



## STUDY OF THE EFFECT MIXTURE MAHKOTA DEWA AND BENTONITE AS AN ADSORBENT FOR THE ABILITY ADSORPTION OF HEXAVALENT CHROMIUM WITH ELECTROPLATING FROM THE LIQUID WASTE

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**ABSTRACT** Hexavalent chromium is the main component in the electroplating industry wastewater. Many methods have been used to separate the chromium from the wastewater, such as ion exchange resins, chemical treatment, and biosorption. Biosorption is a process in which solid natural resources are used for adsorption heavy metals dissolved in the wastewater. This research has focused on the utilization of adsorbent from a mixture of Mahkota Dewa (*Phaleria macrocarpa*) and bentonite with mass ratio 2:1. As an Adsorbent of chromium in electroplating industry wastewater. The sample used was the electroplating industry wastewater and synthesis sample. The variable used in the research is the concentration of chromium before and after treatment, contact times, flow rate, and size of the adsorbent. Experimental results show that the amount of chromium adsorbed increases with increasing contact time. Rapid reduction of chromium concentrations occur at regular intervals up to 50 minutes, flow rate also influenced the decrease in chromium concentrations, the smaller flow rate the greater chromium can adsorb. Analysis of liquid waste using a spectrophotometer (Atomic Absorption Spectrophotometry or AAS). The high chromium removed occurs of contact time 50 minutes, flow rate 1.7 mL/s, and 2.3 mL/s, and high adsorbent packing 60 cm (H2) is 33.74 % with a maximum adsorption capacity. Adsorption isotherm model appropriate for this research is Langmuir Isotherm with a linear value of 0.932.

**KEYWORDS :** mahkota dewa, liquid waste, AAS

### INTRODUCTION

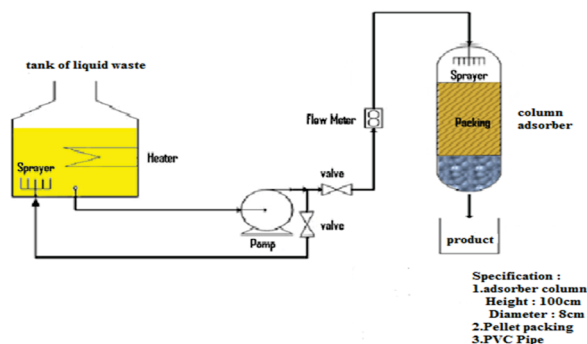
Mahkota Dewa is a plant that develops and bears fruit throughout the year. In its growth, the crown of this god can reach heights of 1-6 meters. The chemical composition of the sap consists of toluquinone, ethyl quinone, octanoic acid, 1-nonene, 1-undecene, 1-pentadecene, 1-heptadecene, 6-alkyl, 1-4 naphthoquinone. The active ingredient of the crown of god consists of alkaloids, tannins, flavonoids, phenols, saponins, lignans, essential oils, and sterols. Mahkota Dewa has anti-oxidant activity, toxicity, and anti-cancer due to the presence of lignans found in the extract of the flesh of the Mahkota Dewa. Tannin is a polyphenol compound and its chemical structure can be classified into two types, namely hydrolyzed tannins (hydrolyzable tannins) and condensed tannins (condensed tannins). Physical properties of tannin generally tannins have high molecular weight and tend to be easily oxidized to a polymer.

