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PARAMETRIC OPTIMIZATION OF DYES ABSORPTION USING POLYPROPYLENE IMINE DENDRIMER FROM TEXTILE WASTEWATER

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Abstract

Recently, Dendrimers are famous for monodispersed, highly branched, three dimensional, macromolecular nanoscopic architecture with several groups of the reactive end. Dendrimers work as dye removal agents from the two systems liquid-solid or liquid-liquid. This study tackles the textile dyes removal from aqueous solutions by Reactive Black 5 (RB5), Acid Blue 7 (AB7), Reactive Red 198 (RR198), Acid Green 25 (AG25), poly (propylene imine) dendrimer (PPI). and have been utilized as model dyes. Operational parameters influence the removal of dye like the concentration of dye, the concentration of dendrimer, pH, time, and temperature were investigated. Findings revealed that the efficiency of dye removal was maximized by increasing both concentrations of dye and dendrimers. Furthermore, results showed that the adsorption of dyes was supported by acidic pH through dendrimer. Besides, tests showed that maximum dyes removal were achieved at time 16h and temperature around 60 °C. As the data revealed, it can be concluded that dendrimers are adsorbent which is environmentally friendly with somehow big adsorption ability of could be an advisable substitute for dyes elimination from coloured textile wastewater.

Keywords: Propylene Imine; Reactive Black 5; Acid Blue 7; Acid Green 25; Reactive Red 198.

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Introduction

Water has been known as a life source, yet, recently, around the whole globe, most of the people still spending their day searching for water. One of the driest areas of the world is the, where water is scarce, Lately, the water consumption in this region has increased faster than before. Water scarcity has been defined as economic scarcity, which is the lack of water access, or physical scarcity, which is scarce of enough water, Water scarcity is considered asa severe crisis and growing problem that leaders of both social and political instability () (), which. Improvement suggestions can show the industrial key role, especially textile one due to its critical and high water-consuming in society. Wastewater recycling and using it as a system input to tot solve the consumption of water issues (Eskandarian et al., 2014).

Dyes enhance the beauty o the world, yet they cause pollution. The other type of dye is synthetic and is presented in several ranges of everyday life and the world witnesses an increase in the growth of its applications. Organic synthetic dyes are extensively utilized wide as colorants in various industries like cosmetics, food, pharmaceutical, colour photography and paper, textile, etc. (Zheng et al., 1999). Around worldwide, factories produce annually around 700 hundred thousand tons of organic synthetic dye. Furthermore, over industries apply around 10000 of pigments and dyes. Research showed that processing and manufacturing operations around 15% of synthetic dyes yearly ist lost which involves the handling and production with several organic compounds hazardous to living organisms (Koprivanac et al., 2008; Mahmoodi et al., 2009). Therefore, there is a massive need for organics treatment like wastewater dyes before discharging into the primary effluent.

The unique polymer type "Dendrimers", is considered as crucial promising molecules in several industries due to their controllable shape and size, highly structure branched molecular, and identical groups. The early research investigated and studied the dendrimers'

synthetic aspects, yet, nowadays, attention is being given to the application of dendrimers. The extraordinary characteristics of features structure endure the promise of several applications in the areas of electrochemical and nanoelectronics (bio) sensors, insulating materials, and active substances carriers, (Cancino et al., 2013; Christopher et al., 2012). Theedited dendrimers were used to extract dyes either in the systems of liquid-solid and liquid- liquid (Burkinshaw et al., 2002) (Baars et al., 1997) (polypropylene fibers dyeing). Triarylmethane dyes removal by polyamidoamine dendrimer was proved, the literature studied generation influence on dye removal percentage and the effective parameters like dendrimer concentration, pH, (Yiyun et al., 2005). Besides, Ghosh et al., (2008) examined the Azo dye molecules extraction from aqueous solution thru the use of polyamidoamine dendrimer based polymeric network by

Researchers in the current study, poly(propylene imine) dendrimer (PPI) is utilized for dyes removal (RR198, AG25, AB7, and RB5). important parameters (pH, the concentration of dendrimer, the concentration of dye, time, and temperature) were investigated to evaluate the adsorption capacity of PPI dendrimer.

2. Experimental

2.1. Chemicals and materials

The adsorbent was used in the study is Dendrimer (molecular weight: 770 g/mol, Generation:2 (G2), and: $C_{40}H_{94}N_{14}$ as the molecular formula). dendrimer chemical structure is illustrated.

