

**PREPARATION OF ACTIVATED CHARCOAL AND CHROMIUM  
REMOVAL USING ADSORPTION**

*A Project submitted to the  
National Institute of Technology, Rourkela*

*In partial fulfillment of the requirements  
of*

**BACHELOR OF TECHNOLOGY (CHEMICAL ENGINEERING)**

**BY**

**VINAY KUMAR**

**ROLL NO. 111CH0454**

**UNDER THE GUIDANCE**

**OF**

**PROF. ARVIND KUMAR**



**Department of Chemical Engineering  
National Institute of Technology  
Rourkela  
2015**



**DEPARTMENT OF CHEMICAL ENGINEERING  
NATIONAL INSTITUTE OF TECHNOLOGY,  
ROURKELA -769 008, INDIA**

**CERTIFICATE**

This is to certify that the thesis entitled **preparation of activated charcoal and chromium removal using adsorption**, submitted by **Vinay Kumar** to National Institute of Technology, Rourkela is a record of bonafide project work under my supervision and is worthy for the partial fulfillment of the degree of Bachelor of Technology (Chemical Engineering) of the Institute. The candidate has fulfilled all prescribed requirements and the thesis.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University / Institute for the award of any Degree or Diploma.

Date-  
Rourkela

Supervisor  
Prof. Arvind Kumar  
Department of Chemical Engineering  
National Institute of Technology  
Rourkela - 769008  
INDIA

## ACKNOWLEDGEMENT

I would like to make my deepest appreciation and gratitude to Prof. (Mr.) Arvind Kumar for his valuable guidance; constructive criticism and encouragement during every stage of this project. I thank Dr. H.M.Jena for acting as the project coordinator. I am grateful to Prof. P Rath, Head of the Department, and Chemical Engineering for providing me the necessary opportunities for the completion of my project. I also want to thank other staff members of my department for their invaluable assistance and guidance.

Date

VINAY KUMAR

Place

111CH0454

Dept. of Chemical Engineering,

National Institute of Technology, Rourkela

## **ABSTRACT**

High amount of heavy metal ions like chromium (Cr) in the environment has been harmful for animal and human health. If we talk about tannery industries it is quite easily contain chromium in the waste water. So removal of chromium (Cr) from tannery wastes is important need of an hour. Here we used adsorption method for removal and activated charcoal as an adsorbent. The concentration of Cr was determined by atomic absorption spectroscopy (AAS) through absorbance of the solution or sample.

Removal of Cr was found to be dependent on pH and maximum adsorption was observed at pH 2.0. Hence, in this study the efficiency of activated charcoal powder to removal Cr from chromium solution is investigated. The results of this study proved that activated charcoal powder can be used to remove chromium (Cr) from tannery effluent.

**Keywords-** activated charcoal, adsorption, chromium removal etc.

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## CHAPTER-1: INTRODUCTION

Industries like leather, textile etc. are having huge importance in the manufacturing of basic need. This is good but our prime concern is the waste water coming out of these tannery industries. Waste water contain chromium and water contamination by chromium is of impressive concern, as this metal has discovered across the board utilizes as a part of electroplating, calfskin assembling, metal completing, material commercial enterprises and chromate readiness. Among all these, tanning methodology is one of the biggest polluter of chromium on the planet. No less than 20 metals are delegated lethal and a large portion of these are display in the earth in adequate amounts that stance dangers to human wellbeing. Chromium and its mixes are harmful, which are being blended with regular water from a mixed bag of modern effluents. It is toxic to the point that it prompts liver harm, pneumonic, Congestion, edema and reasons skin disturbance and results in ulcer arrangement. The Concentration of Cr in industrial wastewater was found in the range of 0.5 mg/L to 270000 mg/L. The tolerance limit for the discharge of Cr (VI) into inland surface water is 0.1mg/L and in potable water it is 0.05 mg/L 5. Chromium exists in the earth in two oxidation states i.e. Cr (VI) and Cr (III). Cr (III) is a supplement species utilized for control of Glucose and lipid digestion system in films, while Cr (VI) is profoundly cancer-causing and mutagenic because of its high oxidative character. In the tanning process around 60% - 70% of chromium responds with the shrouds the staying around 30%-40% of the chromium sum stays in the strong and fluid squanders. The concentration of chromium particle in the tanning waste water fluctuates from 1300 to 2500 ppm.

An extensive variety of physical and compound techniques are accessible for the evacuation of substantial metals including chromium from water. Adsorption utilizing enacted carbon can expel Cr from wastewater. Henceforth, as of late there has been expanded enthusiasm for the subject of characteristic coagulants for treatment of water and wastewater. Our point was to research the capability of actuated carbon in expelling chromium from chromium arrangement. In numerous plants where overwhelming metals are being uprooted, one of the key issues in coming to the coveted emanating breaking points is the colloidal condition of hastened materials. They have not been appropriately killed; coagulated and flocculated .A last part of overwhelming metals is the conceivable arrangement of complex particles, which is regular when managing wastewaters containing smelling salts, fluoride, or cyanide particles alongside substantial metals.

Due to these imperative viewpoints in the precipitation of substantial metals, there is no real way to anticipate the best arrangement of a particular issue without experiencing a progression of seat tests to assess the option accessible (Kemmer, 1988). The present study is gone for choice of an ease actuated charcoal, which can adsorb chromium from the waste water. Bit by bit clump studies with the chose adsorbent, coconut shells (raw material) has been done in the present examination. The impact of pH and temperature, contact time, adsorbent fixation were additionally examined.



## CHAPTER-2: LITERATURE REVIEW

Genuine wastewater was acquired from a little tannery situated in Santa Croce sull'Arno, Italy, and quickly after receipt, it was investigated for its fundamental qualities. Introductory Cr (III) focus, can, come about 6100 mg per L, and starting pH 4.66. At that point, manufactured wastewater was arranged by including 23 g of chromium sulfate to 1 L of deionized water, acquiring the same beginning Cr (III) centralization of the genuine wastewater. As the beginning pH of the readied arrangement was 1.78, a preparatory titration test was performed to distinguish the pH quality relating to chromium precipitation; this was discovered to be give or take 6.00e6.02 (information not indicated). A part of the shrimp shells were gotten from a fishery situated in Trapani, Italy, that creates solidified red shrimp and the rest of got from a neighborhood showcase in Naples, Italy. The shells were finely ground to all the more precisely focus the sum utilized as a part of the treatment process and to build their particular surface. Every single other item utilized as a part of the study were high immaculateness degree. Chromium was measured utilizing a nuclear adsorption spectrometer (GBS Scientific Equipment, USA) amid tests on engineered wastewater, and utilizing an inductively coupled plasma nuclear discharge spectrometer (Agilent Technologies, USA) amid tests on genuine wastewater and amid tanning, in light of the fact that the examinations were completed in two unique research centers. In spite of the fact that information acquired for manufactured and genuine wastewater was not investigated relatively it was checked, on a standard chromium arrangement, that the consequences of the two instruments were tantamount.

