MFC decreases [2].

To sum up, it can be concluded that PMFC is an innovative technology which can be recommended as be one of the complementary elements of studies on wastewater treatment and plant remediation. The work also covers various related factors like carbon dioxide concentration in air, microbial community in rhizosphere and electrode material used which influence the efficiency of PMFC. It can be noted that technology mentioned is in its infancy and there is still work to be done to make it commercially proficient. The main disadvantages of this technology are long pay-back period as well as less energy production. To overcome these challenges, some further research in configuration improvements, are required.

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DEVELOPMENT OF AI AND ML NOWADAYS

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Artificial Intelligence (AI) and Machine Learning (ML) have experienced significant advancements in recent years. Both technologies have a massive impact on various fields such as healthcare, finance, marketing, and transportation, among others.

AI and ML have come a long way since their inception. In the past, AI was primarily focused on rule-based systems, where rules were manually programmed into the system. These systems were not able to adapt to new data or situations, and their usefulness was limited. However, with the development of ML, AI has become more sophisticated, and its applications have become more widespread.

One of the most significant advancements in AI and ML has been the development of deep learning. Deep learning is a subset of machine learning that involves the use of neural networks with multiple layers. It has been successful in solving many complex problems that were previously impossible to solve with traditional machine learning techniques. Deep learning has been used in image recognition, speech recognition, natural language processing, and many other applications.

Another area where AI and ML have made significant progress is in natural language processing (NLP). NLP is the ability of computers to understand and interpret human language. With the help of NLP, chatbots and virtual assistants have become more sophisticated and can interact with humans in a more natural way. NLP has also been used in sentiment analysis, where computers can analyze large amounts of text data to determine the sentiment of the author.

AI and ML have also been applied in the field of healthcare. They have been used to develop predictive models that can identify patients who are at risk of developing certain diseases. This can help healthcare providers to take proactive