GRAFTING OF POLY (STYRENE-CO-MALEIC ANHYDRIDE) ONTO CALCIUM ALGINATE HYDROGEL FOR ENHANCING THE ADSORPTIVE REMOVAL OF METHYL VIOLET 6B CATIONIC DYE FROM AQUEOUS SOLUTIONS

[1]FAWZI BANAT, [2]ASMA ESKHAN, [3]MUNIRASU SELVARAJ

[1]Department of Chemical Engineering, PO Box 2533, Abu Dhabi, UAE
E-mail - fbanat@pi.ac.ae

I. INTRODUCTION

Dye-based industries such as textile, leather, printing, plastics, medical, food and cosmetics release colored effluents into the environment containing up to 15% of the total dye used in the dyeing process(Mani andBharagava, 2016). The presence of these dyes in water, even at low concentrations, can affect the aesthetic merit, sunlight penetration and the gas solubility in water bodies. It can also convey toxicity to the aquatic life(Pereira andAlves, 2012). In addition, most of the used synthetic dyes have complex aromatic structures and thus are highly stable and resistant to light, heat and oxidizing agents(Li et al., 2016). Therefore, it is substantially required to remove the residual dye in the wastewater prior to its discharge into aquatic ecosystems. In this work, calcium alginate hydrogel was grafted with poly (styrene-co-maleic anhydride) synthetic polymer (PSMA) and used as a biosorbent for the effective removal of methyl violet 6B cationic dye from aqueous solutions. Adsorption batchexperiments and equilibrium studies were conducted for the synthesized adsorbent.

II. METHODS

Preparation of the adsorbent

Calcium alginate beads were initially prepared by dripping a solution of 2.5 % (w/v) sodium alginate into a 0.1 M $CaCl_2.2H_2O$ solution. Prior to PSMA grafting, the formed beads were thoroughly rinsed several times with acetone to exchange the water trapped inside the hydrogel. To ensure a complete solvent exchange, the beads were left suspended in fresh acetone overnight. The beads were then added to a 0.0125 M of PSMA in acetone solution and heated at 40 °C for one hour. Thereafter, the reaction solution was decanted and the modified beads were thoroughly washed with acetone overnight to remove any unreacted PSMA.

Batch adsorption studies

The adsorption experiments were carried out in conical flasks containing 20 ml of methyl violet dye solutions prepared with the concentration range of (10-200 mg/L). The pH adjustments (3-11) were performed by the dropwise addition of 0.1 M HCL or 0.1 M NaOH solutions. The required dose of the wet beads was added to the methyl violet solution and agitated in a water bath at 150 rpm and at the desired temperature until reaching equilibrium. After that, the beads were removed and the remaining solutions were centrifuged. The residual concentrations of methyl violet in the supernatants were determined using Hach DR 5000 UV spectrophotometer at a wavelength of 582 nm.

III. RESULTS AND DISCUSSION

Effect of PSMA grafting onto alginate surface

The higher removal observed for the grafted alginate at all pH investigated values (Fig.1) is attributed to the new adsorption sites introduced to the adsorbent by the synthetic polymer chains. Grafting alginate with PSMA establishes electrostatic attraction and π-πstacking interactions with the aromatic rings of the cationic dye improving the removal percentage of the dye.

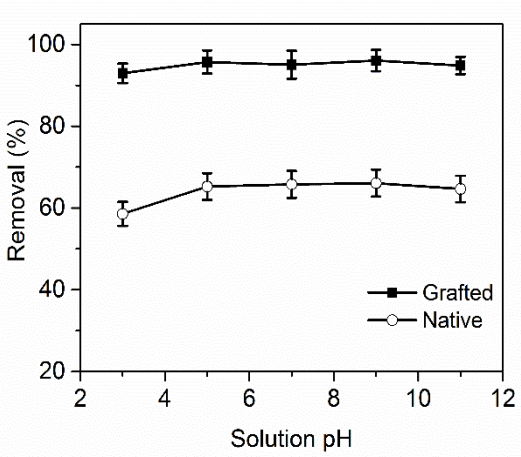


Fig. 1. Effect of solution pH on the removal percentage of methyl violet by PSMA grafted alginate and native alginate beads.

Equilibrium studies

The equilibrium adsorption data were modelled by Langmuir and Freundlich isotherms and the calculated results are represented in Table 1. The calculated values of R_L at the investigated temperatures (20 °C , 30 °C and 40 °C) fall in the range between 0 and 1 indicating that the adsorption is favourable. The obtained q_{max} values reveal that

grafted alginate can be used as a sustainable and promising adsorbent for the removal of cationic dyes from wastewater.

Isotherm model	Parameter	Temperature (°C)		
		20	30	40
Langmuir	q_{max}(mg/g)	78.7	93.5	109.9
	k_L (L/mg)	0.140	0.187	0.263
	R_L	0.125	0.0967	0.0707
	R^2	0.998	0.986	0.966
Freundlich	k_F([mg $^{(1-1/n)}$. L $^{(1/n)}$/ g]	10.6	15.6	24.3
	n	1.45	1.50	1.68
	q_{max}(mg/g)	156.6	212.6	249.9
	R^2	0.996	0.966	0.973

Table 1. Isotherms' parameters for the adsorption of methyl violet onto grafted alginate.

CONCLUSIONS

The removal performance of calcium alginate hydrogel towards methyl violet 6B cationic dye could be enhanced up to 30 % with the grafting of PSMA on its polymer chains. The grafted alginate beads exhibited a higher thermal stability and higher swelling properties compared to the native hydrogel. The equilibrium data were better fitted to the Langmuir model.

REFERENCES

[1] LI, Y.,NIE, W.,CHEN, P. and ZHOU, Y. (2016) Preparation and characterization of sulfonated poly(styrene-alt-maleic anhydride) and its selective removal of cationic dyes. Colloids Surf Physicochem Eng Aspects, 499: 46-53.

[2] MANI, S. and BHARAGAVA, R. N. 2016. Exposure to crystal violet, its toxic, genotoxic and carcinogenic effects on environment and its degradation and detoxification for environmental safety, Cham, Springer International Publishing.

[3] PEREIRA, L. and ALVES, M. 2012. Dyes-Environmental Impact and Remediation, Dordrecht, Springer Netherlands.