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Endocrine Disruptive Estrogens: Bio-electrochemical Remediation and their role in Electron Transfer

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Abstract

Statement of the Problem: Ethinyl estradiol (EE2), an oral estrogen medication, is used widely in birth control pills, treatment of gynecological disorders and prostate cancer, and also an occasionally used component of menopausal hormone therapy. EE2, a endocrine disruptive compound (EDC), is released into the environment from the urine and feces of people (who take it as a medication) as inactive polar conjugates such as glucuronides and sulphates. EE2 is implicated among the major and potent estrogenic contaminants in effluents with high persistence and a tendency to bioconcentrate in organisms. Long-term exposure to environmentally relevant concentrations of EE2 can interfere with the endocrine system, affect organisms' reproductive physiology, induce infertility, altered sexual behavior, sex reversal, etc. and cause Venous thromboembolism, Cardiovascular toxicity, Cholestatic hepatotoxicity and Endometrial cancer thereby posing either acute or chronic adverse effects

Methodology & Theoretical Orientation

Removal of EE2 from environment is extremely important to reduce the potential risk caused by them. Treatment of EDCs by natural attenuation mechanisms viz., enzyme mediated and biological processes have gained much attention due to their efficiency and economic viability. Single chambered Bio-electrochemical treatment (BET) system with non-catalyzed graphite plates as electrodes was used for the experimental study. Anodic chamber with enriched anaerobic culture was operated in fed batch mode by varying the EE2 concentration (1000-5000 µg/L) and poised potentials (100-1500 mV)

Findings

Initially, the EE2 showed lower removal pattern which increased with time. Reduction in toxicity levels was observed after treatment in BET. The increment in power generation efficiency of BET strongly supports the positive role in electron transport

Conclusion & Significance

This study exhibited superior performance in treating EE2 even at high concentrations compared to other conventional treatment processes. The designed BET is ecologically complex, mechanically simple, consumes low energy, easy to operate, inexpensive to construct and moreover enhances esthetic value and also capable to treat EDCs (EE2) along with domestic sewage.

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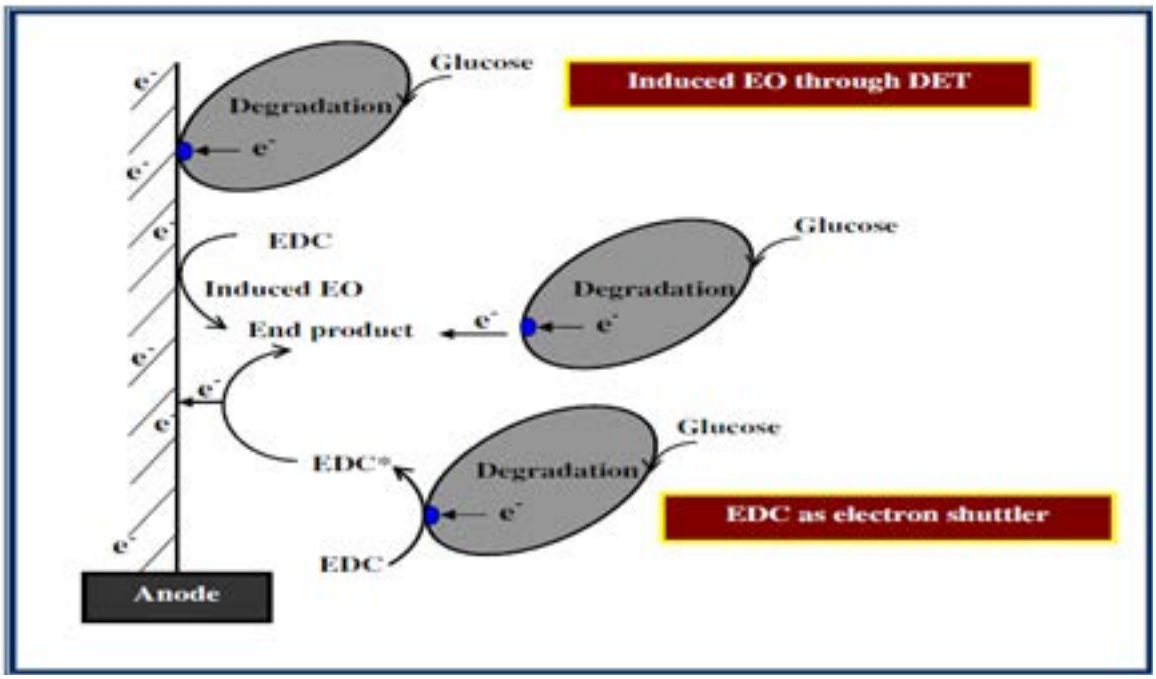

Figure: Schematic representation of EDC break down via electrochemical oxidation and its function as mediator. (Adapted- Kumar et al., 2012)