

Factor Affecting Textile Dye Removal Using Adsorbent From Activated Carbon: A Review

Mohd Adib Mohammad Razi^{1,*}, *Mimi Nur Attahirah* Mohd Hishammudin¹ and *Rafidah* Hamdan²

¹Faculty of Civil Engineering and Environmental, Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor

²Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor

Abstract. Industrial company such as textile, leather, cosmetics, paper and plastic generated wastewater containing large amount of dye colour. The removal of dye materials are importance as the presence of this kind of pollutant influence the quality of water and makes it aesthetically unpleasant. As their chemical structures are complicated, it is difficult to treat dyes with municipal waste treatment operations. Even a small quantity of dye does cause high visibility and undesirability. There have been various treatment technique reviewed for the removal of dye in wastewater. However, these treatment process has made it to another expensive treatment method. This review focus on the application of adsorbent in dye removal from textile wastewater as the most economical and effective method, adsorption has become the most preferred method to remove dye. The review provides literature information about different basis materials used to produce activated carbon like agricultural waste and industrial waste as well as the operational parameters factors in term of contact time, adsorbent dosage, pH solution and initial dye concentration that will affect the process in removing textile dye. This review approach the low cost and environmental friendly adsorbent for replacing conventional activated carbon.

1 Introduction

Textile industries processes are among the most industrial that release coloured wastewater containing dye that become major environmental concern. Without a proper treatment, the disposal of dye wastewater can cause harm for the aquatic species and environment. [1]. Therefore, wastewater from textile industry has to be treated before being discharged into the environment. The textile industry is classified into three main categories as in Table 1. Dye is a coloured substance that been used widely in textile industries which provide bright and lasting colour when binding with fabric or surface. Dye was estimated to be used for thousands year back and about 180,000 year ago, colorant is believed to be use earliest by Neanderthal [2]. Synthetic dyes gained huge popularity in textile and dyeing process because of their stability to light, temperature, detergent and variety in colour [3]. In fact, it

¹Corresponding author: adib@uthm.edu.my

has reached nearly 100,000 different types of dyes and annually produce over 7.0×10^5 tonnes per year worldwide [3-8].

Table 1. Fibre and fabric categories for textile industries.

Fibres	Fabric	Type of dye and chemical	Ref.
Cellulose	Cotton, rayon, linen, ramie, hemp and lyocell	Reactive dyes (remazol, procion MX and cibaxron F). direct dyes (congo red, direct yellow 50 and direct brown 116), naphthol dyes (fast yellow GC, fast scarlet R and fast blue B) and indigo dyes (indigo white, tyrisn purple and indigo carmine)	[9]
Protein	Wool, angora, mohair, cashmere and silk	Acid dyes (azo dyes, triarylmethane dyes and anthraquinone dyes) and lanaset dyes (Blue 5G and Bordeaux B)	
Synthetic	Polyester, nylon, spandex, acetate, acrylic, ingeo and polypropylene	Dispersed dyes (disperse yellow 218 and disperse navy 35), basic dyes (basic orange 37 and basic red 1) and direct dyes	

Loss of up to 40% dye during the dyeing process are the result of coloured wastewater that passed into the environment or treatment plants [10]. The coloured wastewater are unpleasant and heavily pollute the environment. Dyes present in industrial wastewater are carcinogenic, mutagenic, teratogenic and toxic [11]. In addition, most of dye leads to hazardous affects not only to animal and human health but also microorganisms [12-14]. Dye have complex aromatic molecular structures and stable towards heat and oxidizing agent [14,15]. Therefore, dyes removal is prime important issue for researchers. Recently, many different techniques such as biological treatment [16], nanofiltration, oxidation process, ion exchanges, ozonations, ultrafiltration, coagulation, etc. have been studied for the treatment of dyes from wastewater [12,17-19]. However, these processes are expensive and ineffective to treat huge range of wastewater unlike adsorption using activated carbon which is proven to be one of the most effective technique [20].

Adsorption process is among the famous process that been studied by researchers. Adsorption is effective in removing colour and soluble organic pollutants include organic dye, toxic chemical, phenol, pesticides and cyanides [18,21]. The most used adsorbent in removing colours and other pollutants include heavy metal from effluents is activated carbon. However, conventional activated carbon that been used today are expensive for a large scale of treatment [21-23]. Recently, the researchers has been focus on the development of low cost adsorbent for a full scale treatment [5,24,25]. Therefore, this review provide comprehensive information on the application of activated carbon for the treatment of dye and study the effect of adsorption factors towards dye removal.