Rapid technological developments encourage industrial growth that has a large share of environmental pollution. Increasing the number of industries will always be followed by an increase in the amount of waste, both in the form of solid and gas-liquid waste. One of the hazardous industrial wastes is heavy metals [6]. Heavy metals are dangerous because they cannot be degraded by the body and have toxicity in living things even at low concentrations and can accumulate in certain periods [7]. One example of heavy metals is chrome (Cr), which includes metals that have a high toxicity. The toxicity of chrome metal depends on the valence of the ion. Cr (VI) ion is a form of chrome metal that is most studied by its toxic properties because of the toxicity of Cr (VI) ions which are very toxic, corrosive, and carcinogenic for living things [8]. Viewed from the magnitude of the threat of heavy metal pollution, especially chrome metal, many alternative methods have been developed to reduce the concentration of Cr (VI) ions, including those that have been carried out in various ways, namely chemical precipitation, membrane separation (reverse osmosis, electro dialysis, ultrafiltration), adsorption and ion exchange [9]. Most of the adsorbent currents used in the adsorption process are alumina, activated carbon, silica gel, and zeolite. The adsorbent has fairly good adsorption ability but is not economical. One of the biomaterials in the form of plants that can be used to absorb heavy metal waste is the fruit of the Mahkota Dewa (*Phaleria macrocarpa*). The god crown contains tannins, which play a role in facilitating the digestive system by absorbing pathogenic bacteria in the intestine. With this adsorption principle, the god's crown can be used as biosorbents to absorb heavy metals [10], about the effect of the Mahkota Dewa juice that the crown can work as an antioxidant and as a metal binder. Based on previous research the ability of biosorbents absorption has not been able to

significantly reduce the metal content of chrome in wastewater. Therefore in this study, we will study the possibility of god crown fruit mixed with bentonite as biosorbents for the absorption of chrome metal from electroplating industrial waste.

### MATERIAL AND METHOD

Various chemicals are sulfuric acid, chromium acid, Mahkota Dewa powder, and bentonite. The adsorption process uses solids derived from natural ingredients in the form of plants made as chrome heavy metal binders. The natural material used as an adsorbent is the Mahkota Dewa (*Phaleria macrocarpa*) which is mixed with bentonite. This study used adsorbent columns made of stainless steel with a diameter of 8 cm and a height of 100 cm. The adsorbent column is complete with a mixture of Mahkota Dewa powder and bentonite with a combination of volume 2 : 1. Then diluted with air, made or formed tablet with a diameter size of 1,5 cm, the tablet is called packaging. Then this packing is heated with the furnace to a temperature of 700°C. The packing height in the column is 40 and 60 cm. Variation in flow rate of chromium acid solution 1,70 mL/s and 2,30 mL/s. The contact time was varied for 10, 20, 30, 40, and 50 minutes.



**Fig. 1** Experimental scheme of research processing

### RESULT AND DISCUSSION

#### A. Effect of Adsorbed Chromium with Contact Time

The results of the final concentration of chromium (VI) in the solution after adsorption using a mixture of Mahkota Dewa and bentonite adsorbents at various variations in the size of the adsorbent and the number of adsorbents and flow rate, can be seen from the figures 2, 3 and 4. This image is a graph that shows the relationship between

percent chrome (VI) adsorbed to the contact time, at the initial concentration of chrome (VI) 24171,2 ppm, packing height in a column of 60 cm with variations in the size of the packing adsorbent 1,5 cm and variations in flow rate 1,70 mL/s and 2,30 mL/s. From the graphs in Figures 2, 3, and 4, it can also be seen that the process of absorption of chrome (VI) with a contact time of only 30 minutes can on average absorb above 20% of chrome (VI) metal. The chrome (VI) waste is initially dark yellow, the color is getting easier and finally clear as the contact time increases, this shows the concentration of chromium (VI) in liquid waste continues to decrease with increasing contact time, at 30 minutes the contact has begun turns bright green, this means that chrome (VI) ions have been reduced to chrome (III) ions because solutions containing chrome (III) ions are green, and at the time of contact 50 minutes the waste has started clear.

