RIVER TREATMENT USING BIOFILM GROWTH ON COCONUT AND OIL PALM CELLULOSIC FIBRES

LOW WEN PEI

UNIVERSITI TEKNOLOGI MALAYSIA

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requirements for the award of the degree of
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DEDICATION

Dedicated to My beloved father, mother, brothers, sister & *fung lung*

For giving me infinite love, care, blessing with endless support to me.

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ABSTRACT

Many conventional treatments have been proposed to reduce river pollution issues in Malaysia. However, the application of these technologies is still expensive and sophisticated in terms of both operation and management. Recently, natural waste materials have been found to successfully treat different types of pollutants from contaminated water. Therefore, in this study, coconut fibre (CF) and oil palm fibre (OPF), two highly available natural materials in Malaysia have been selected for the development of adsorption and filtration materials. Instead of multi-purpose usage as furniture, slope protections and others, fibres (CF and OPF) can performed as a treatment medium for removing organic and nutrient pollutants, as well as providing an ideal biofilm formation platform to enhance removal rates. The main goal of this study is to develop biofilm on cellulosic fibres (CF and OPF) for organics and nutrients removal in river water and elucidate its adsorption mechanisms using modified empirical model. Desa Bakti River which is one of the polluted rivers in Johor, Malaysia due to domestic effluent discharge from nearby oxidation ponds was chosen as sampling site throughout the study. Initially various amounts of CF and OPF were tested in a jar test. Then, the obtained amount of fibres (CF and OPF) was used for organic and nutrient removal in a fabricated model with 0.2 m^3 of river water at different flow rates. A same study that used the optimum flow rate was conducted again for biofilm developed fibres (CF and OPF). All the results were analyzed using modified empirical model. This model tested various loading rates and the predicted accumulation rate of adsorbates was found to decrease along with the percentage of outflows. It was discovered that CF with an attached biofilm have a higher mass transfer rate than OPF due to the fact that the thickness of the extracellular polymeric substance on CF was less than on OPF. The global mass transfer factor for the developed biofilm CF was found to be highest at 2% outflow, where chemical oxygen demand, total nitrogen and total phosphorus were 1.0067 d^{-1}, 0.4857 d^{-1} and 0.1485 d^{-1} respectively. By using these modified empirical models as an analysis tool, the natural biofilm formation by using both CF and OPF were confirmed based on optimized yield in removal of organics and nutrients from river water.

ABSTRAK

Banyak jenis olahan sungai telah dicadangkan bagi mengurangkan masalah pencemaran sungai di Malaysia. Walau bagaimanapun, penggunaan teknologi ini masih mahal dan canggih dalam operasi dan pengurusan. Kebelakangan ini, bahan-bahan buangan semula jadi telah berjaya mengolah bahan pencemar daripada air tercemar. Oleh itu dalam kajian ini, serat kelapa (CF) dan serat kelapa sawit (OPF) adalah antara dua bahan semula jadi yang tersedia di Malaysia dalam kemajuan teknik penyerapan dan penapisan. Selain digunakan sebagai perabot, perlindungan cerun dan lain-lain, ia juga boleh digunakan sebagai medium olahan untuk mengurangkan bahan pencemar organik dan nutrien, dan juga sebagai asas pembentukan biofilm bagi meningkatkan kadar penyingkiran bahan pencemar. Matlamat utama kajian ini adalah untuk membangunkan biofilm pada serat (CF and OPF) untuk mengurangkan pencemaran organik dan nutrien dalam air sungai dan menjelaskan mekanisme penyerapannya menggunakan model empirikal yang diubahsuai. Sungai Desa Bakti merupakan salah satu sungai yang tercemar di Johor, Malaysia disebabkan oleh pelepasan efluen domestik dari kolam pengoksidaan telah dipilih sebagai lokasi kajian. Pelbagai kuantiti CF dan OPF telah diuji menggunakan uji balang. Kemudian, jumlah yang diperolehi digunakan untuk mengurangkan pencemar organik dan nutrien dalam model yang direka dengan 0.2 m^3 air sungai pada kadar aliran yang berbeza. Kajian yang sama diulang dengan menggunakan kadar aliran optimum yang diperolehi bagi serat (CF and OPF) yang mengandungi biofilm. Keputusan kajian dianalisis menggunakan model empirikal yang telah diubahsuai. Model ini akan diuji dengan pelbagai kadar beban dan kadar bahan serapan yang mungkin terkumpul secara beransur-ansur mengikut peratusan aliran keluar. Biofilm pada CF didapati mempunyai kadar pemindahan jisim yang lebih tinggi dari OPF kerana ketebalan bahan polimer *extracellular* pada CF adalah lebih nipis dari OPF. Faktor pemindahan jisim sejagat bagi CF yang mengandungi biofilm didapati paling tinggi pada masa 2% aliran keluar, yang mana permintaan oksigen kimia, jumlah nitrogen dan jumlah fosforus masing-masing adalah 1,0067 d^{-1}, 0,4857 d^{-1} dan 0,1485 d^{-1}. Oleh itu, dengan menggunakan model empirikal yang telah diubahsuai ini sebagai bahan bantu analisis, pembentukan biofilm semula jadi dengan menggunakan kedua-dua sabut kelapa dan sabut kelapa sawit telah disah berdasarkan hasil yang optimum untuk menyingkirkan organik dan nutrien dalam air sungai.