2 Textile dye

Commercially, more than 100,000 dye are used and available in colour index today [19]. Dye are stable to light [26] and can be classified in several ways based on their structures, application method used or even by colour [27]. The common dyes applied in textile industries are classed as direct dye, acid dye, basic dye, mordant dye, azo dye, reactive dye, disperse dye, sulphur dye, vat dye [28]. Nowadays, the classification of dye in term of application used in dyeing process are often. In addition, dye can also be classified by their

solubility in water [29] or else by their particle charge during dissolution such as anionic dyes (reactive, direct and acid dye), cationic dye (basic dye) and also non-ionic dye (disperse dye) [30]. In addition, anionic and cationic dye including in water soluble dye while non-ionic dye is in the categories of water insoluble dye.

Reactive dye been design for cellulose fiber and contain high colour of organic substance [31]. This reactive dye have high solubility in water and the most permanent dye among others dye [32]. As for direct dye from azo group, these dye provide dull colour and is lightfast as compared to reactive dye. Some azo direct dye may contain benzidine-based dye that could result an exposure to allergies, irritation, cancer risk and treating aquatic life if they are directly release without any treatment. Back then, benzidine-based dye are used to colour textile, leather, wood, paper, plastic, fur and cosmetic industries [33]. As for worldwide textile industries, dye are discharged more than 1000 tones/year into waste stream [5,34]. Consequently, these textile wastewater containing benzidine-based dye may cause major damage to ecosystem including loss of soil productivity, disturbing the oxygen transfers in water interface and also interrupt photosynthesis activity.

3 Classification of adsorbent

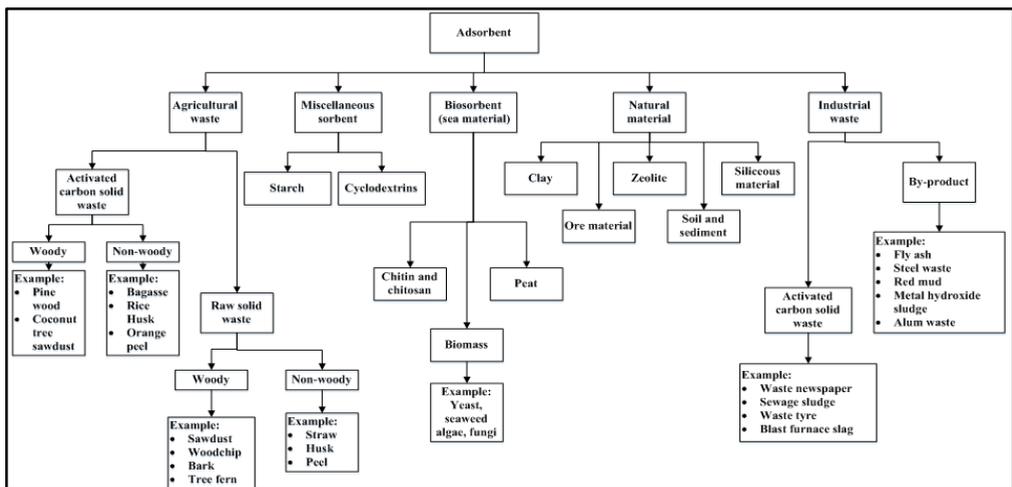


Fig. 1. Type of adsorbent materials used for wastewater treatment. [24,25]

Among several wastewater treatment process, adsorption have the potential in reducing water pollutants and dyes from textile industries. Adsorption is effective to be used in lowering dye concentration in the effluents [35-36]. Fig. 1 shown various type of adsorbent being studied in order to treat wastewater containing dye, pigments and other pollutants. Today, the most commonly adsorbent used for treatment is activated carbon [37] and applied for various water pollutant removal such as dye and heavy metal [35,38]. Activated carbon also known as solid sponge [39] is a carbon form by using either physical or chemical treatment [40]. Activated carbon have extended surface area, high capacity of adsorption, higher surface reactivity degree and also micro-pore structure which is suitable in eliminating dye from wastewater [41-43]. However, treating wastewater by using conventional activated carbon that is available in the market are expensive [1, 5, 31, 43-44] and its regeneration are even costly [26]. Therefore, various raw material have been

examined to produce activated carbon and each presents different properties as some previous research of adsorbent shown in Table 2.