In tanneries it was for the most part watched that waste alcohols from shaft house and townhouse discover some way or another into a typical channel. Blending of these two streams frames a composite tannery profluent. An aggregate of eighteen specimens were gathered from every tannery. Two specimens were acquired for every tannery, one example of chrome tanning profluent , and other specimen of composite example of the profluent of remaining methods. Blending of these two examples was then done relatively. Samples were gathered in polyethylene bottles. The jugs were initially cleaned with metal free nonionic cleanser and washed with faucet water. These were absorbed 1:1 HNO<sub>3</sub> + H<sub>2</sub>O answer for 24 h at 71 °C. After this, these were washed thrice with de-ionized water. The specimens were saved quickly in the wake of testing by acidifying with 5mL concentrated nitric corrosive (HNO<sub>3</sub>) included every

liter of test answer for a  $\text{pH} < 2$ . After fermentation the specimens were put away in an icebox at roughly  $4\text{ }^{\circ}\text{C}$ . Systematic evaluation chemicals were utilized all through the examination. Merck salts and norms utilized for evaluation were of high virtue (99.9% or above) having follow metal substance far underneath their identification limits. Watery standard arrangements of Cr (III) were arranged by dissolving a precisely measured measure of the pertinent salt in corrosive/deionized water in order to yield a metal particle centralization of  $1000\text{ mg l}^{-1}$ . Suitable aliquots were taken from these principles for resulting weakening to the coveted focus level. Every time crisp working gauges were arranged for alignment. The outcomes/fixations were recorded after legitimate alignment of the gear. Wastewater examples from chrome tanning methodology were at that point in the acidic medium as showed by  $\text{pH}$  in the scope of  $2.5\text{--}3.0$  and was investigated specifically after legitimate weakening with de-ionized water on nuclear ingestion spectrophotometer. In the second arrangement of investigation, wastewater examples from consolidated profluent were initially shaking completely and afterward processed with concentrated  $\text{HNO}_3$  as tper US-EPA strategies for compound examination of wastewater. The processed examples were dissected for Cr (III) by utilizing nuclear ingestion spectrophotometer (Unicom, Solar 929) at a wavelength of  $357.9\text{ nm}$  by utilizing air-acetylene fire. Explanatory alignment was fulfilled with watery norms in  $3\%$  (v/v)  $\text{HNO}_3$ . Crisp adjustments were set aside a few minutes prior to examination. The outcomes for Cr (III) fixation are accounted for regarding normal concentration  $\pm$  standard Deviation. For adsorption purposes, two overall composite samples were prepared from the above wastewater samples as follows: one by mixing equal portions of chrome tanning wastewater and the other by mixing thoroughly equal portions of combined wastewater and then divided into two equal portions. One filtered portion and the second unfiltered portion. Both of the samples (filtered and un-filtered) were then analyzed for Cr (III) concentration on AAS as indicated above.

Characterization of adsorbent- Commercial grade bentonite, grey in color, 30 mesh size, mwas used as an adsorbent. It was first dried, and then washed with distilled water several times to remove any dust and other Water-soluble impurities. The washed sample was dried in an electric oven at  $150\text{--}200\text{ }^{\circ}\text{C}$  for several hours before use in the adsorption studies. Major elements were determined by high Frequency bead sampler (OYO Danki Co-Japan) X-ray fluorescence spectrometer. The surface area of the bentonite sample was measured using a BET Quantasorb Sorption System, Model No. QS-11. Bulk density and Tap density of the bentonite were

measured according to the ASTM standard methods no. B329-70 and No. B527-70, respectively and True density of the bentonite was determined using a Quantasorb (Quantachrome Corporation, New York). The measurement of the cation exchange capacity of bentonite is made by saturating the clay with  $Ba^{2+}$  and determination of the amount held at pH 7. For surface charge determination, method adopted by Appel and Lena was used. Concentration of  $Na^{+}$  was determined by AAS and  $Cl^{-}$  by ion analyzer (Model No. Thermo Orion EA-940) from 0.01M NaCl solutions. PZNC value for bentonite was obtained at the point of intersection of the plot of  $Na^{+}$  and  $Cl^{-}$  as a function of pH.

#### Effect of adsorbent dosage, pH and shaking time

To study the effect of adsorbent dosage, pH and shaking time, wastewater sample (CTB-19) was diluted with de-ionized water to bring the concentration of Cr (III) to 100 mg l<sup>-1</sup>. The Volume and shaking time were fixed at 100 ml and 15 min, respectively while the amount of the bentonite was varied from 0.05 to 2.0 g. Adsorption measurements were made in triplicate By batch technique at room temperature ( $25 \pm 2$  °C). A water bath having shaker model Yamato, BT-47 was used for shaking the adsorption batches at a shaking speed of 120 strokes min<sup>-1</sup>. The concentrations of solutions before and after adsorption were measured by using flame atomic absorption spectrophotometer Unicam model Solar-929. The calibration work standard of atomic absorption spectrophotometer were prepared by diluting stock solution of 1000 mg l<sup>-1</sup> Cr (III). Fresh calibration was made before the analysis of each batch of samples for Cr (III) Determination. The influence of pH in the range of 1.6–5.6 was studied by Keeping the Cr (III) concentration, volume, shaking time and amount of bentonite as 100 mg l<sup>-1</sup>, 100 ml, 15 min and 1.0 g, respectively. The pH of the solution had been adjusted by using Buffers of many different compositions. Concentration of Cr (III) was measured by AAS after adding buffers of different pH in order to check the possibility of precipitation of Cr (III) in The solution, it was found that the concentration of chromium remains same after addition of buffers, indicating no precipitation. pH of the solution was measured with Orbeco–Hellige pH meter. For pH determination of the solutions, the pH meter was calibrated every time with buffers of pH 4.0 and 10.0. Effect of equilibration time on the removal of Cr (III) was Carried out in the range of 5–60 min. The concentration of Cr (III) was kept as 100 mg l<sup>-1</sup> while the amount of bentonite added was 1.0 g and pH of both the treated and untreated samples was 2.4–2.5. The percent adsorption was estimated.