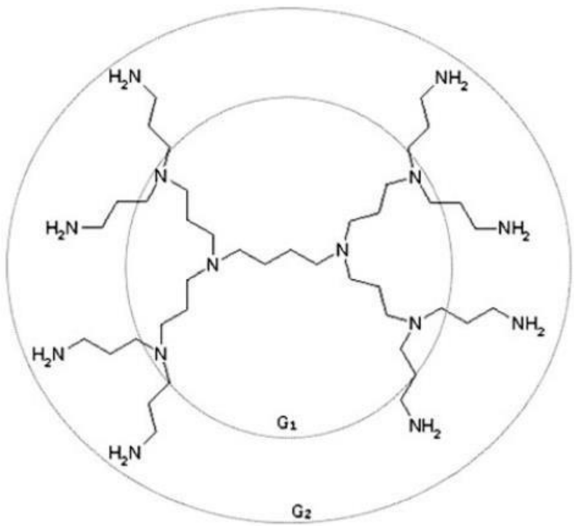

Figure . 1. PPI dendrimer chemical structure (C40H94N1 and G2, MW: 773 g/mol and 4).

The model dyes have been used in the study Acid Green 25 (AG25), Reactive Red 198 (RR198), Acid Blue 7 (AB7), and Reactive Black 5 (RB5) which was bought from Ciba Ltd. Dye's chemical formulas are illustrated below. The other analytical grade chemicals have been bought from Merck. The solution pH is modified through the addition of a bit of NaOH or H_2SO_4. It was used to the dye concentration determination that was gained by the use of A CECIL 2021 UV–VIS spectrophotometer.

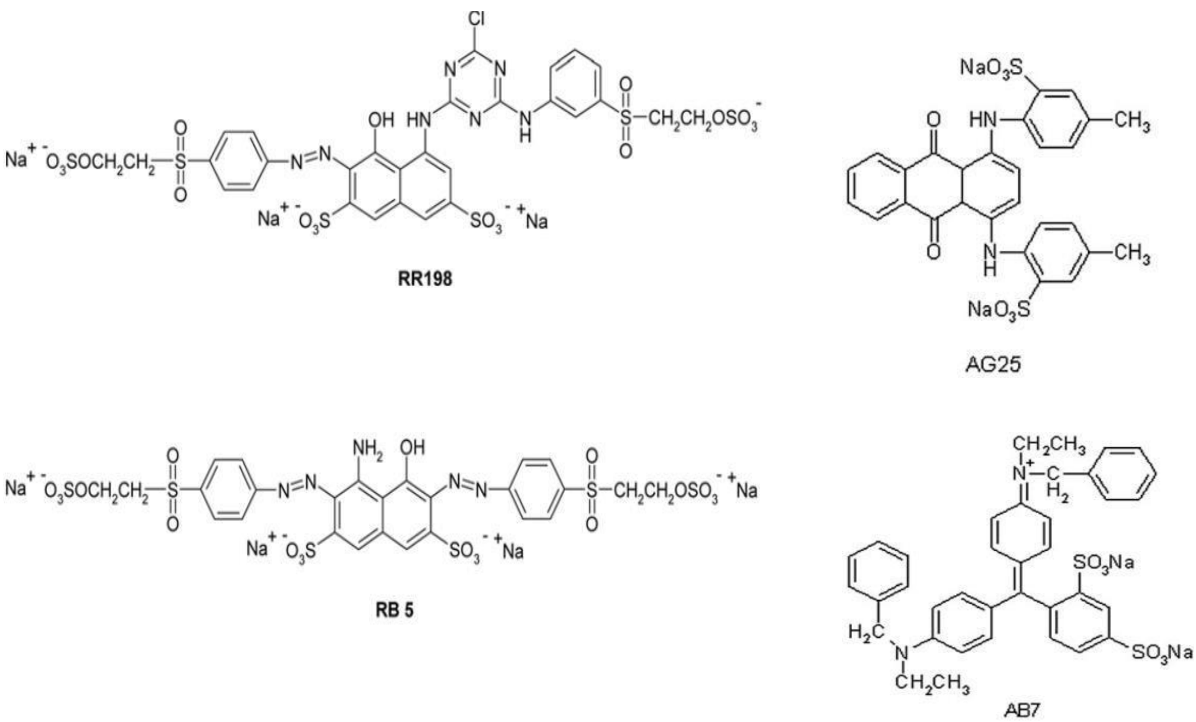

Figure 2. Dyes chemical structure .