Table 2. Previous research on adsorbent in removing dye from wastewater.

Adsorbent	Type of dye	Max Adsorption Capacity	Ref.
Date pits activated carbon	Methylene blue	244 mg/g	[20]
Date pits activated carbon	Remazol yellow	173 mg/g	[20]
Nickel doped zinc sulphide activated carbon	Congo red	285.714 mg/g	[45]
Palladium nanoparticles activated carbon	Congo red	126.58 mg/g	[45]
Myrtus communis activated carbon	Congo red	19.231 mg/g	[1]
Pomegranate activated carbon	Congo red	10 mg/g	[1]
Argemone Mexicana	Direct red 81	6.9 x 10 ⁻⁵ mol/g	[46]
Grape marc-based activated carbon	Reactive Black 5	333 mg/g	[47]
TiO ₂ /GMAC	Reactive Black 5	56 mg/g	[47]
Pomegranate peel activated carbon	Remazol Brilliant Blue R	370.86 mg/g	[32]
Bagasse fly ash	Malachite green	170.33 mg/g	[26]
Activated carbon commercial grade	Malachite green	8.27 mg/g	[26]
Activated carbon laboratory grade	Malachite green	42.18 mg/g	[26]
Phoenix dactylifera seeds	Congo red	61.72 mg/g	[14]
Sugarcane bagasse activated carbon	Methylene blue	198 mg/g	[48]
Spent tea leaves	Brilliant green, Porcion red	9.57 mg/g 4.8 mg/g	[49]
Jackfruit peels	Brilliant green, Porcion red	9.47 mg/g 6.12 mg/g	[49]
Rambutan peels	Brilliant green, Porcion red	9.64 mg/g 4.12 mg/g	[49]
Mangosteen peels	Brilliant green, Porcion red	9.27 mg/g 4.51 mg/g	[49]
Sugarcane bagasse activated carbon	Acid Blue 80	384.6 mg/g	[38]

3.1 Agricultural waste

Adsorbent produce from agricultural waste is cheap and can be divided onto two groups: i) activated carbon ii) solid waste which from raw agricultural waste and material waste from forest industries. Various studied by researchers has been conduct on raw and activated carbon agricultural waste [50] such as sugarcane bagasse [8,18,50-55], olive stone [56], date pits [20], langsat peel [34], apple waste [42], macadamia shell [57], rice husk [52], orange peel [58], prosopis juliflora plant [59], bamboo [60], corncob [41], coffee residue [61], pomegranate peel [1,32], coconut shell [11,62] etc. These agricultural waste have been investigated for various dye removal from aqueous solution such as basic dye [15,63-64], direct dye [11], benzidine-based dye [6], reactive dye [47,65] and others. Wan suraya et al. [44] have been studied the potential of sugarcane bagasse to be an alternative for conventional activated carbon. Sugarcane bagasse which is non-woody activated carbon are proven to be environmental friendly and low cost activated carbon and also efficient adsorption agent in removing dye and other pollutants from textile wastewater as compared to woody activated carbon [35,38,44,64]. Fig. 2 shown an example of structure surface for agricultural waste adsorbent. The use of agricultural waste in order to treat wastewater not only can solve environmental issue with inexpensive cost but also can reduce the

agricultural waste in landfill as the waste can be reused. Agricultural waste is one of famous material to be used as activated carbon, however only few research are mention in this review as this review focusing on factors affect adsorption process.

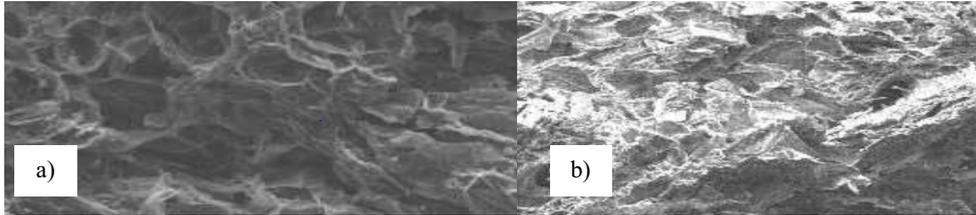


Fig. 2. Agricultural waste adsorbent SEM picture a) sugarcane bagasse activated carbon [38] b) raw sugarcane bagasse [38]