### Sample Digestion

25 ml of the sample was digested by mixing with 5 ml mixture of (1:1) conc. H<sub>2</sub>SO<sub>4</sub> and conc. HNO<sub>3</sub>. The solution was boiled on a hot plate at 120°C until dense white fumes of SO<sub>3</sub> just appeared. Aliquots of 5 ml conc. HNO<sub>3</sub> were added and the heating was continued until the solution is clear and no brown fume is observed. 15 ml of 0.5% v/v HNO<sub>3</sub> was added and the solution was boiled to dissolve the soluble salts. Potassium permanganate's 5 drop was added for complete oxidation of Cr (III) to Cr (IV). The excess of KMnO<sub>4</sub> was reduced by adding sodium azide, 1 ml. After cooling, the solution was transferred into a 50 ml flask and the volume was made up with 0.5% v/v HNO<sub>3</sub> (Ibrahim, 2008).

### Chromium Removal

Different masses 1.0 g, 1.5 g, 2.0 g and 2.5 g of powdered *Moringa Stenopetala* was dissolved to 100 ml effluent wastes and the mixtures were stirred for around 1 h. The mixtures were settled down by gravity through filter paper and the chromium concentrations of the filtrates were determined using Flame atomic absorption spectrometry (FAAS). Effect of pH on Chromium Removal

Effluent samples having pH 2.5, 4.5, 5.5, 6.5 and 9.5 had been prepared by adjusting the pH of 100 ml tannery waste solution using 0.1 M NaOH and 0.1M HCL. Now the resulting solutions were going to treated with 1 g powdered *Moringa stenopetala seed* powder and stirred for near 1 hr. After 1 hr, the mixtures were filtered through Whatman filter paper and the chromium concentrations of the filtrate were quantified using FAAS.

Now we observed the Effect of Contact Time on Chromium Removal using adsorption.

100 ml of tannery waste solutions and *Moringa Stenopetala* seed powder having mass 1g was mixed and stirred at 60 minutes, 90 minutes, 120 minutes, 150 minutes and 180 min intervals. The mixture was filtered due to gravity through Whatman No.1 filter paper and the concentrations of the filtrates were determined using FAAS.

100 ml tannery waste water was treated with *Moringa Stenopetala's* seed powder having 1.0 g mass seed powder at various temperatures from 20 °C to 80 °C. The *Moringa Stenopetala* suspension had been immersed in a constant temperature water bath with shaking for near 1 hr. After 1 hr the mixtures were filtered through Whatman filter paper and the chromium concentrations of the filtrate were quantified using FAAS.

### CHAPTER-3: MATERIALS AND METHODS

**CHARCOAL** - Charcoal is a light black residue consists of carbon and any remaining ash obtained by removing water and other volatile constituent from animals and vegetation substances. It is normally created by warming of wood or other substance without oxygen. It is normally a sullied type of carbon. Initiated carbon can be delivered from distinctive crude carbon assets like lignite, peat, coal, and biomass assets, for example, wood, sawdust, bagasse, and coconut shells. Enacted carbon, additionally called initiated charcoal, actuated coal, or an "air conditioner channel", is a manifestation of carbon prepared to have low volume pores that build the surface territory accessible for adsorption or substance responses. Enacted is in some cases substituted with dynamic. Because of its high level of micro porosity, only one gram of enacted carbon has a surface zone in overabundance of  $500 \text{ m}^2$ , as dictated by gas adsorption. An actuation level adequate for helpful application may be accomplished singularly from high surface zone; be that as it may, further concoction treatment regularly upgrades adsorption properties. Enacted carbon is typically gotten from charcoal and, progressively, high-porosity bio char. Enacted carbon is created in most created in large rage. It is one of the strongest adsorbents known and has surface territories that can achieve  $1500 \text{ m}^2/\text{g}$ . The exceptionally permeable carbon is created financially in the created world through a conventional steam initiation process. Unfortunately, such a fantastic enacted carbon obliges pyrolysis temperatures of more or less  $800$  to  $1000^\circ\text{C}$ . This temperature reach is infeasible utilizing the innovations promptly accessible as a part of the creating scene on a little scale. On the other hand, enacted carbon can be created through synthetic enactment of charcoal. The source and nature of the carbon may assume a part in the quality and consistency of initiated carbon created, yet to lessen biological effect, nearby farming waste repercussions can be utilized as a substitution as a part of the actuated carbon creation process.

## ACTIVATED CHARCOAL PREPARATION

Charcoal can be created anywhere on the planet. Wood is the material frequently used to create charcoal; one of numerous reasons for the quick rate of worldwide deforestation.<sup>17</sup> Instead of trees, numerous agrarian waste repercussions are utilized to supplant wood as the carbon source. Enacted carbon can be produced from numerous sources, for example, macadamia nutshells, cherry stones and palm husks. The source and also nature of the carbon may assume a part in the quality and consistency of enacted carbon delivered, yet to lessen natural effect, nearby horticultural waste results can be utilized as a substitution as a part of the initiated carbon generation process.

Clean, fiber-free, and soil-free coconut shells were milled to reduce the size down to mesh 8 (2.4 mm diameter). Phosphoric acid solutions were prepared to the required impregnation ratios of 1.0, 1.5 and 2.0, defined as the ratio of dry weight of  $H_3PO_4$  to the weight of the coconut shell based on a study by Molina-Sabio et al. (1995). Ten grams of the coconut shells were utilized every specimen. Dousing time was altered at 12 h. Since most literary works reported that ideal actuation temperature for most biomass materials by and large falls somewhere around 400 and 500 degree C (Srinivasakannan and Zailani Abu Bakar, 2004), temperatures of 400, 450, 500°C were assessed for this study. Actuation times of 10, 20, and 30 min were likewise surveyed. These circumstances were in light of a starting exploratory run at 400°C, where in smoke development stopped after around seven min. It was assumed that right now, dampness and the vast majority of the volatiles were disposed of from the antecedent. Therefore, the base time assessed was situated at 10 min. Wash it then took after to evacuate hints of corrosive in the enacted carbon. The enacted specimens were over and over washed with around 100 ml of refined water. The causticity of the wash alcohol was observed until the pH perusing is at 6–7. On the normal, 7–8 washings had the capacity kill the example. The enacted carbon was of course washed with 0.1 M sodium hydroxide arrangement lastly with refined water. The washed actuated carbon tests were then put in an electric stove with temperature set at 105°C for drying.

