Bioremoval of dyes in a microbial fuel cell by the fungi *Trichoderma harzianum*

Sébastien Votat [1,2], Mehri Shabani[2] , Maxime Pontié[2], Laurent Lebrun[1]

[1]*Université de Rouen, UFR Sciences et Techniques, PBS, UMR CNRS 6270, Bd Maurice de Broglie, 76130, Mont-Saint-Aignan, France*
[2]*Université d'Angers, UFR Sciences, Groupe Analyses et Procédés, 2 Bd. Lavoisier, 49045 Angers 01, France*

sebastien.votat@univ-rouen.fr

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Large volumes of water are used in processing operations of textile industries. Substantial quantities of wastewaters are released. The presence of dyes, even in a very small amount, degrades the drinkability of the water, its aesthetic and the oxygen solubility necessary for plants. Many classes of dyes are used in textile industries, among them triphenyl methane group is the predominant in most dying applications. Among this group we found Violet crystal (VC) and methylene blue (BM). VC was used for a long time as biological stain and as textile dye but has been classified as potent carcinogen. MB is dye used in several applications like in medicine, biology and textile industries. It is suspected to interfere with photosynthetic activity and the growth of biota.

Dye removal from wastewater include several physical – chemical methods but are not sufficient for a complete removal and generate a large amount of sludge containing secondary pollutants. Biological methods using bacteria, fungi or their enzymes are now well appreciated because they are very useful and often low-cost. Among them, microbial fuel cells (MCF) could be also considered for dye degradation (Mbokou[1-2]) . MFC are bioelectrochemical systems. They can produce electricity by degradation of chemical compounds using microorganisms. After microorganism colonization, the bioanode can produce power by oxidation of the substrate. Microorganisms are often bacteria but sometimes fungi.

The aim of this work was to develop an MFC using the fungi *Trichoderma harzianum* fungus for efficient VC and BM removal associated with high electrical performances. *T. harzianum* possess enzymes (i.e., peroxidase, laccase) that allow the degradation of molecules containing aromatic rings like MB and VC (Shabani[3]). The MFC consisted in dual chambers separated by a cation exchange membrane. The anode was made by *T. harzianum* cultivated on a carbon cloth, the cathode a carbon cloth. Two carbon clothes were tested (KIP and CSV reference).

Results illustrated in Fig. 1 (a) (as example for KIP) showed that MB was almost completely removed from the 100 mgL^{-1} solution after only 22h whatever the carbon cloth. VC was not completely removed, respectively 52% and 57% with KIP and CSV. The difference was explained by the difference in the number of aromatic structures in the two dyes. Maxima currents powers were higher with KIP ($6.5*10^6$ $mW.m^{-3}$ with MB and $4.6*10^7$ $mW.m^{-3}$ with VC) (Fig. 1 (b)) compared to CSV. KIP has a lower resistance and is thicker permitting a faster electrons collection and is more hydrophobic allowing better interaction with *T. harzianum* which is hydrophobic. So, KIP carbon cloth gave more intensity and power than CSV.

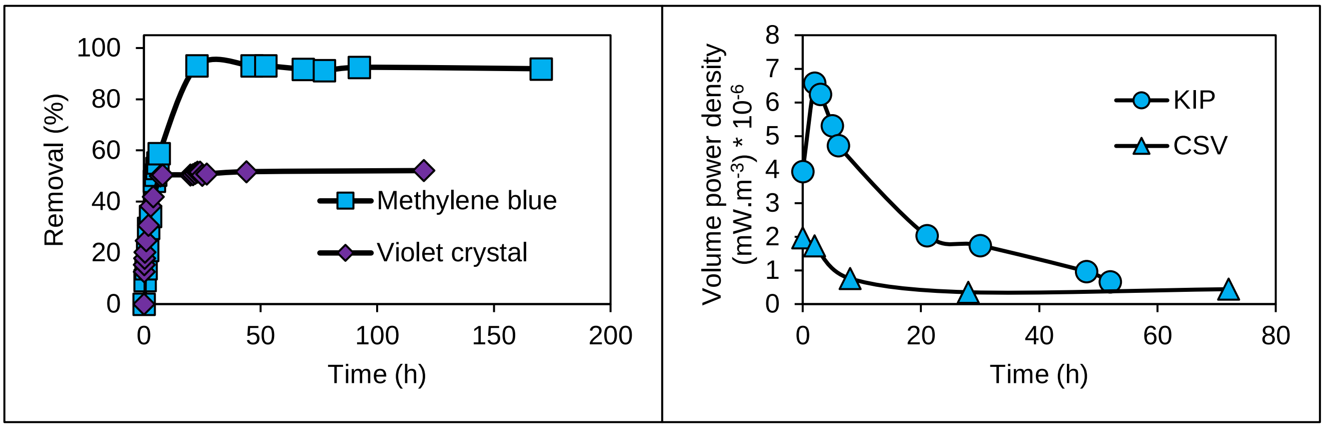

Figure 1 (a) Evolution of percentage of MB and VC removal through time. (b) Volume power density evolution through time with MB substrate and KIP or CSV carbon clothes.

References

[1] Mbokou, S. F.; Pontié, M.; Bouchara, J.-P.; Tchieno, F. M. M.; Njanja, E.; Mogni, A.; Pontalier, P. Y.; Tonle, I. K. Electroanalytical Performance of a Carbon Paste Electrode Modified by Coffee Husks for the Quantification of Acetaminophen in Quality Control of Commercialized Pharmaceutical Tablets, International Journal of Electrochemistry 2016, 2016, 1–10.

[2] Mbokou, S. F.; Tonle, I. K.; Pontié, M. Development of a Novel Hybrid Biofuel Cell Type APAP/O2 Based on a Fungal Bioanode with a Scedosporium Dehoogii Biofilm, J Appl Electrochem 2017, 47 (2), 273–280.

[3] Shabani, M.; Younesi, H.; Pontié, M.; Rahimpour, A.; Rahimnejad, M.; Guo, H.; Szymczyk, A. Enhancement of Microbial Fuel Cell Efficiency by Incorporation of Graphene Oxide and Functionalized Graphene Oxide in Sulfonated Polyethersulfone Membrane, Renewable Energy 2021, 179, 788–801.