3.2 Industrial waste

Industrial waste also produce adsorbent that can be divided into two groups which are activated carbon solid waste and by-product. Sewage sludge is one of the adsorbent materials included in activated carbon solid waste categories. In addition, several sewage sludge based adsorbent has been used to remove pollutants [22,66-68]. These adsorbent can be produced using different activation process to adsorb metals and dye from wastewater [22]. Example of structure surface for industrial waste adsorbent can be shown as in Fig. 3. Research by Kacan and Kutahyali [67] analysed that the structure surface of sewage sludge prepared from chemical activation shortened the time of adsorption. As for industrial by product categories, fly ash and red mud is popular to be adsorbents materials [24,25]. Moreover, fly ash used in many countries even though it may contain some hazardous substance [25] because it is abundance and easily available material [36]. There are lot of researcher also interest to studies on industrial waste but not all are listed in this review.

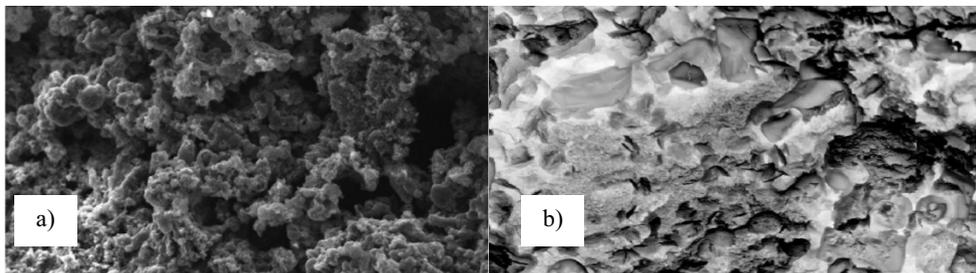


Fig. 3. Industrial waste adsorbent SEM picture a) sewage sludge activated carbon [67] b) used tyre activated carbon [68]

3.3 Biosorbent

Biosorbent or sea material based adsorbent also has been studied by several researcher as an alternative material to treat wastewater [69-72]. Chitosan, algae and seafood waste are include in biosorbent materials [24] and example of surface structure for biosorbent is shown in Fig. 4. In Copello et al. [23] research, chitosan and chitin was used to remove three type of dye which is reactive dye (Reactive Black 5), basic dye (Basic Red 5 and Basic Violet 3) and acid dye (Acid Red 51). Other research explored the used of biomass of

Trametes Virscicolor in eliminating direct dye which is benzidine based dye [70]. The result shown that heat-treat biomass adsorb more dye effectively as compared to native biomass for both direct blue 1 and direct red 128 dye. The maximum biosorption capacities of heat-treat biomass recorded is 152.3 mg/g direct blue 1 and 225.4mg/g for direct red 128. Das and Charumathi [71] mention that yeast have attractive futures as compared to fungi and bacteria with the ability to resist unfavourable environment and can rapidly growth. Miao et al. [72] research using alligator weed as activated carbon which produced a rough and high surface area, resulting high adsorption capacity. As same as agricultural waste and industrial waste, biosorbent also listed in researcher favourite subject but only few are mention in this review.

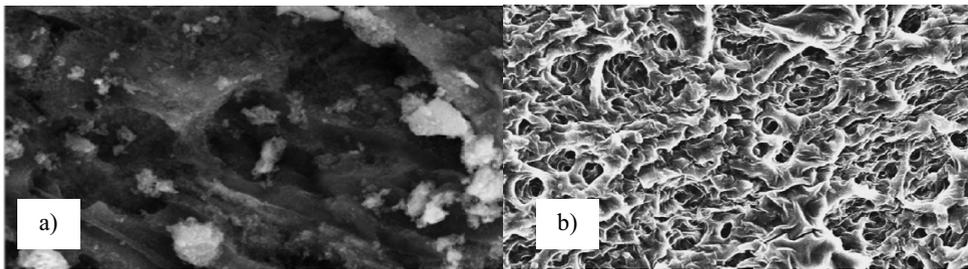


Fig. 4. Biosorbent SEM picture a) alligator weed activated carbon [71] b) fungus [70]

4 Factor affecting adsorption

Table 3 shows the operational parameter factors that affecting adsorption process conducted by other researchers. Dye adsorption can be affected by various factor like contact time, dosage of adsorbent, pH and initial dye concentration. These factors optimisation can be refer to be applied on full scale treatment process for eliminating dye. Thus, these parameters will be discussed in this review.