## CHROMIUM

Chromium is a chemical element with symbol **Cr** having atomic number 24. It is the first element in Group 6. The characteristics are gray in color, lustrous, hard and brittle metal which takes a highly shining, resists tarnishing, and has a high melting point. Chromium is an individual from the move metals, in gathering 6. Chromium (0) has an electronic design of  $4s^1 3d^5$ , inferable from the lower vitality of the high turn setup. Chromium displays an extensive variety of conceivable oxidation states, where the +3 state is most steady vivaciously; the +3 and +6 states are most generally seen in chromium mixes, though the +1, +4 and +5 states are uncommon. Chromium (VI) mixes are intense oxidants at low or impartial pH. Most imperative are chromate anion ( $\text{CrO}_2^{4-}$ ) and dichromate ( $\text{Cr}_2\text{O}_7^{2-}$ ) anions, which exist in harmony. Chromium (VI) mixes in arrangement can be identified by including an acidic hydrogen peroxide arrangement. Chromium is viewed as unimportant for plant however a key follow component for creatures. Hexavalent compound have been demonstrated to be cancer-causing by inward breath and are harmful to tissue. The chromium rules for regular water are connected to the hardness or alkalinity of the water.

## ADSORPTION

Adsorption is a process that occurs when a gas or fluid solute gathers on the surface of a strong or a fluid (adsorbent), shaping an atomic or nuclear film (the adsorbate). It is unique in relation to assimilation, in which a substance diffuses into a fluid or strong to frame an answer. The term sorption includes both procedures, while desorption is the opposite procedure. Adsorption is agent in most common physical, organic, and synthetic frameworks, and is broadly utilized as a part of modern applications, for example, enacted charcoal, manufactured gums and water cleaning. Like surface pressure, adsorption is a result of surface vitality. In a mass material, all the holding necessities (ionic, covalent or metallic) of the constituent molecules of the material are filled. Anyway, molecules on the (clean) surface experience a bond lack, on the grounds that they are not entirely encompassed by different iotas. Therefore it is vigorously great for them to bond with whatever happens to be accessible. The careful way of the holding relies on upon the points of interest of the species included, yet the adsorbed material is for the most part delegated

showing physisorption or chemisorption process. Physisorption can also called physical adsorption is a kind of adsorption in which the adsorbate holds fast to the surface just through Van der Waals (frail intermolecular) collaborations, which are additionally in charge of the non-perfect conduct of genuine gasses. Chemisorption is a sort of adsorption whereby an atom sticks to a surface through the development of a compound bond, instead of the Van der Waals strengths which cause physisorption. Adsorption is normally depicted through isotherms, that is, capacities which unite the measure of adsorbate on the adsorbent, with its weight (if gas) or fixation (if fluid). One can discover in writing a few models portraying methodology of adsorption, to be specific, Langmuir, BET and Freundlich isotherm.

### **ATOMIC ABSORPTION SPECTROSCOPY (AAS)**

It is a spectro analytical system for the quantitative determination of compound components utilizing the ingestion of optical radiation (light) by free particles in the vaporous state. In explanatory science the method is utilized for deciding the amassing of a specific component (the analyte) in an example to be examined. AAS can be utilized to focus more than 70 unique components in arrangement or straightforwardly in strong examples utilized as a part of biophysics, pharmacology, and toxicology research. The strategy makes utilization of assimilation spectrometry to evaluate the convergence of an analyte in a specimen. It obliges models with known analyte substance to make the connection between the deliberate absorbance and the analyte focus and depends in this manner on the Beer-Lambert Law.

To put it plainly, the electrons of the particles in the atomizer can be elevated to higher orbitals (energized state) for a brief time of time (nanoseconds) by engrossing a characterized amount of vitality (radiation of a given wavelength). This measure of vitality, i.e., wavelength, is particular to a specific electron move in a specific component. As a rule, every wavelength relates to stand out component, and the width of an assimilation line is just of the request of a couple of picometers (pm), which gives the method its natural selectivity. The radiation flux without a specimen and with an example in the atomizer is measured utilizing an indicator, and the proportion between the two values (the absorbance) is changed over to analyt бье focus or mass utilizing the Beer-Lambert Law



## CHAPTER-4: EXPERIMENTAL WORK

1. Washed the sample (carbonized coconut shell) with water.
2. Dried it under sun for one day and then burnt it at 650 degree centigrade for 2 hours. It got completely carbonized.
3. Then crushed the sample which brought it down into small particles and separated into different mesh size, basically we wanted very fine particle.
4. Now, charcoal sample (30g) soaked into zinc chloride (40 ml) which is dehydrating agent for 8 hours to convert into activated charcoal or carbon. For this we prepared 0.1 M solution of zinc chloride by dissolving 3.4 gram zinc chloride into 250 ml water.
5. Activated carbon was now been treated with HCL (0.1M) and NaOH (0.1M). For 0.1M HCL, we added 1.53 ml of HCL into 500 ml of water and for 0.1 M NaOH, we dissolved 1 gram NaOH in 250 ml of water. This gave the removal of acidic and basic volatile component present in the sample.
6. The moist activated carbon we got, now kept it in the furnace at 700 degree centigrade a very high temperature to increase the porosity of activated carbon.
7. After taking out from the furnace we again washed it with distilled water and dried in the furnace at 110 degree centigrade for 2 hours.
- 8 Activated charcoal is now ready to use.

## PREPARATION OF STANDARD CHROMIUM SOLUTION

We prepared 1000 PPM standard chromium solution for that we needed chromium salt. So we took potassium dichromate as a salt.