2.2. Adsorption procedure

Measurements of adsorption have been prepared by increasing different portions of dendrimer (2.4, 1.8, 1.2, and 0.6, , , mg/L) for RB5, AB7, AG25, and RR198 , in jars including 200 mL of a dye solution (50 mg/L) at numerous pH (2–10). Examination of pH were done for optimum pH determination at which colour removal maximum can be gained with dendrimer. Experiments were conducted at numerous concentrations of dye(100, 75, 50, and 25, mg/L) through the use of 1.8 mg/L of dendrimer for RB5, AB7, AG25, and RR198 ,

, at pH 2 and 25 8C for half an hour . Absorbance changes have been gained at specific time intervals (30, 15,20,15,10,7.5, 2.5, 5min). After experiments, within the process of adsorption. using Hettich EBA20 the researchers centrifuged samples and the concentrations of the dyes has been identified. The following Eq (1) was used to count the efficiency of dye removal :

Dye removal efficiency (%) = $(C0 - C/C0) \times 100$ (1)

wherein C and $C0$are early concentrations of dyes (mg/L) and concentration of dyes(mg/L) at time t, accordingly.

1. Results and discussion

a. Dendrimer concentration effect

The efficiencies of adsorption on dendrimer RB5, AB7, AG25, and RR198, , , were assessed through absorbance determination the at 505, 640, 605, 543 nm, accordingly. Dendrimer concentration influence on dyes removal is illustrated in Fig.3.Removal percentage maximized by concentration of dendrimer to specific limit until it reaches a fixed value. Concentration of optimum dendrimer for RB5, AB7, AG25 and RR198, , , removing6 dyes solutions was 1.7 mg/L for 200 mL of 50 mg/L. Dyes adsorption increase with concentration of dendrimer was because of the affordance of plenty dendrimer sites active surfaces regarding adsorption. A portion of dendrimers has the ability of adsorbinga constant mass of adsorbate only. Then, the adsorbate solution early concentrations is critical. This process

illustrated the reason of no further enhancement could be gained regarding the dendrimer concentration. .

