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Removal of Turbidity from Raw water by Novel Coagulant Based on PVC Pipe Waste and Sodium Alginate

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ABSTRACT

In the current study, waste polyvinyl chloride pipes were used as a primary material in the reactions, which are widely used for water supply and drainage systems where the waste pipes were prepared by cleaning them from suspended materials and grinding them into small particles, then reacting natural polymers from a plant; Alginic acid. We have obtained modified polymer (PVC/Alginate) or AL-PVC which have been grinded to obtain a powder. Four methods were used to characterize the properties of natural and prepared polymers: Fourier infrared spectroscopy (FTIR), scanning electron microscopy (SEM) X-ray diffraction (XRD), and thermogravimetry (TGA-TG). The effectiveness of AL-PVC polymer as a coagulant flocculant in the treatment of surface water has been studied. Tests were carried out in the laboratory on two kinds of water (50 NTU and 100 NTU). The first one is the synthesis of water mixed with high and low concentrations of bentonite, simulating thus turbid water. The second one is raw water from the treatment station of the Shatt Al-Arab River. The performance of the coagulation-flocculation process has been assessed by measuring the supernatant turbidity for different pH, doses, and flocculation times of the AL-PVC polymer. The obtained results show that AL-PVC polymer effectiveness was strongly dependent on pH and the doses of AL-PVC polymer, the initial turbidity, and the water quality. The physical and chemical methods used in the present study of water treatments are mainly due to their simplicity, ease of use, low cost as well as excellent removal efficiency.

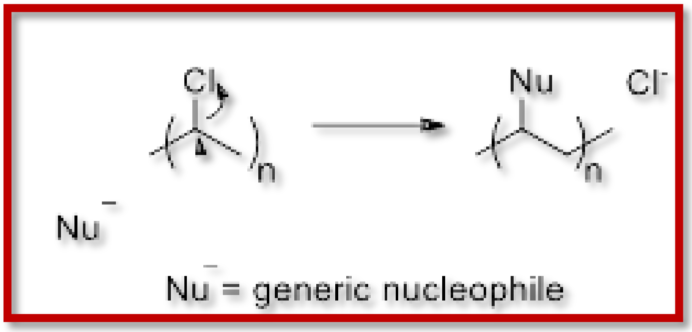
Keywords: *PVC , Sodium alginate, coagulation, turbidity.*

I-INTRODUCTION

Coagulation–flocculation the most popular technique for removing particles and organic materials from waste water is still flocculation or coagulation [1]. In this instance, a coagulant agent is used, which typically combines with water to create polymeric compounds and hydrophobic hydroxides, according on the pH of the solution. By charging either neutralization or adsorption, coagulant compounds interact with colloidal materials to cause coagulation or flocculation, which is strategy is implemented by sedimentation. [2] Coagulation-flocculation processes frequently employ natural polymers, either on their own or in conjunction with an inorganic coagulant. Polyelectrolytes are the name for ionic polymers[3] .

Colloidal particles and suspended solids can be successfully removed using the coagulation and flocculation procedures. It is also possible to eliminate some soluble substances with a net negative charge, including orthophosphate, fulvic acid, and humic acid. Carbohydrates and other non-charged compounds are inefficiently extracted. [4] When it comes to how various types of particles are eliminated, coagulation and flocculation require multiple techniques. The most crucial ones are **bridging**, **patching, sweeping coagulation, and charge neutralization**. In charge neutralization, the coagulant neutralizes the surface charge of the particles, allowing for the possibility of aggregation. For instance, Al^{3+} produces several positive aluminum ions in water, which are adsorbed by opposing particles to produce neutralization. The coagulant overdose results in stability. In sweep coagulation or flocculation, the suspended material is carried down by precipitates of insoluble aluminium or iron hydroxide. Alum [$Al_2(SO_4)_3.14H_2O$], ferric chloride [$FeCl_3.6H_2O$], sodium aluminate, aluminum chloride, and ferric sulfate are common coagulants used in wastewater treatment. Traditional coagulants are essentially salts of a strong acid (such as HCl or H_2SO_4) and a weak base (such as $Al_2(OH)_3$ or $Fe(OH)_3$); as a result, they are a mixture of an anion and a cation (from a base) (from an acid). Recent research has found that using aluminum salts has a number of major downsides, including the development of Alzheimer's disease. Alum response to the water's natural alkalinity, which causes in pH lowering, is another issue. In this situation, an environmentally friendly coagulant offers a workable substitute for wastewater treatments[5]. The natural source from which they are extracted allows us to classify natural organic coagulants (vegetable and animal). Given that natural coagulants (tannin, Moringa oleifera, lignin, and chitosan) are biodegradable, using them to coagulate wastewater may produce waste that is better suited for fertilizing [6] . The natural source from which they are extracted allows us to classify natural organic coagulants (vegetable and animal). Given that natural coagulants (tannin, Moringa oleifera, lignin, and chitosan) are biodegradable, using them to coagulate wastewater may produce waste that is better suited for fertilizing [6].