Molecular wt. of chromium = 51.996

Molecular wt. of potassium dichromate = 294.185

The molecular formula of potassium dichromate is  $K_2 Cr_2 O_7$

So 103.992 Cr is present in 294.185 salt

1 Cr is present in  $294.185/103.992 = 2.828$

For 1000 PPM it came out to be 2828.91 mg/L

i.e. 2.828 g/L

So finally we have to dissolve 2.828 g in 1 L water to get 1000 PPM solution.

But here we didn't have 1L flask therefore we added or dissolved 1.414 g chromium in 500 ml water to get 1000 PPM solution.

After preparing standard solution, we had taken 10 samples from the standard solution.

We knew that  $C_1V_1 = C_2V_2$  and  $V_2$  is fixed 50 ml flask volume.

For 10 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 0.5 \text{ ml}$$

For 20 PPM sample we got -  $1000 \times V_1 = 20 \times 50$

$$V_1 = 1 \text{ ml}$$

For 30 PPM sample we got -  $1000 \times V_1 = 30 \times 50$

$$V_1 = 1.5 \text{ ml}$$

For 40 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 2 \text{ ml}$$

For 50 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 2.5 \text{ ml}$$

For 60 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 3 \text{ ml}$$

For 70 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 3.5 \text{ ml}$$

For 80 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 4 \text{ ml}$$

For 90 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 4.5 \text{ ml}$$

For 100 PPM sample we got -  $1000 \times V_1 = 10 \times 50$

$$V_1 = 5 \text{ ml}$$

After preparing the 10 samples, we went for atomic absorption spectroscopy (AAS). We got the absorbance of each sample which has mentioned latter on in the table. Now we added 1 gram activated charcoal to each sample and left for 2 hours. Adsorption of chromium had taken place and again we had gone for AAS to get absorbance.

## CHAPTER-5: RESULT AND DISCUSSION

The experiment gave the knowledge about various things and various factors played their significant role in it. The experiment stated the chromium removal and for that we had drawn a calibration curve (figure 1) between Absorbance on y axis and concentration on x axis through the table 1 as given below. To make Calibration curve, we needed the absorbance of the chromium solution which we got from AAS.

For calculating % of chromium removal we have,

$$(C_0 - C_1)/C_0 \times 100$$

Initial concentration (before adsorption) =  $C_0$

Final concentration (after adsorption) =  $C_1$

So the average efficiency or % chromium removal = 54.001 % (from table 4)

The factors analyzes are-

1. Effect of time
2. Effect of dose/ adsorbent
3. Effect of PH

**Table 1. CALIBRATION PLOT READINGS**

S No.	concentration of samples(PPM)	Absorbance	PH value
1	10	0.209	6.013
2	20	1.005	5.449
3	30	1.993	5.091
4	40	2.872	4.531
5	50	3.926	4.101
6	60	5.003	3.478
7	70	6.010	2.951
8	80	7.321	2.491
9	90	8.568	2.013
10	100	9.976	1.502

Table 1 Represent the data of initial concentration of 10 samples and their absorbance and PH values. This data is really very important to plot the calibration curve. In the table it is quite clear that as the concentration increases the absorbance increases and its PH vale decreases.

**Table 2.** CONCENTRATION (AFTER ADSORPTION)

S No.	concentration of samples(PPM)	Absorbance After adsorption	corresponding conc. After adsorption
1	10	0.112	4.794
2	20	0.243	9.948
3	30	0.489	13.547
4	40	0.825	19.618
5	50	1.253	23.952
6	60	1.713	28.869
7	70	2.125	32.216
8	80	2.192	32.878
9	90	2.473	35.952
10	100	3.201	43.351

Table 2 Represent the concentration and absorbance of 10 samples after adsorption. After adsorption the concentration of the samples decreases.

**Table 3. TIME AND CHROMIUM REMOVAL READINGS**

sl.no	time in (min)	Absorbance	Concentration Of Cr (PPM)	Chromium removal In (PPM)
0	0	0	90	0
1	20	5.832	72.51	17.49
2	40	4.791	58.27	14.24
3	60	3.682	47.38	10.89
4	80	2.892	40.31	7.07
5	100	2.625	37.02	3.29
6	120	2.473	35.41	1.61
7	140	2.415	34.23	1.18
8	150	2.401	34.01	1.13

Table 3 Represent the absorbance and concentration of 10 samples at different interval of time.

**Table 4. EFFICIENCY**

S No.	Initial concentration of samples (PPM)	Concentration or After adsorption	% chromium removal efficiency (%)
1	10	4.794	52.06
2	20	9.943	50.28
3	30	13.547	54.84
4	40	19.618	50.09
5	50	23.952	52.08
6	60	28.869	51.18
7	70	32.216	53.97
8	80	32.878	58.81
9	90	35.952	60.05
10	100	43.351	56.64

Table 4 represent the efficiency for 10 different samples and its average value is 54.001 %.



**Table 5. CONCENTRATION FOR 2g (GRAM) ADSORBENT**

Sl.no	initial conc. (PPM)	Absorbance	Concentration (After adsorption)	Efficiency (%)
1	50	0.660	16.375	67.25
2	60	0.832	18.354	69.41
3	70	0.956	19.184	72.03
4	80	0.993	19.362	75.80
5	90	1.152	21.249	76.39