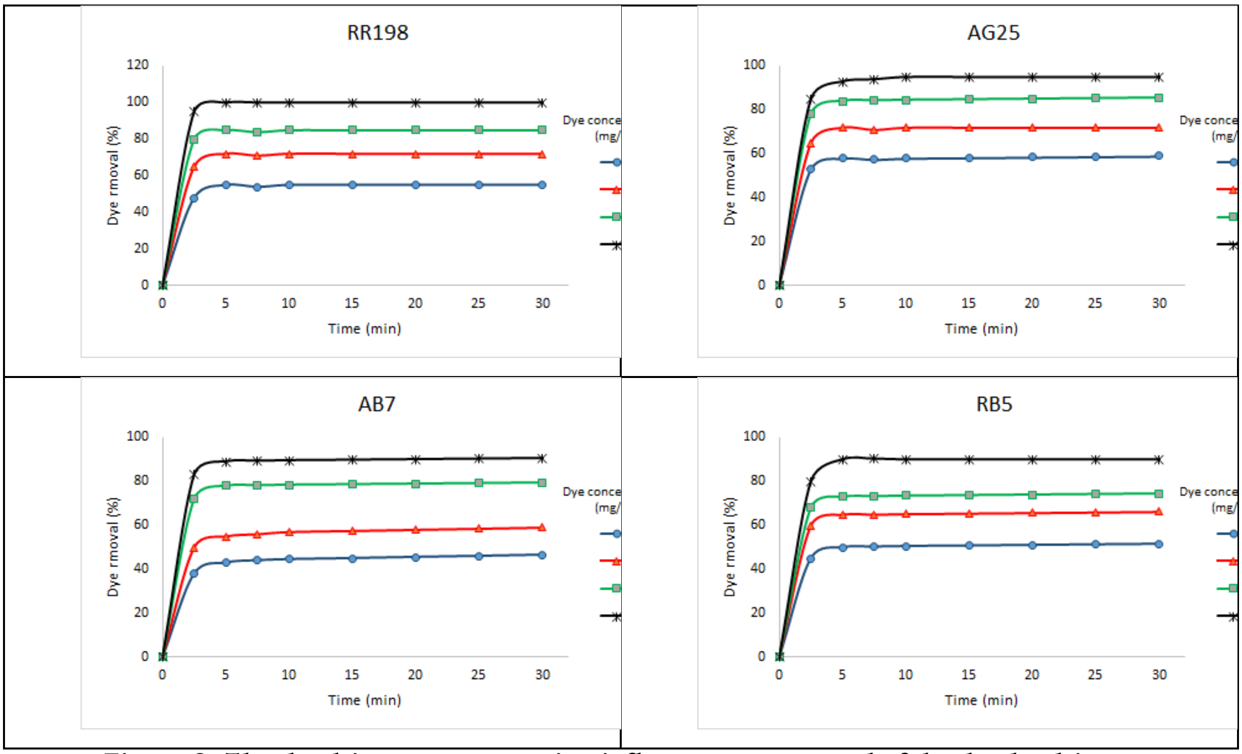

Figure 3. The dendrimer concentration influence on removal of dye by dendrimer.

Conditions: pH= 2, T = 60 °C, C_0 = 50 mg/L, DR80, AG25, AB7, and DR23.

b. Dye concentration effect

The study examined the early influence of dye concentration on remove of dye . Dendrimer (1.7 mg/L) has been added to two hundred e mL of solutions of RB5, AB7, AG25, and RR198 at various concentrations of dye of 100, 75, 50, and 25 mg/L (Fig. 4). The aforementioned tests were conducted at at pH 2. Findings demonstrated a decrease in the capacity of equilibrium with an as the initial concentrations dye increase as illustrated in Fig.

2. The increases of dye concentration causes a decrease in dye removal . It is possible to conclude that the aforementioned fact is applicable to the adsorbent active sites ..

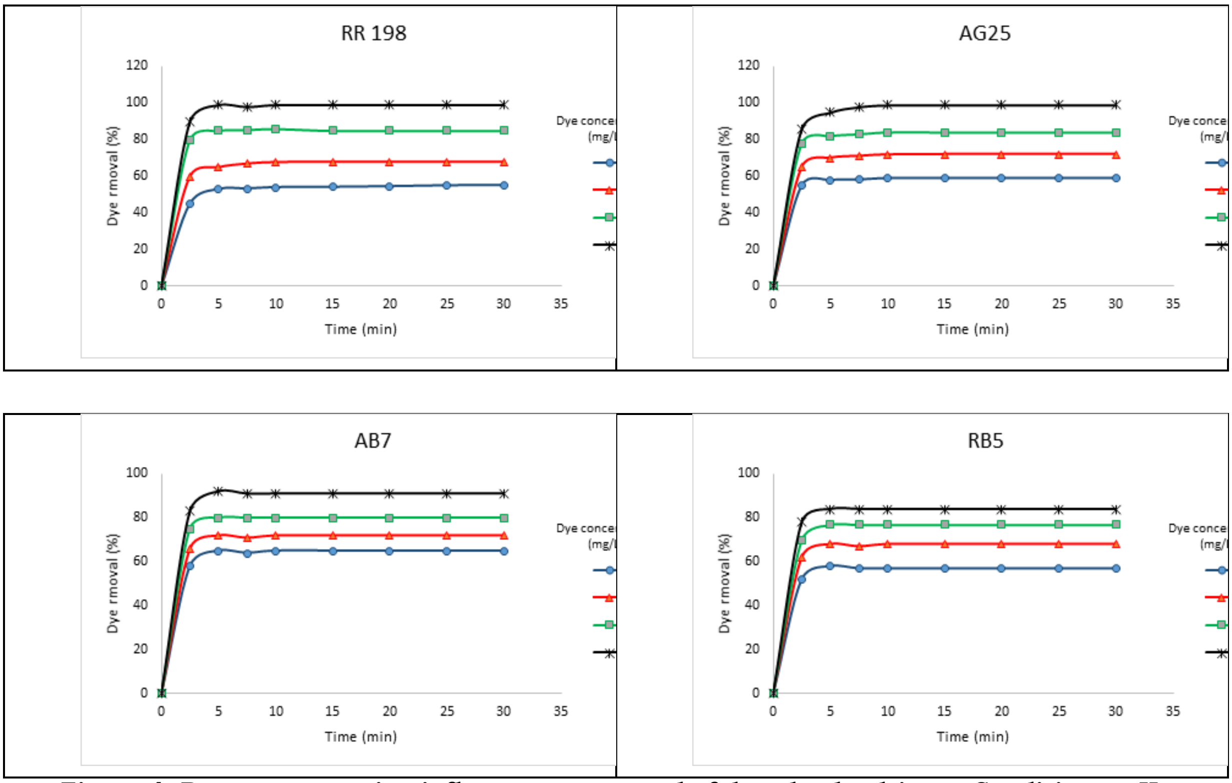

Figure 4. Dye concentration influence on removal of dyes by dendrimer. Conditions: pH = 2,T = 60 °C, C_{dendr} = 1.7 mg/L, RR198, AG25, AB7, and RR5.