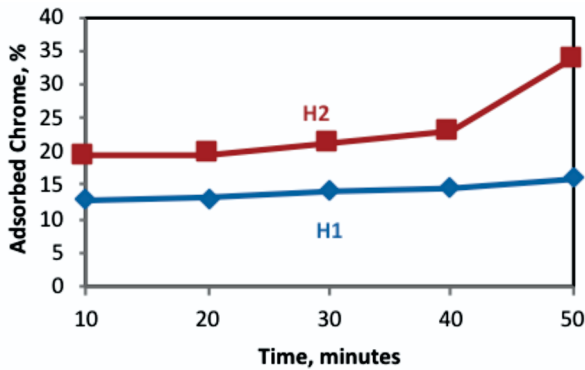


Fig. 2 (%) chrome adsorbed with contact time for a flow rate of 1,7 mL/sec

In Figure 2, the results showed at flowrate 1,7 mL/s at 30 minutes, High adsorbent 40 cm (H1) the percentage of absorption chromium is 14,30% and for high adsorbent 60 cm (H2) is 27,01%. Respectively, at 50 minutes, the percentage of absorption of chromium was 16,06% for High packing 40 cm and 33,73% for High packing 60 cm. High packing 60 cm can make much more a particle of adsorbent and the larger of the specific adsorbent surface area effected with the larger capacity of absorption. The maximum adsorbent capacity was determined of the longest contact time was 50 minutes. The smaller flow rate causes greater contact between the adsorbent and liquid waste. The increase of surface makes the smaller particle size. If the particle has pores will also increase the specific area. The specific surface area is necessary for the process of industrial and reaction of chemicals [11]. The change of surface activity and adsorption volume is based on the specific surface area even with similar material. That is why it is necessary to evaluate the activity and adsorption capacity of materials in measuring the specific surface area (e.g., catalysis and adsorbent) [12-13].

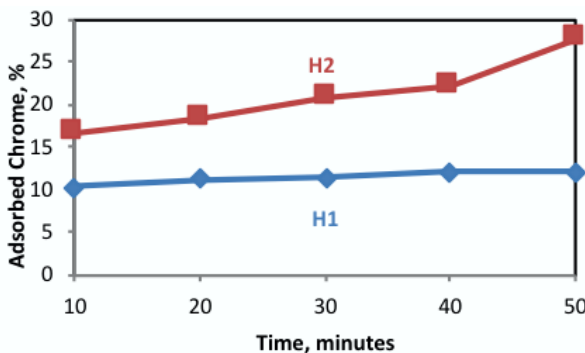


Fig. 3 Graph of the percentage (%) of chrome adsorbed with contact time for a flow rate of 2,3 mL/sec

In Figure 3, the results showed at flowrate 2,3 mL/s at 30 minutes, high packing 40 cm (H1) the percentage of absorption chromium is 11,39% and for high packing 60 cm (H2) is 20,79%. Respectively, at 50 minutes, the percentage of absorption of chromium was 12,11% for high packing 40 cm and 27,67% for high packing 60 cm. High packing 60 cm can make much more a particle of adsorbent so the large specific adsorbent surface area, the larger capacity of absorption. Maximum adsorbent capacity was determined of the longest contact time at 50

minutes, some factors could affect the process of adsorption. They are temperature, pH, contact time, and initial concentration of adsorbates [14].

The two flow rates that were tried it turned out that the rate of 1.70 mL/sec had the highest absorption capacity of chromium metal, this is because a low flow rate would increase the duration of contact between the adsorbate and the adsorbent in the adsorber column, and result in the availability of sufficient space in the pore adsorbent for the absorption process so that the absorption of chrome metal will also increase. The adsorbent packing height also affects the adsorption power, as shown in Figures 2 and 3, in the graph curve, the adsorbent packing height of 60 cm has more adsorption capacity than 40 cm of adsorbent packing, this is due to the amount of adsorbent used to absorb more waste so that absorption of chromium waste is greater. The effect of this two flowrates on two design parameters (overall number of gas-phase transfer units; NtOG and overall height of a gas-phase transfer unit, HtOG) was determined while the effect of both liquid solvent and gas mixture give flowrates on four of necessary process parameters (tower diameter, packing height, gas pressure drop, and overall mass-transfer coefficient) was also measured for the four packings [15].

**A. Effect of Concentration Chrome Metal (IV) VS Contact Time**

In figures 4 and 5 it can be seen from the graph curve, that the adsorption process reaches the equilibrium point in the contact time of 30 minutes to 50 minutes. The equilibrium point is reached when the reduction in the concentration of chrome metal ions reaches the maximum point so that the addition of contact time will not have a significant effect on reducing the concentration of chrome metal ions.