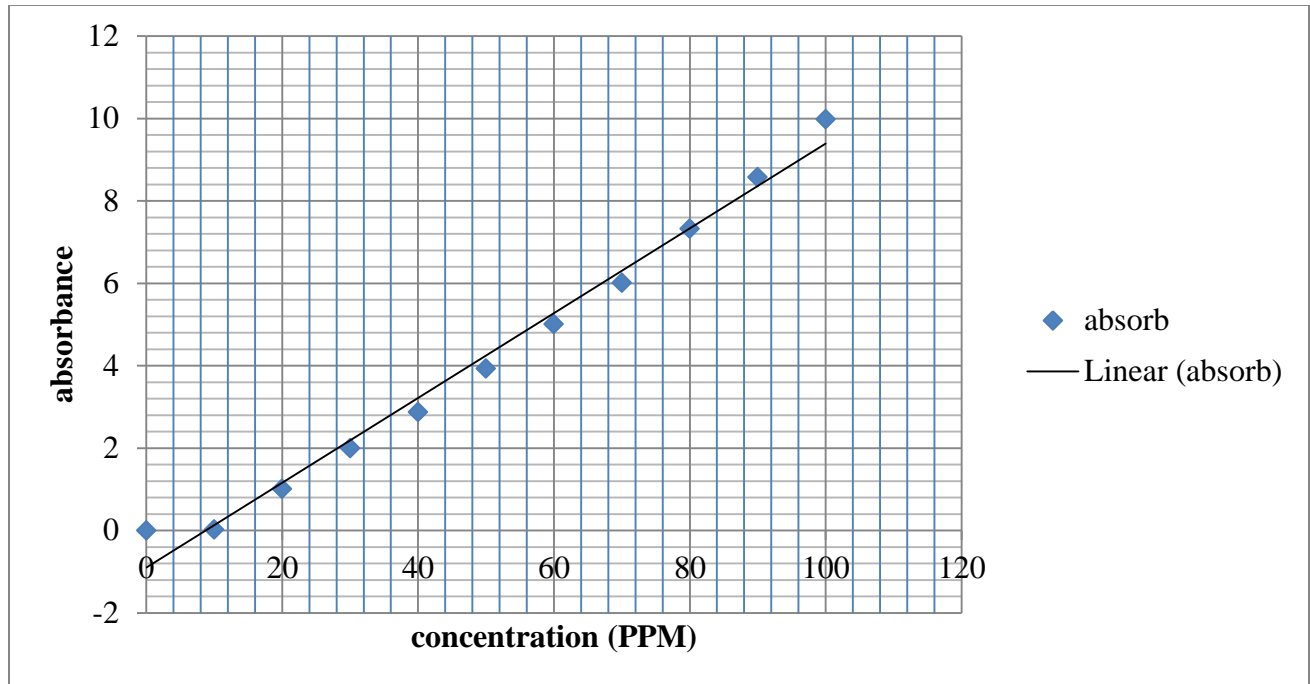
Table 5 represent the efficiency and concentration of chromium after adsorption the activated charcoal is taken 2 gram. Since the amount of activated charcoal increases the more number of sites for adsorption hence the adsorption increases.

**Table 6. INITIAL AND FINAL PH VALUES**

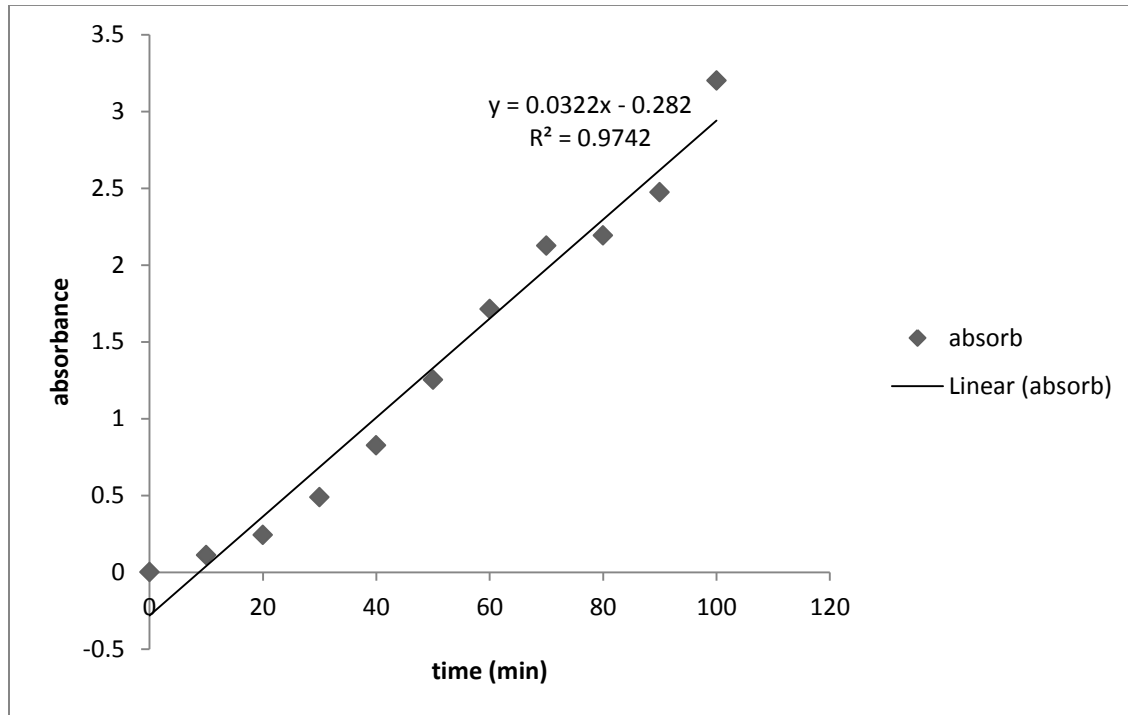
Sl.no.	Initial conc. (PPM)	Initial PH vale (before adsorption)	Final PH value (After adsorption)
1	10	6.013	6.682
2	30	5.091	5.834
3	50	4.101	5.301
4	70	2.951	4.859
5	90	2.013	4.725

Table 6 represents the initial PH value of the samples and final PH value of the samples after adsorption. It is clearly visible in figure 5.

**FIGURE 1. STANDARD CURVE OR CALIBRATION PLOT**



**FIGURE 2. PLOT AFTER ADSORPTION**



## 1. EFFECT OF TIME

Initially the adsorption was fast and as the time gone passes it no longer remain same. Actually it decreases because chromium removal decrease as the time increases and after certain time it became constant. The quick adsorption at the starting stage is presumably because of the expanded concentration gradient between the adsorbate in arrangement and adsorbate in adsorbent as there must be increases number of empty sites accessible first and foremost. Since in the figure from 0 to 20 min the chromium removed is around 17.5 which is maximum after that the chromium removed have decreases as contact time was increased, more and more functional groups participated in adsorption of the chromium ions until it reached equilibrium. After it reached the equilibrium, there was no a significance changes in chromium concentration in the solution. Look at the figure 3 (b) the curve decreases and after certain time it got straight parallel to time axis.