3.3. pH Effect

The concentration of the last dyes after adsorption noticeably changed with the first pH of the solution of dye. therefore, research at broad pH range of 2–10 were conducted . PH influence of on the adsorption of RB5, AB7, AG25, RR198, , by dendrimer is illustrated in Fig. 3. The maximum adsorption dye was at pH 2.

dyes of AB7, AG25, RR198, , , and RB5 are polar molecules ($R-SO_3^-$). The dendrimer PPI has basic amine sets at every ending branch that may be influenced by pH resolution . so, the attraction of electrostatic, also, the dye organic structure and properties of dendrimer and molecules, plays a huge critical role in dye dendrimer and adsorption . On pH 2, an of electrostatic attractions habits among the anionic dye and the dendrimer positively charged surface of the . the increase of pH in the system decreases the positively charged sites numberthat gives no benefit to the adsorption off dye anion. The 2 was the efficient pH it has been utilized in extra researches.

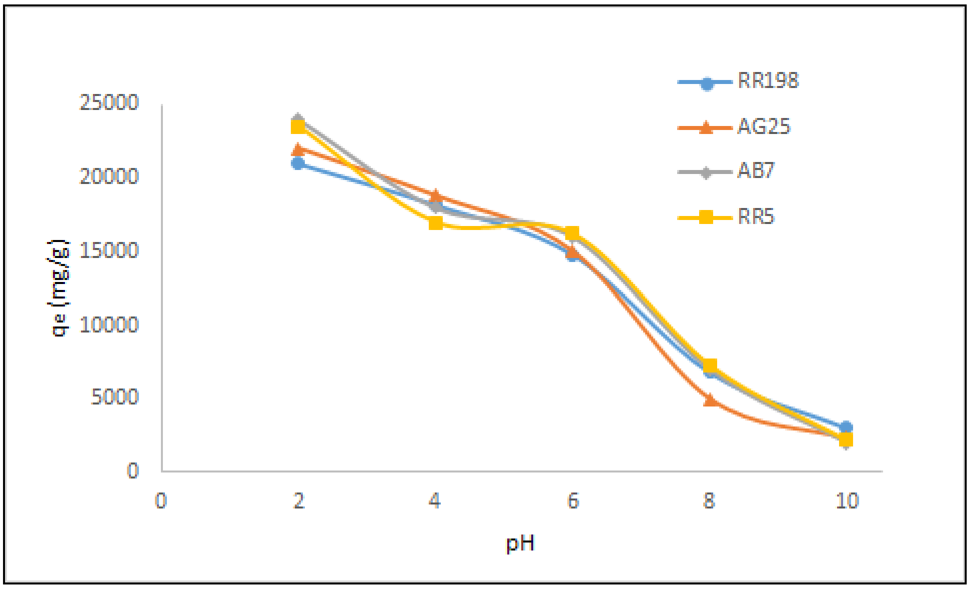

Figure 5. pH influence on the removal if dye by dendrimer. Conditions: C_0 = 50 mg/L, T = 60°C, C_{dendr} = 1.8 mg/L.

3.4. Temperature effect

Removal of textile dyes efficiency can be increased by increase the temperature of from aqueous solutions by dendrimer (PPI) poly (propylene imine) (Xiaoxu et al., 2010; Wang et al., 2009). Figure 4 demonstrated that the removal of dye is unwanted at low temperatures. It

has been showed that the removal of dyes has been was distinctly enhanced with the increased temperature from 30 to 60 °C; though, increasing the temperature to 70 °C has not been much fruitful. Therefore, based on the findings, 60 °C has been selected as most suitable temperature for dye removal.