Waste pipes made of polyvinyl chloride were used and reacted with alginic acid and used as a coagulant. For the purpose of reducing pollution and using waste polyvinyl chloride pipes as a raw material in the reaction .one of the most popular plastics used in the manufacture of a variety of products, polyvinyl chloride (PVC), was assessed for its effects on the environment. The negative environmental impacts of PVC production may be reduced by recycling, a sustainable, effective, currently available alternative of waste management . PVC pipes and fittings are necessary for sewage, drinkable water supply, irrigation systems, drainage and duct systems in buildings and facilities, and cable protection. In 2013, 56 percent of total demand was met by buildings and facilities, followed by sewer (15 %), water supply (12 %), agriculture (4%), and cable protection (2%) [7] . Due of the comparatively simple chemical alterations that may be made to PVC's surface, it is also widely used in chemistry and materials engineering. PVC is a generally nonpolar material that yet has hydrophobic plasticizers that may diffuse throughout the structure and has strong nucleophilic substitution reaction reactivity with a variety of nucleophiles, including cross-linkers. [8,9].



Scheme (1) Generic substitution reaction of Cl with a nucleophile in PVC

Alginic Acid Polymannuronic acid or Alginic acid is a hydrophilic colloidal polysaccharide found in brown seaweed of diverse types (Phaeophyceae) Figure (1). Macrocystis pyrifera, the largest species of giant kelp. It's a linear copolymer made up mostly of D-mannuronic ß-1,4-linked acid residues and a-1,4-linked L-glucuronic acid residues. These monomers are frequently organized in homopolymeric blocks, with regions resembling an alternating sequence of the two acid monomers between them. [10]

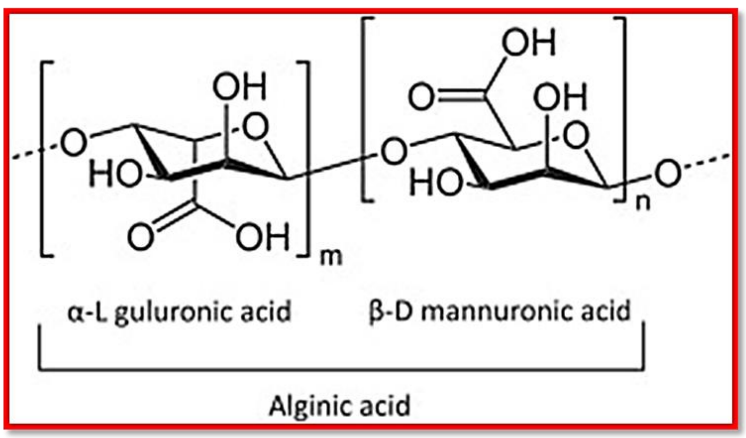


Figure (1) Structure of Alginic acid

Alginic acid is utilized to make pharmaceutical tablets that carry probiotics and medications because of its hydrophilic nature and strong water insolubility [10]. According to FDA restrictions [11], Alginic acid can be used as an emulsifier, emulsifier salt, formulation aid, stabilizer, or thickening. It is generated in situ when sodium alginate is introduced to acidic foods [10] with a lower pH, causing Alginic acid to precipitate from the solution [12] rather than being added directly to food. Due to its insolubility in water, the newly generated Alginic acid will form a gelatinous film [10].