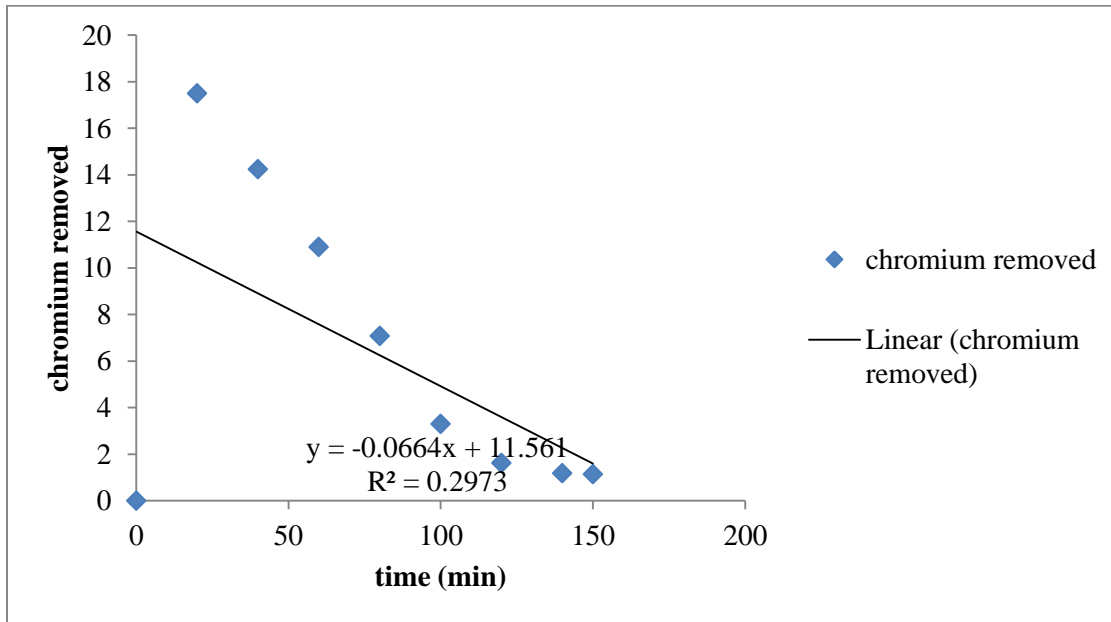
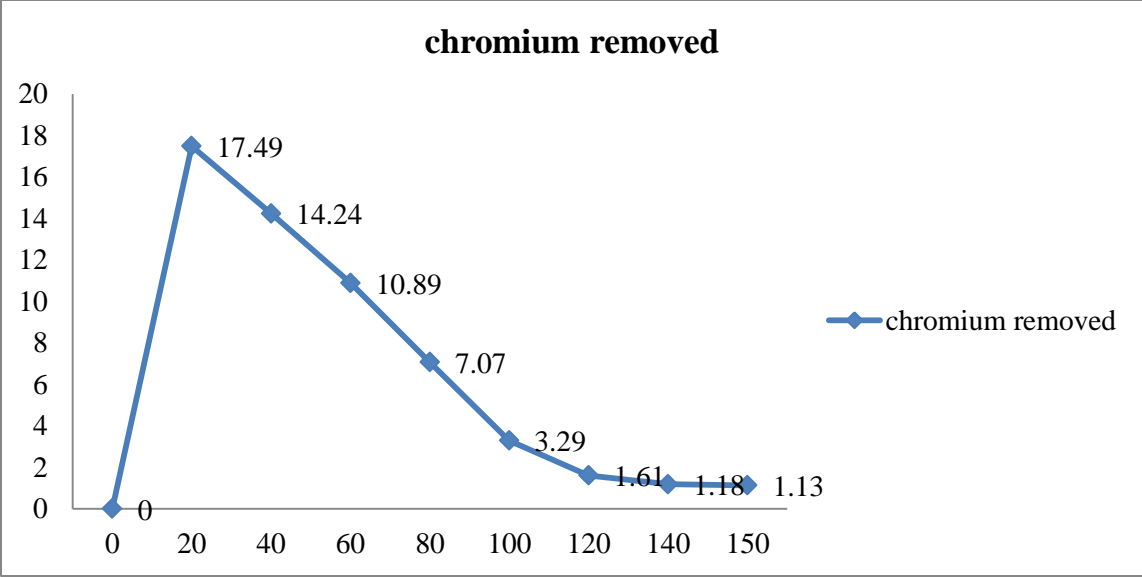


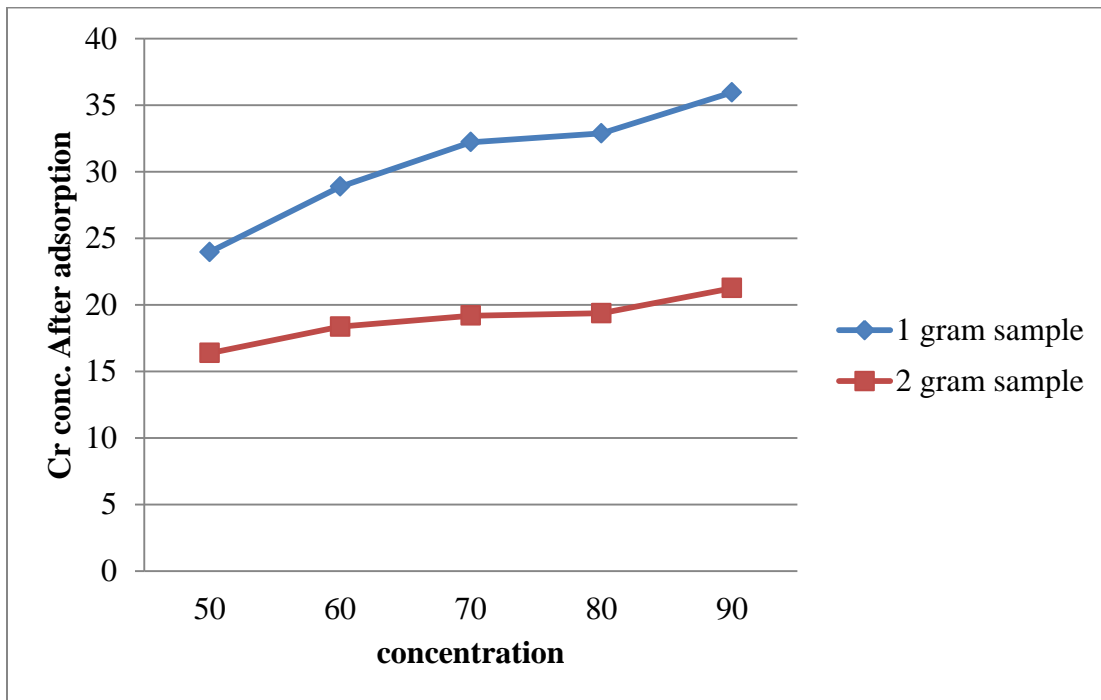
Figure 3 (a)