The ability of the adsorbent to absorb chrome metal is inseparable from the activeness of the chrome metal itself. Chromate (VI) ion,  $CrO_4^{2-}$  which is yellow, is stable when in an alkaline or neutral atmosphere, and is a strong oxidizer where this ion will experience a reduction (decrease in oxidation number) into chrome (III) ion with the addition of dilute sulfuric acid [16]. The movement of chrome (VI) ions in diffusion in the waste depend on the size of the diameter of the adsorbent pore channel. A very supportive factor to speed up the absorption process on the adsorbent is that the liquid waste enters the adsorbent pores. At the beginning of the process, the new waste liquid can move on the surface of the adsorbent, as time increases, the liquid waste will flow throughout the pore so that the entire surface of the adsorbent will be wetted. This situation will cause swelling of the adsorbent pores so that the contact surface area will be greater. Filling the pores of the adsorbent by liquid waste will also increase the rate of absorption of chrome (VI) elements. Because adsorption is a surface phenomenon with the accumulation of solids with liquids. Adsorption can occur because of an attractive electrostatic attraction or attractive attraction that is enlarged by hydrogen coordination bonds or Van der Waals bonds. Whereas the relationship between chromium (VI) ions which are absorbed with the concentration of adsorbate in solution in a state of equilibrium and temperature can still be expressed by adsorption isotherm.

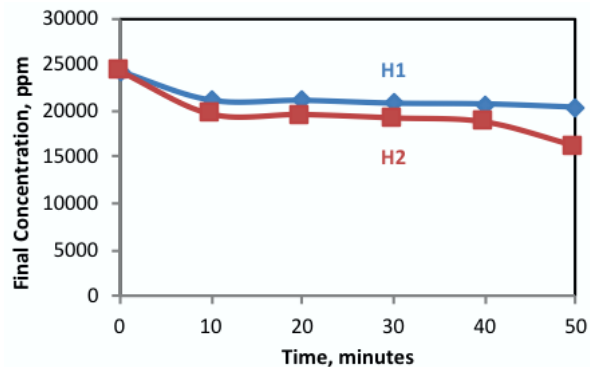
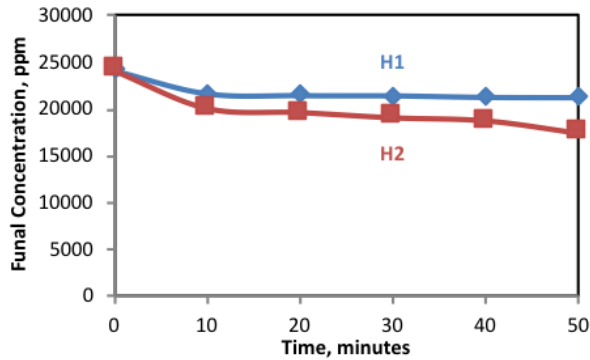


Fig. 4 Relationship between the final concentration of chrome and the time of contact at various high packing

In figures 4 it can be seen from the graph curve for diameter packing 1,5 cm for variation high packing 40 cm (H1) and 60 cm (H2) concentration chromium solution was 24171,2 ppm at 0 minutes, therefore, decrease under 21000 ppm at 30 minutes, that the adsorption process reaches the equilibrium point in the contact time of 30 minutes

to 50 minutes. The equilibrium point is reached when the reduction in the concentration of chrome metal ions reaches the maximum point so that the addition of contact time will not have a significant effect on reducing the concentration of chrome metal ions. The ability of the adsorbent to absorb chrome metal is inseparable from the activeness of the chrome metal itself. Chromate (VI) ion,  $CrO_4^{2-}$  which is yellow, is stable when in an alkaline or neutral atmosphere, and is a strong oxidizer where this ion will experience a reduction (decrease in oxidation number) into chrome (III) ion with the addition of dilute sulfuric acid.