Table 3. Review on factors affecting adsorption studied by previous researchers.

Type of adsorbent	Type of removal	Operational parameter factors						Ref.
		pH	Contact time	Adsorbent concentration	Dosage	Initial dye concentration	Temperature	
Raw bagasse and modified bagasse	Basic dye (malachite green)			✓	✓			[73]
Treated sugarcane bagasse and powdered activated carbon	Acid dye (acid red 2)	✓			✓	✓		[8]
Modified immobilized activated alumina	Reactive dye (reactive yellow)		✓	✓	✓			[74]
Fly ash bagasse and commercial activated carbon	Basic dye (malachite green)	✓	✓		✓	✓		[26]

Table 3. Review on factors affecting adsorption studied by previous researchers. (*Cont...*)

Type of adsorbent	Type of removal	Operational parameter factors						Ref.
		pH	Contact time	Adsorbent concentration	Dosage	Initial dye concentration	Temperature	
Cloth activated carbon	Arsenic	✓	✓	✓		✓		[75]
Green vegetable waste activated carbon	Copper II	✓	✓		✓			[76]
Orange peel activated carbon	Direct dye (direct navy blue 106)	✓	✓		✓	✓		[58]
Alligator weed activated carbon	Cephalexin	✓	✓		✓	✓	✓	[72]
Coconut shell activated carbon	Reactive dye (reactive blue 19)	✓	✓			✓		[31]
Walnut activated carbon and poplar activated carbon	Acid dye (acid red 18)	✓	✓		✓			[77]
Cryogenic grinding used tyre activated carbon	Cationic dye (methylene blue)	✓	✓		✓	✓		[68]
Commercial activated carbon	Reactive dye (reactive black 5)	✓	✓			✓	✓	[78]
Loofa sponge activated carbon	Cationic dye (methylene blue)	✓			✓	✓		[79]
Olive stone activated carbon	Cationic dye (methylene blue)	✓	✓			✓		[80]
Ficus carica bast activated carbon	Cationic dye (methylene blue)	✓	✓		✓	✓		[14]
Lansium domesticum peel	Cationic dye (methylene blue)	✓	✓		✓	✓		[34]
Raw wheat straw, raw sawdust and sugarcane activated carbon	Fluoride	✓	✓		✓	✓		[55]

4.1 Effect of contact time

Generally, dye removal rate increase with an increase in contact time to a certain extent. Due to deposition of dyes on the available adsorption site on adsorbent material, any further increase in contact time will not increase the uptake [5]. At this point, the amount of dye desorbing from the adsorbent is in a state of dynamic equilibrium with the amount of dye being adsorbed onto the adsorbent. The time required to attain this state of equilibrium is termed the equilibrium time and the amount of dye adsorbed at the equilibrium time reflects the maximum adsorption capacity of the adsorbent under those operating conditions [34]. El-Sayed et al. [41] mention that contact time between adsorbent and adsorbate significantly affecting the performance of dye removal. As result in Fig. 5a, the removal was rapidly increase at the first 10 min but then slowly to obtain the equilibrium because of the strong attraction force between methylene blue dye and activated carbon. The time taken for corncob activated carbon with 400°C temperature of activation is 45 min, while for 500°C and 600°C longer time needed which is 120 min. The relation between direct blue 6 with contact time was studied in Khaled et al. [58] research. The time to reach equilibrium for orange peel activated carbon claim to be nearly 3h for maximum adsorption to be obtained as in Fig. 5b, with pH at 2 and dye concentration at range 50-150 mg/L. The slow process was mention probably due to the slow of pore diffusion of solution ion into adsorbent bulk [58]. Based on the literature information, the pattern of contact time effect for agricultural waste activated carbon are basically shown as in Fig. 5.