(b)

## 2. EFFECT OF DOSES/ ADSORBENT

It is quite evident that if we increase the amount of activated charcoal in the chromium solution, then the adsorption also increases. To optimize the adsorbent dose for the removal of Cr (VI) from the chromium solution, adsorption studies were carried out at an initial Cr (VI) concentration of 10 PPM with different adsorbent doses like 1 gram and 2 gram at a fixed period of time for 2 hrs. Increment in adsorption with dosage can be ascribed to expanded surface territory and the accessibility of all the more tying destinations for adsorption. It can be watched that the rate of Cr (VI) tying with adsorbent was more prominent in the beginning stages, then steadily diminished and remained practically consistent after an ideal period. Figure below is clearly showing, at 50 PPM the Cr (VI) concentration for sample 1 and 2 is 23.952, 16.375 PPM respectively. Hence the removal of chromium is more in case of sample 2.



**Figure 4**

### 3. EFFECT OF PH

The Cr (VI) removal efficiencies are about to decrease consistently with increase in pH. The removal efficiencies is about to increase slightly with time at all pH values. As the pH of the solution was increased from 1 to 6 the adsorption of Cr (VI) decreased. It means that on pH scale 1.5 the concentration of Cr solution was more and hence the chances of more adsorption and therefore more chromium removal. At low pH values, the dominant species of Cr (VI) in solution is  $\text{HCrO}_4^-$ . This is converted to  $\text{CrO}_4^{2-}$  and  $\text{Cr}_2\text{O}_7^{2-}$  ions as the pH increases. The adsorption free energy change for  $\text{HCrO}_4^-$  is lower than those of  $\text{CrO}_4^{2-}$  and  $\text{Cr}_2\text{O}_7^{2-}$  ions. Therefore,  $\text{HCrO}_4^-$  is more easily adsorbed than  $\text{CrO}_4^{2-}$  and  $\text{Cr}_2\text{O}_7^{2-}$  at lower pH values. In this figure it is quite clear the comparison between initial and final pH.

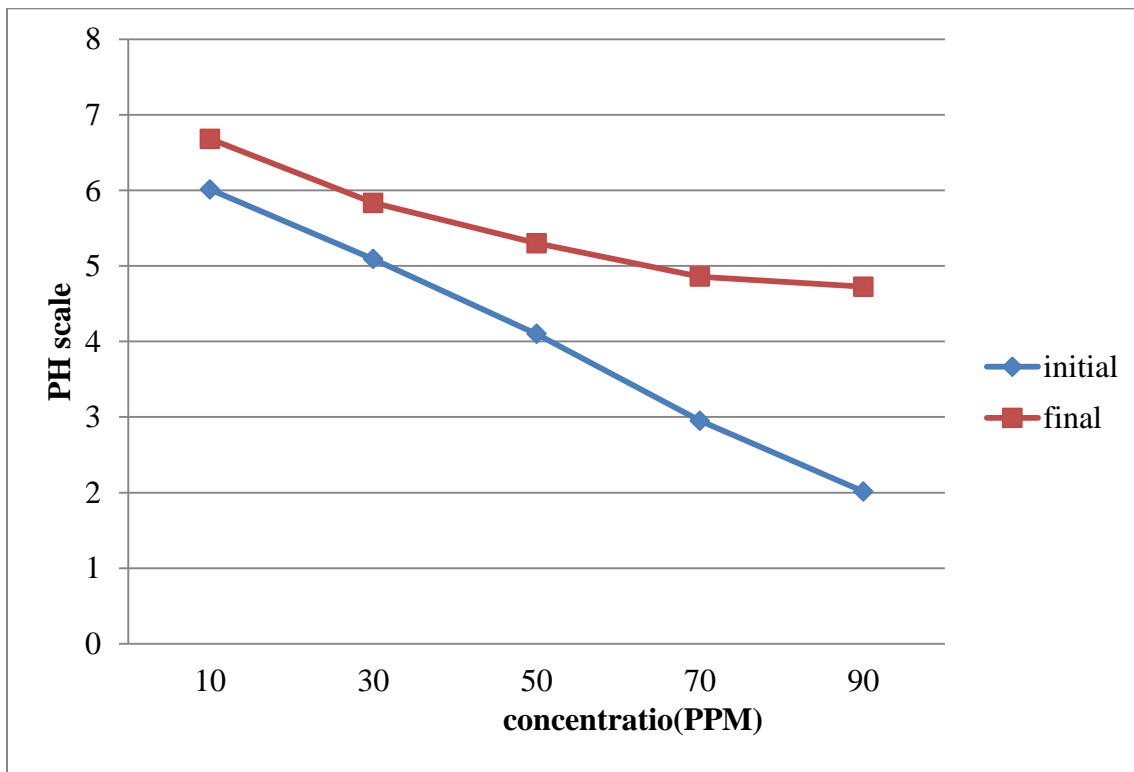


Figure 5



## CHAPTER-6: CONCLUSIONS

Removal of poisonous hexavalent form of chromium from solutions was possible using selected adsorbents. Prepared Activated charcoal from the raw material (carbonized coconut shells) is the effective and easy technique for removing impurities but here it gets useful in removing chromium.

The percentage of chromium removed increase with increasing adsorbent dosage, increase with increasing contact time and changes with pH. The % of chromium removal reached 60.04%. Increases in the dose of adsorbent, initial concentration of Cr (VI) and increase in contact time up to 2 h are favorable for all increase the adsorption of Cr (VI). The kinetic of the Cr (VI) adsorption on activated charcoal was found to follow first order mechanism. Optimum contact time for equilibrium to be achieved is found to be 2 hours (120 min). It is basically due to saturation of the active site which does not allow further adsorption to take place.

Result found that initially the rate of adsorption is more and as the time passes the adsorption decreases with decrease in chromium removal.

Preparation of activated charcoal has to be more efficient so instead of using 0.1 M solution of HCl, NaOH, and ZnCl<sub>2</sub> we should use 0.2 M solution to have better form of activated charcoal.

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