Local positively charged zones are created when the polymer adsorbs on the surface of an anionic particle (patches). The stronger interaction between the particle's differently charged sections causes flocculation to start. In bridging flocculation a long chain polymer is adsorbed on a particle's surface, and the polymer's loops and tails are free to bind to additional particles .A polymer can adsorb using hydrogen bonds (such those seen in PAM and polyethylene oxide) or ion binding in addition to electrostatic interaction [3]. The presence of divalent positive metal ions, which likely act as a bridge between the anionic polyelectrolyte and negatively charged surface [13], causes the anionic polyelectrolyte to become adsorbed on negatively charged surfaces during the ion cross - linking process. Because the pH affects how charged the particles are, the pH value has a significant impact on how the coagulation process works. Increases in pH typically result in a rise in negative charges and a reduction in positive charges. A preferred pH range exists for coagulants as well. For each type of water and metal salt, it is needed to ascertain the residual content of iron and aluminum in filtered water as they rely on pH . [4].

The aim finding the most beneficial way of reusing the waste PVC pipes through ground improvement which will contribute to sustainable development. The use of waste polymer as raw materials in the reaction instead of using pure chemicals. Reducing pollution that results from the accumulation of waste polymers modification of PVC pipes waste by Alginic acid. Characterization the synthetic compounds by different technique .Using new compound those were prepared in the different applications such as Evolution the efficiency of synthesized polymers to remove turbidity of water and evaluate its coagulation performance for water treatment

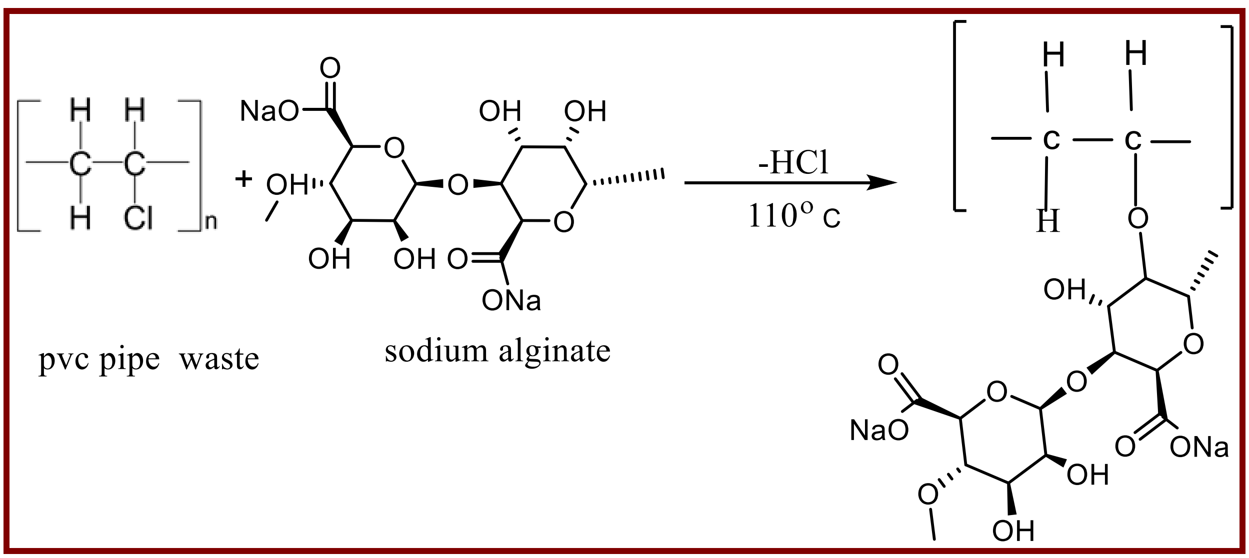
II .Materials and methods

- **Initialization PVC pipe Waste:-**

PVC pipe waste were collected from Basra scrap site, Iraq. The PVC pipe were washed with water to remove dirt and were subsequently air dried. The cleaned pieces of the pvc pipe were cut into sections using very sharp knives to small pieces.