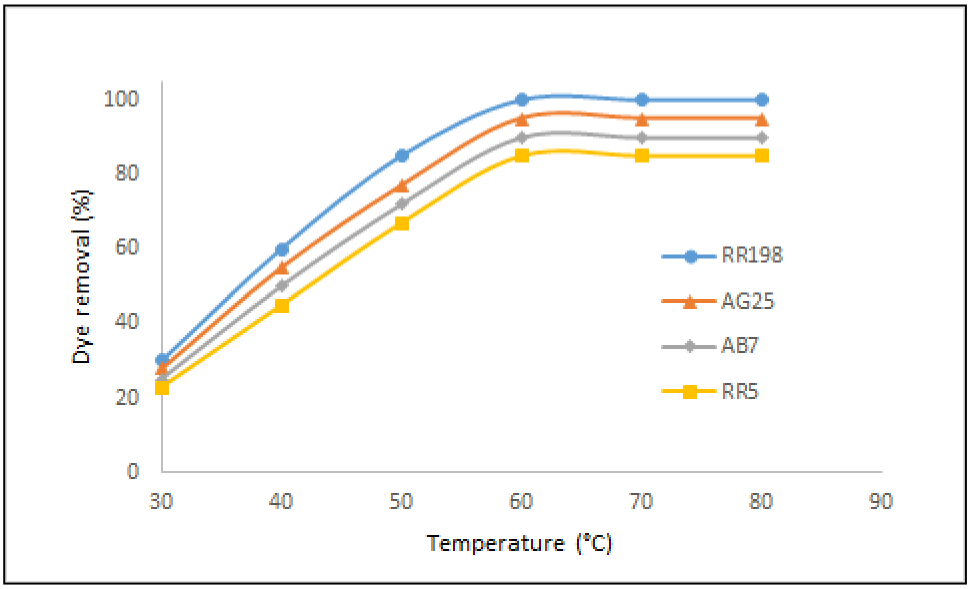

Figure 7. Time influence on removal of dyes by dendrimer. Conditions: C_0 = 50 mg/L, C_{dendr}= 1.8 mg/L.

3.5. Time effect

To the most suitable time for the removal of dye, the experiment was carried in the chosen conditions as follows: PPI concentration 1.7 mg/L for 200 mL of 50 mg/L dye solution, pH 2 at 50 °C. Figure 5 illustrates that values of removal have been increased with the increasing the time process from 6 to 16 h,. Though, no further variations have been noticed for times reaction higher than 16 h. Thus, depending on obtained the findings, optimum grafting time was 16 h.

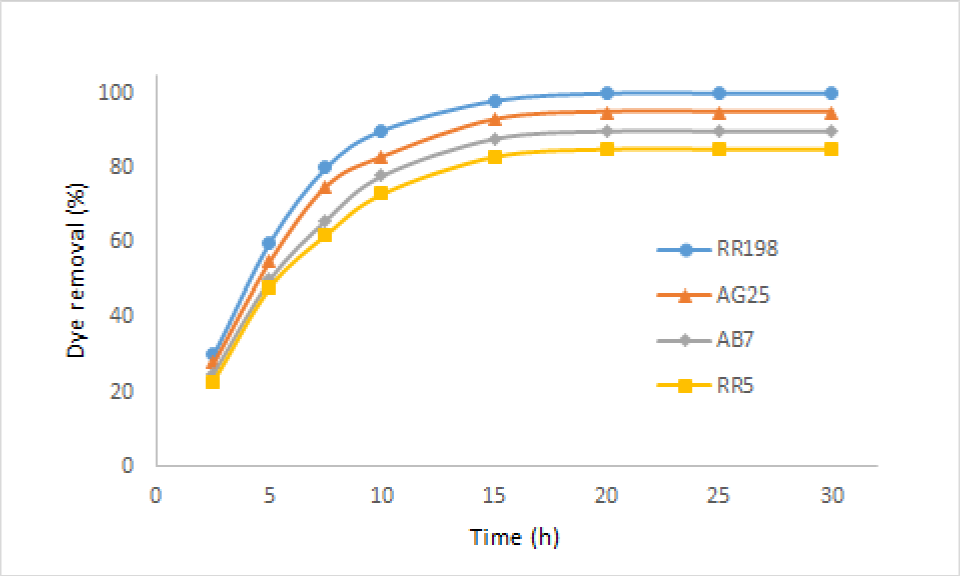

Figure 7. of time influence on the remove of dyes using dendrimer. Conditions: C_0 = 50 mg/L, T = 60 °C, C_{dendr} = 1.8 mg/L.

4. Conclusion

The findings of the study demonstrate that the dendrimer PPI (G2) owns a huge and critical adsorption ability regarding the of RR198, AB7,AG25, and RR5 removal through aqueous solutions. Operational parameters influence on the removal of dye like concentration of dye and dendrimer, pH, time and temperature were investigated. Based on the findings of the current research, researchers can state that the dendrimer is effective adsorbent has no harm to the environment regarding the remove of the dyes from coloured textile wastewater.

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