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# Removal of cationic dye using polyvinyl alcohol membrane functionalized by D-glucose and agar

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ABSTRACT

The composite membranes of polyvinyl alcohol (PVA) functionalized by D-glucose and agar using the solution casting method were prepared for dye wastewater treatment. The composite membranes improved their hydrophobicity and thermal stability with respect to the parent PVA. The membranes possess good mechanical behaviors and have suitable pore sizes and $pH_{pzc}$ for the adsorption of cationic dyes as well as were sustainable in aqueous solution for more than 350 min. In which, the 6P2D2A membrane containing 60 % PVA, 20 % D-glucose and 20 % agar can adsorb cationic dye (methylene blue) at the maximum adsorption capacity of 29 mg/g for 120 min, whereas negligible adsorption for anionic dye such as Congo red. The high and selective adsorption capacity of the composite membranes makes them promising candidates for further filtration and separation of dye molecules. Also, the adsorption data well fitted with the nonlinear pseudo-first-order kinetic and Langmuir isotherm model.

## 1. Introduction

Wastewater from the textile industry causes a big problem in water resources due to a large volume of wastewater discharged from various steps in dyeing and finishing processes without treatment [1,2]. The dye-contaminated wastewater contains reactive dyes, which posed a threat to aquatic life and public health [1,2]. Also, it may cause toxicity, mutagenicity, and carcinogenicity to humans [3]. For example, methylene blue (MB) cause health problems such as nausea, vomiting, increased heart rate, tissue necrosis, eye burn, and difficulty in breathing [4–6]. Hence, many treatment methods have been developed to eliminate textile dyes, including photo-degradation, adsorption, coagulation, ion exchange, and membrane filtration [1,4,7–17]. Among them, adsorption is one of the most economic methods due to facile operation and high removal efficiency [18]. Typically, activated carbon is a preferred adsorbent for dye elimination due to its high adsorption capacity [19,20]. Nevertheless, it has a major drawback in the difficult and high-cost recovery after decolonizing organic species [19,20]. Therefore, it is great to develop inexpensive, easy handle, and eco-friendly adsorbents with high removal efficiency for organic dyes. The requirement for a good adsorbent with high removal efficiency for organic dyes should have a high uptake of dye, easy to produce in large quantities, have a low cost, and easy collection after use [21].

Polyvinyl alcohol (PVA) – derived material is considered a potential material due to its containing biodegradable property [22,23]. In fact, the PVA has many applications including the textile, paper industry, and food packaging industry because of its biodegradability, film-forming ability, chemical stability, transparency, gas barrier, nontoxic and mechanical properties [24–28]. However, the strong affinity toward water molecules of PVA arising from the high density of hydroxyl groups along

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