- **Modifications of PVC with Alginic acid[14]:-**

A (6.00 g) of the initialized PVC pipe waste was 5.5 g of Alginic acid (as sodium alginate salts) and 25 ml of DMF were combined while stirring at 110 °C. The acidification with 10% v/v H_3PO_4 was carried out for one hour before the reaction was stopped. Cold ethanol was used to filter the product and precipitate it. Purification of the modified polymer was accomplished by using THF . The modification of PVC with Alginic acid (as sodium alginate salts) according to Scheme (2)



Scheme (2) Chemical equation of the modification of PVC pipe with Sodium Alginate

III .Characterization methods :-

Four methods were used for the characterization of the natural and prepared polymers : Fourier Transformed Infrared spectroscopy (FTIR), scanning electron microscopy (SEM) X-Ray diffraction (XRD) , and Thermo-gravimetry (TGA-TG)

❖ **Fourier Transformer Spectroscopy (FT-IR)** :-

The vibration frequency of the functional groups in the five distinct modified polymers was determined using Fourier transform infrared spectroscopy (FT-IR). An FTIR spectrometer measured the spectra between 400 and 4000 cm^{-1} wave number. After completely combining the dry amount of polymers (approximately 0.1 g) with KBr and pressing the mixture into a pellet, the FT-IR spectra was captured.

- **The FTIR spectrum of PVC :-**

The PVC FTIR spectrum is displayed in Figure (2). The asymmetric stretching bond of C-H is seen by the peak at 2978.19 cm^{-1}, and the symmetrical stretching bond of CH_2 is shown by the peak at 2854. cm^{-1} the peak for the asymmetric stretching bond of CH_2 in phase is at 2908.75 cm^{-1} The -CH2 aliphatic bending bond in phase is given to the peaks at 1489.10 cm^{-1}. The bending bond of -C-H near Cl is thought to be responsible for the peak at 1234 cm^{-1}. The PVC backbone chain's C-C stretching bond can be found between 1172.76 cm^{-1}. Finally, the C-Cl gauche bond is represented by the peak at 613.38 cm^{-1} [15.16].

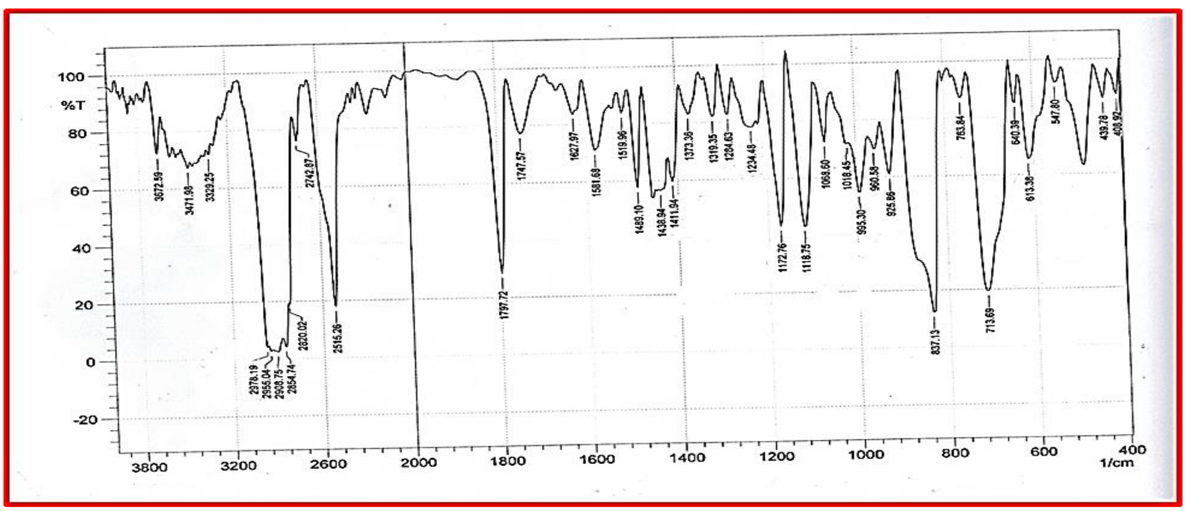
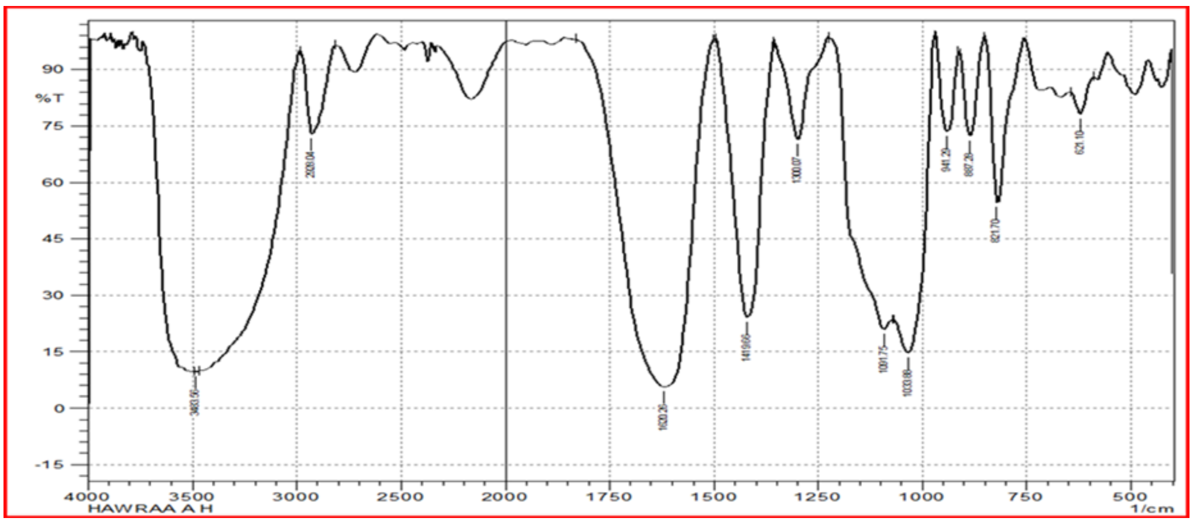