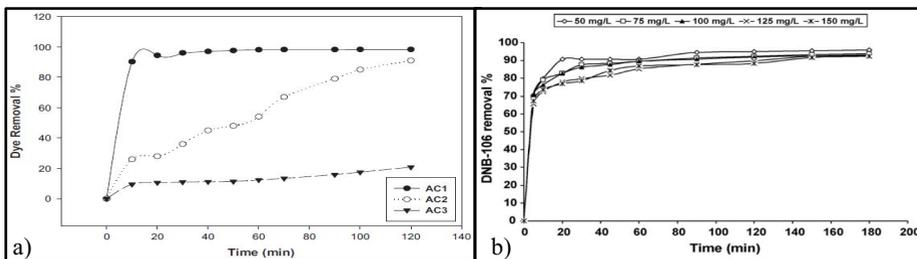


Fig. 5. Effect of contact time on dye removal using agricultural waste activated carbon from a) corncob [41] b) orange peel [58].

4.2 Effect of adsorbent dose

Dosage of adsorbent is one of important parameter in order to determine the adsorbent's capacity for a given amount of adsorbate at the operating conditions. In general, the increase in dye removal along with the increasing of adsorbent dose, where the amount of sorption site at the adsorbent surface will increase by increase of adsorbent dosage that will result on the increase of dye removal percentage [81]. In order to study the effect of adsorbent dose on the adsorption process, it can be carried out by preparing adsorbent-adsorbate solution with different amount of adsorbents added to fixed initial dye concentration then shaken together until reach the equilibrium time [82]. Sharma and Uma [83] carried out an experiment using different dose of adsorbent (0.40–0.60 g) in 50 ml of dye solution in order to find the effect on different rice husk activated carbon dosage to remove methylene blue. They reported that by increasing adsorbent dose from 0.40 to 0.60 g, the percentage of removal increased from 86.75 to 99.83%. Another researcher Heibati et al. [77] analysed the effect of adsorbent dose on the removal of acid red 18 (acid dye) by activated carbon from walnut (ACW) and poplar wood (ACP). The result shown as in Fig. 6a that the efficiency of dye removal increased as the adsorbent dosage increased up to 10 mg/g and after that remain almost constant for both activated carbon. In Amin N.K [18]

research on bagasse pith activated carbon to remove reactive dye, the same condition of result being detected. As in Fig. 6b, the percentage in removing reactive orange dye increased with the increase of adsorbent dose whereby the result may due to increment of dosage provides more surface area which lead to more binding site for adsorbent. Based on the literature review, analysing the effect of adsorbent dose showed the adsorption ability toward dye using minimum dosage of adsorbent. The rise in dosage provide more site for dye saturation during adsorption. Referring Fig. 6a and 6b, woody activated carbon optimum dose obtain at 1g of adsorbent while non-woody activated carbon claimed the optimum dose to be at 15g of adsorbent. The activated carbon from agricultural waste reviewed using minimum dose of adsorbent and have a great potential in remove dye.

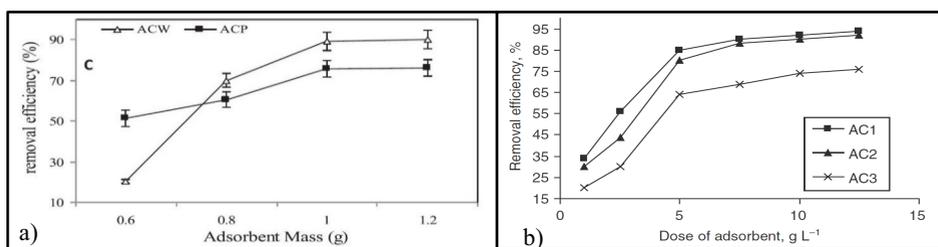


Fig. 6. Effect of adsorbent dose on dye removal using agricultural waste a) woody activated carbon [76] b) non-woody activated carbon [18]