**Fig. 5 Relationship between the final concentration of chrome and the time of contact at various high packing**

In figures 5 it can be seen from the graph curve for diameter packing 1,5 cm, for variation high packing 40 cm (H1) and 60 cm (H2) concentration chromium solution was 24171.2 ppm at 0 minutes, therefore, decrease under 20000 ppm at 30 minutes, that the adsorption process reaches the equilibrium point in the contact time of 30 minutes to 50 minutes. The movement of chrome (VI) ions in diffusion in the waste depend on the size of the diameter of the adsorbent pore channel. A very supportive factor to speed up the absorption process on the adsorbent is that the liquid waste enters the adsorbent pores. At the beginning of the process, the new waste liquid can move on the surface of the adsorbent, as time increases, the liquid waste will flow throughout the pore so that the entire surface of the adsorbent will be wetted. This situation will cause swelling of the adsorbent pores so that the contact surface area will be greater. Filling the pores of the adsorbent by liquid waste will also increase the rate of absorption of chrome (VI) elements. Because adsorption is a surface phenomenon with the accumulation of solids with liquids. Adsorption can occur because of an attractive electrostatic attraction or attractive attraction that is enlarged by hydrogen coordination bonds or Van der Waals bonds. Where the relationship between chromium (VI) ions which are absorbed with the concentration of adsorbate in solution in a state of equilibrium and temperature can still be expressed by adsorption isotherm.

The equilibrium point is reached when the reduction in the concentration of chrome metal ions reaches its maximum point so that the addition of contact time will not have a significant effect on reducing the concentration of chrome metal ions. The ability of the adsorbent to absorb chrome metal is inseparable from the activeness of the chrome metal itself. Chromate (VI) ion,  $CrO_4^{2-}$  which is yellow, is stable when in an alkaline or neutral atmosphere and is a strong oxidizer where this ion will experience reduction (decrease in oxidation number) into chromium (II) ions with the addition of dilute sulfuric acid. The movement of chrome (VI) ions by diffusion in the waste depends on the size of the diameter of the adsorbent pore channel. The new waste liquid can move on the surface of the adsorbent as time increases, the liquid waste will be wetted. The relationship between chromium (VI) ions which are absorbed with the concentration of adsorbate in solution at equilibrium and fixed temperature can be expressed by adsorption isotherm.

**Table 1. The wettest amount of packing**

Flow Rate Q (mL/sec)	High Packing adsorbent (cm)	Isotherm Langmuir		
		K	r <sup>2</sup>	θ
1,7	40	0,00032	0,9313	569
	60	0,00039	0,7223	
2,3	40	0,000215	0,9327	853
	60	0,00029	0,9327	

**CONCLUSION**

The absorption of chromium (VI) from synthetic liquid waste by adsorption process using a mixture of crown gods and bentonite adsorbents, turned out to be quite effective and efficient, this can be seen from the ability of adsorbent to absorb chrome (VI) metal up to 33.73%, at flow rate 1,7 mL/s, the packing height of the adsorbent in the column is 60 cm (H2). High packing 60 cm (H2) has a greater adsorption capacity because one of the factors that influence the adsorption process is the surface area of the adsorbent, the surface area of the adsorbent will increase the adsorption capacity namely adsorption process. The flow rate of 1,7 mL/s which has a large adsorption capacity of 33.73% with a contact time of 50 columns the greater the metal chrome (VI) that can be absorbed by the mixed adsorbent of the crown god with bentonite. The adsorption equilibrium condition was reached at the contact time of about 30 minutes, with a flow rate of 1,7 mL/s, the initial concentration of chrome (VI) was 24171.2 ppm, at a temperature of 40°C, and the packing height of the adsorbent in the 60 cm (H2) adsorbent column. The adsorption isotherm model which is suitable for the chrome (VI) adsorption process with a mixture of crown god and bentonite adsorbent is Langmuir Isotherm because its determination coefficient is r<sup>2</sup> = 0.9327 close to 1.

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