Figure (2) FTIR spectrum of pvc pipe waste

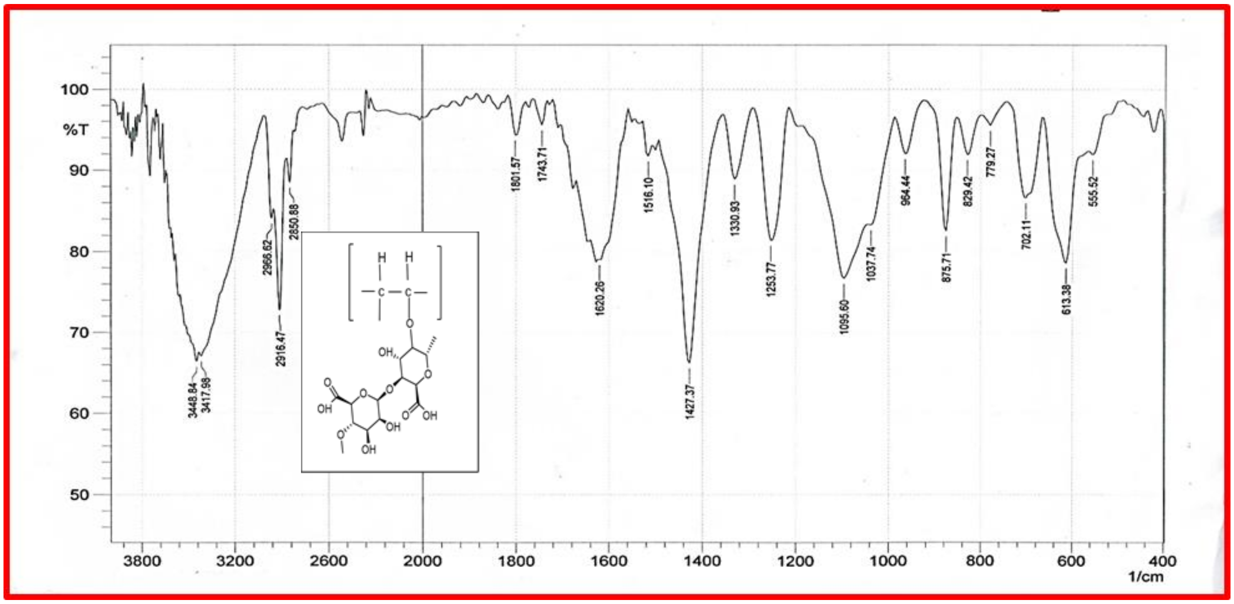
- **FTIR spectrum of Sodium Alginate** :-