4.3 Effect of pH

The pH factor is very important for dye adsorption in the adsorption process. A medium pH will control the electrostatic charges magnitude which are imparted by ionized dye molecules and resulting the adsorption rate vary with the pH of the medium used [68,84]. Generally, dye removal percentage for cationic dye will decrease at a low pH, while increment in dye removal percentage for ionic dyes adsorption. In contrast, cationic dye adsorption preferred for high solution of pH but as for anionic dye adsorption the efficiency will be lower [5]. As surface charge density decreases with an rising of pH, the electrostatic repulsion between the positively charged dye and adsorbent surface is lowered, which may result in an increment in the adsorption extent [4,85-86]. Yasin et al. [85] investigated that in condition of 28°C of temperature with 180 min contact time and 0.25 g / 25 ml dosage of adsorbent, the pattern as in Fig. 7a obtained for effect of pH on adsorption. The trends shown increment in methylene blue removal with the rising in pH, while they predict that at the low pH, the presence of H⁺ ions competing with cations in dye for adsorption sites resulting lower adsorption [85]. Ahmad et al [32] reported that the effect of pH on the adsorption of remazol de by pomegranate activated carbon with the adsorption for the azo dye was initial at pH 3.6 and the maximum dye removal was at 94.36%. In other research, N.K. Amin [18] studied the adsorption of reactive dyes on activated carbon from sugarcane bagasse which result obtained that the dye adsorption was maximum at initial pH of 1 and increment in pH decrease the percentage of dye removal as shown in Fig. 7b. Based on literature review, the increment of removal for cationic dye at high pH due to the decrement of positive charge at the solution interface which resulting the adsorbent surface to be negatively charged. As the increment of anionic dye adsorption at lower pH as result of adsorbent surface appear to be positively charged due to positive charge increment in solution interface. Fig. 7 shows the evidence where the percentage of dye removal for activated carbon was affected by pH variation. The strong force of interaction either H⁺ or OH⁻ ions between the activated carbon and the dye could influence the adsorption capacity [28].

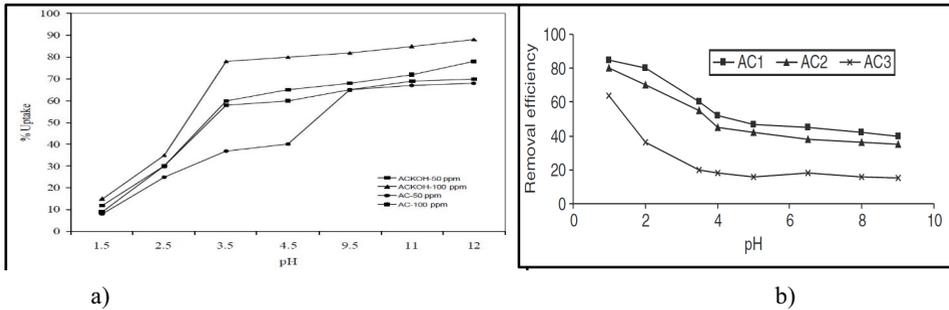


Fig. 7.Effect of solution pH on removal of a) cationic dye [85] b) anionic dye [18] using agricultural waste activated carbon

4.4 Effect of initial concentration

A given mass of sorbent material can only adsorb a fixed amount of dye, hence the initial dye concentration of an effluent is one of important factor to studied [5]. The effect of dye initial concentration can be conducted by shaken adsorbent-adsorbate solution until equilibrium using fixed the adsorbent dosage with different initial dye concentration for different time intervals [82]. The effect of increment in dye initial concentration will increase the adsorbent loading capacity [81]. Amin N.K. [18] analysed the effect of initial dye concentration on removing reactive orange dye where the percentages of removal was noticed to be decrease. In research on *Myrtus communis* and pomegranate activated carbon [1], the different pattern was obtained. At concentration of 30 mg/L congo red, the percentage of removal was significantly increase with increment of congo red initial concentration. They concluded that by lowering the initial dye molecules, the adsorbent surface area will be low as well, hence the adsorption is depends on the initial concentration of dye [1]. Hazzaa and Hussein [80] reported that the increment of initial concentration enhance higher adsorption of dye as the driving force of mass transfer become large. Fig. 8b shown the effect of initial concentration of dye in Hazzaa and Hussein [80] research where the rising of 50 to 150 mg/L initial concentration, the methylene blue adsorbed by olive stone activated carbon (OSAC) increased from 4.8 to 12.4 mg/g at pH of 5, 25°C of temperature with 30 min contact time and 10 g/L dosage of adsorbent. From the literature review, it is mention that the immediate relation between the available surfaces site on adsorbents and the concentration of dye affect the initial concentration factors [68]. As the initial concentration increase, the available site on adsorbent surface area become fewer which causing increment in dye being adsorbed. However, the removal dye percentage decreased [8] which been proved in Fig. 8.