The sodium alginate FT-IR spectrum was displayed in Figure (3), with a broad band centered at 3483 cm^{-1} assigned to hydrogen bonded O-H stretching vibrations, the weak signal at 2928 cm^{-1} due to C-H stretching vibrations, and the asymmetric stretching of carbonyl group C=O vibration at 1712.85 cm^{-1}. The carbonyl group's O-C-O symmetric stretching vibration may be contributing to the band at 1419 cm^{-1}, which is caused by C-OH deformation vibration. It is possible to attribute the weak bands at 1091 cm^{-1} to C-C-H and O-C-H deformation and C-O stretching. The distinctive absorption of a -D glucose unit is represented by the absorption band at 887 cm^{-1} [17].



Figure(3) FTIR spectrum of Sodium Alginate

The compounds AL-PVC was preparing by modification of pvc pipe waste After that , this compound was characterized by FTIR . The FT-IR spectrum shown in Figure(4) appear decrease in peak intensity broad peak at abroad band centered at 3483.84 cm^{-1} assigned to hydrogen bonded O–H stretching vibrations, the weak band at 2966.62 cm^{-1} due to C–H stretching vibrations and bending 1330. 93 (cm-1), and the asymmetric stretching of carbonyl C=O vibration located at 1743.71cm^{-1} . The band confirms the existence of the functional group C-O-C. at 1801.57cm^{-1} The band at 1427.37 cm^{-1} may be assigned to C-OH stretching. Spectrum stretching vibrations of C-O groups can be seen at 1235.77 cm^{-1}. The distinctive D-glucose absorption is represented by the absorption band at 875.71 cm^{-1}.



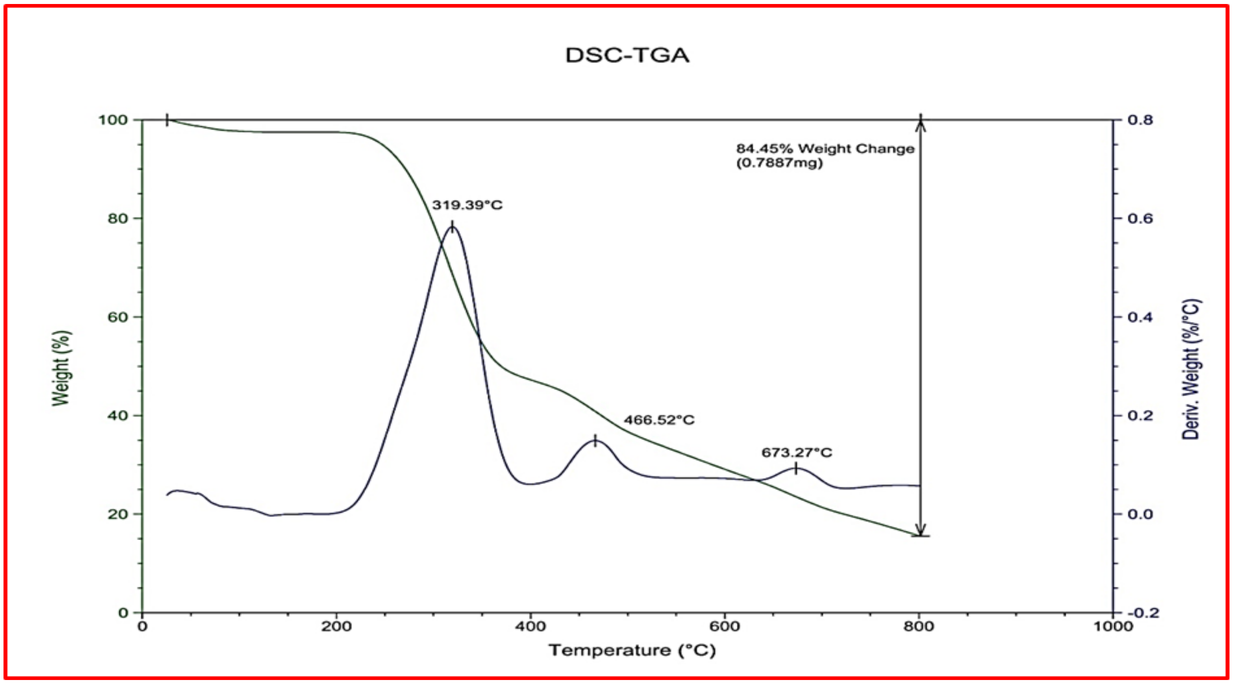
Figure(4) The FT-IR spectrum prepared compound AL-PVC

❖ Thermal gravimetric analysis (TGA) :-

Thermal gravimetric analysis (TGA) is one of the methods of thermal analysis techniques used to study the thermal stability of a wide variety of materials. TGA assesses the quantity and rate of change in a sample's mass as a function of time or temperature in an inert environment [18,19]. The primary purposes of those measurements are to ascertain the compositional and thermal properties of materials. [20]. It is especially useful for studying polymeric materials. The thermal stability of polymers is defined as the resistance of polymers toward thermal and thermochemical degradation under isothermal or dynamic conditions. The generated thermograms were used in the current work to determine many of the thermal stability characteristics, such as the tangential decomposition temperature (initial decomposition temperature T_i). The degree of decomposition temperature at 50% weight loss of the sample (T_{50}), the final decomposition temperature (T_f), the amount of char at the conclusion of the decomposition process, [21].

- **Concerning polymer PVC-Sodium Alginate AL-PVC**,

three stages of decomposition are shown in Figure (5) The first stage at 319.39°C can be attributed to the decomposition of carbohydrates (52.53 % wt.). The second stage at 466.52°C from the cleavage of the methylene group, (15.72% wt.) .The third stage is equivalent to 16.19 % wt. loss at 673.27 ^{o}C are attributed to According to such a results, the salt decomposed by dehydration followed by degradation to Na_2CO_3 and a carbonized material that decomposes slowly leaving the carbon residue about (15.55 wt.%) . [22] [23] . As shown table (3.5) The TGA Parameters for the Synthesized Polymers



Figure(5) The TG/DTA curve of prepared compound AL-PVC

Table (3.5) The TGA Parameters for the Synthesized Polymers

polymer	TG/DTG	Mass	Ruds.	Total

	Decomposition Stage	T_i °C	Tm (max) °C	T_f °C	loss %	At C°	C°% Weight Loss
AL-PVC	First stage	220	319.39	390	52.53	800	84.45
	Second stage	435	466.52	520	15.72		
	Third stage	650	673.27	720	16.19		

❖ X-ray Diffractometry :-

Physically, diffraction is the result of electromagnetic radiation deflecting away from obstructions. As the atom plans are positioned at distances similar to X ray lengths, this phenomenon can be used to analyze materials. X rays are electromagnetic waves that resemble light but have a much shorter wavelength (= 0, 2 - 200 Å). [24].

The way the material's atomic planes are arranged within the crystal lattices determines how much light is diffracted. The law describes the diffraction angle and the spacing between atomic planes in a crystal structure for a given wavelength of electromagnetic radiation. Typically, diffracted X-rays are found using a detector, then processed and counted to create diffracted or pattern beams. An unknown sample can be identified by converting diffracted patterns into d-spacing. Usually, the diffracted pattern beams are compared to numerous reference patterns in order to identify the materials. [25]. The interplanar spacing d and the value of 2θ are described. The broad diffraction peaks from the obtained XRD patterns showed that the structure performed a semi-crystalline nature, which was defined by the location of the maximum 2θ of the broad peaks. The average values of d were determined using Bragg's equation ($2d\sin\theta = n\lambda$). [26] .

The molecular weight and crystallinity of polymers were the main determinants of their qualities. XRD The crystallinity index (CI), which is frequently used to gauge crystallinity, can be computed by X-ray diffract. I propose the following formula to calculate the crystallinity index (CI):

$$CI\ (\%) = [(Im - Iam)/Im] * 100$$

where Im is the crystalline peak's maximum intensity in arbitrary units, about 2θ, and Iam is the amorphous diffraction, in arbitrary units. The majority of the time, CI offers details regarding the crystal state. The area of the crystalline peaks could also be divided by the overall area under the curve in an X-ray diffractogram [27] to determine crystallinity. The typical **AL-PVC** diffraction pattern, given in angle form Figure (6) shows crystalline peaks with varying indexes but strong reflections at 2θ at 29.49° and 2θ of 30.20° (85.13 percent).