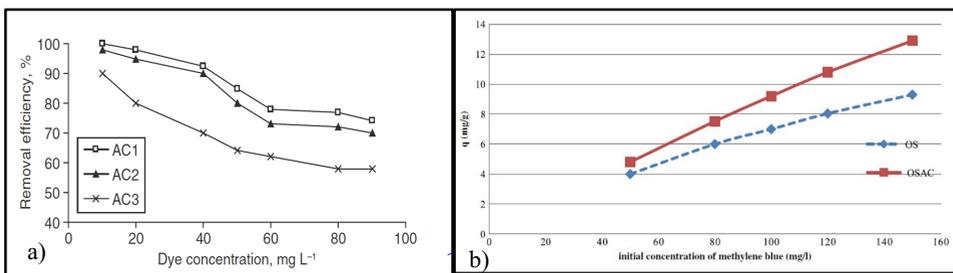


Fig. 8. Effect of initial concentration on removal of a) reactive dye [18] b) direct dye [80] by using agricultural activated carbon

5 Discussion

Literature information give evident that activated carbon is the most preferred adsorbent material to treat wastewater that containing dyes and pigments. In addition, activated carbon prepared from agricultural waste came to be promising in the case of sugarcane bagasse, pomegranate peel, coconut shell [31-32,44,87]. Several activation process also been studied to improve the efficiency in removing dyes and pollutants in wastewater [38,52,46,87-88]. However, most of the study referred in this review referring to lab-scale experiment. Based on literature information, only few study focus on comparing the adsorbent in removal of dye and pollutants [25]. These problems may depends on the performance of material used. These easily available agricultural waste may have a variable characteristic of each materials and each of the materials or adsorbent has its own feature in the treatment for wastewater that will influence the adsorbent properties parameter. As example sugarcane bagasse effective in removing acid dye [35], grape marc-based in removing reactive dye [47] and coconut shell offer effective removal of basic dye but a bit lower for direct dye [11]. Yet, the variables and condition in adsorption process also influence the effectiveness of treatment including dose of adsorbent, contact time, adsorbent concentration, pH value and temperature. To ensure the adsorbent effectively can be used for industrial scale, further investigation on development of adsorption process for real condition of wastewater need to be conducted as the industrial effluents containing several pollutants simultaneously. Additional information on kinetic study and modelling is needed on this topic. Based on literature review, many researchers had been study on adsorbent especially activated carbon. However they were focusing on the production of the activated carbon and those researches were not mentioned in this review. As for adsorption process study, environment condition is important as the effectiveness in removing dye depends to it. There a lot more factor that can affect the dye removal, however solution pH, contact time, initial concentration and adsorbent dose gave the major affect in percentage of dye remove from wastewater. Further research is necessary, especially concentrate on the characteristics of adsorbents including the average size of particles and activation time to standardize the activated carbon. Besides that, more investigation should be conducted on benzidine-based dye (direct black 38, direct brown 95 and direct blue 6) as these dye is harmful to human, animals and environment. In addition, interest studies should be focus in real wastewater as majority of previous studies used synthetic solution to predict the performance of adsorption process towards removal of dye.

6 Conclusion

A review of various type of activated carbon as adsorbent has been presented. The use of these activated carbon as adsorbent is recommended since they show a good potential in eliminating dyes from industrial wastewater, easily available, low cost and renewable. This paper presented the potential of adsorption process using activated carbon from agricultural waste to remove dye from textile wastewater. The factors effecting dye adsorption such as contact time, adsorbent dosage, pH and initial dye concentration has been discussed. Solution of pH turn to be the most important condition in adsorption process as for anionic dye, a low pH value are preferable in contrast for cationic dye where the suitable pH value is high. For the adsorbent dose, that the adsorption capacity increase along with the increment of adsorbent dosage due to the increase of available amount of sorption site. Is was also highlighted that the contact time between adsorbent and dye affecting the efficiency of dye removal where strong attraction force will shortened the time. As for the effect of dye initial concentration, increasing the initial concentration, enhance the

increment of adsorbent surface area to adsorb dyes. Extensive studies in literature show that industrial waste and biosorbent activated carbon are among the less selective compound in removing dye. Furthermore, agricultural waste activated carbon showed effectiveness in removing dye such as basic dye and direct dye yet often being test for other pollutant such as copper II, fluoride and phenol. However, the raw material of activated carbon to be used are depends on the local sources available at low cost. According to the literature reviewed, these adsorption method using agricultural waste activated carbon have potential to be applied at full-scale wastewater treatment. These low cost adsorbent can used to replace the expensive adsorbents in the market nowadays.

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