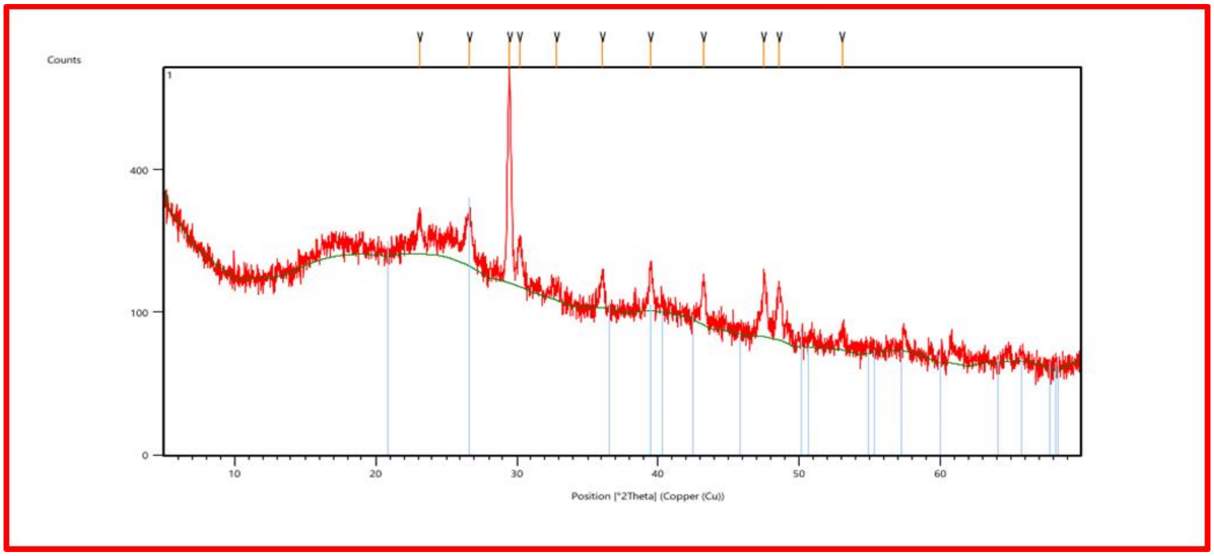
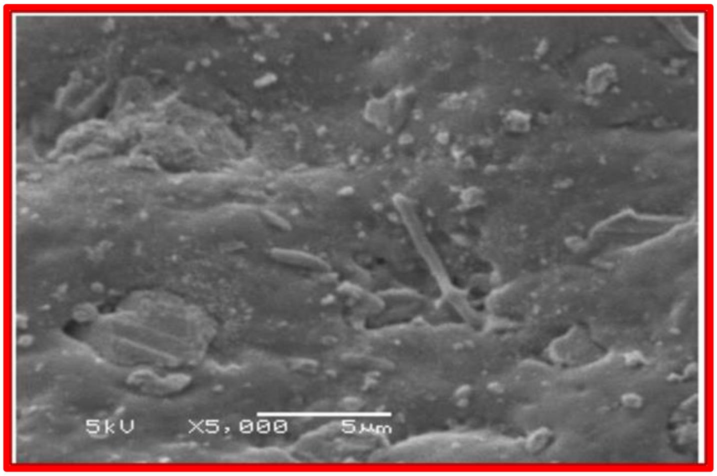


Figure (6) XRD AL-PVC

- **Scanning Electron Microscopy (SEM)**:-

A focused electron beam is used in scanning electron microscopy, a form of electron microscope, to produce images on the sample surface. The sample's atoms and electrons interact, resulting in a variety of signals that carry details on the surface's general composition and structure. [28, 29]. The SEM micrographs of PVC showed smooth and neat surfaces with a high degree of homogeneity [30] Figure (7)The surface morphology was investigated using SEM



Figure(7) SEM images of PVC

Figure (8) shows the SEM micrograph of Algninc acid modified PVC pipe Waste **AL-PVC** This figure shows the asymmetrical prismatic structures of different sizes, and when the magnification continues, we notice that these structures contain nanospherical shapes of different sizes, and they also contain spaces spreading between these nanospheres seen at 200 nm.

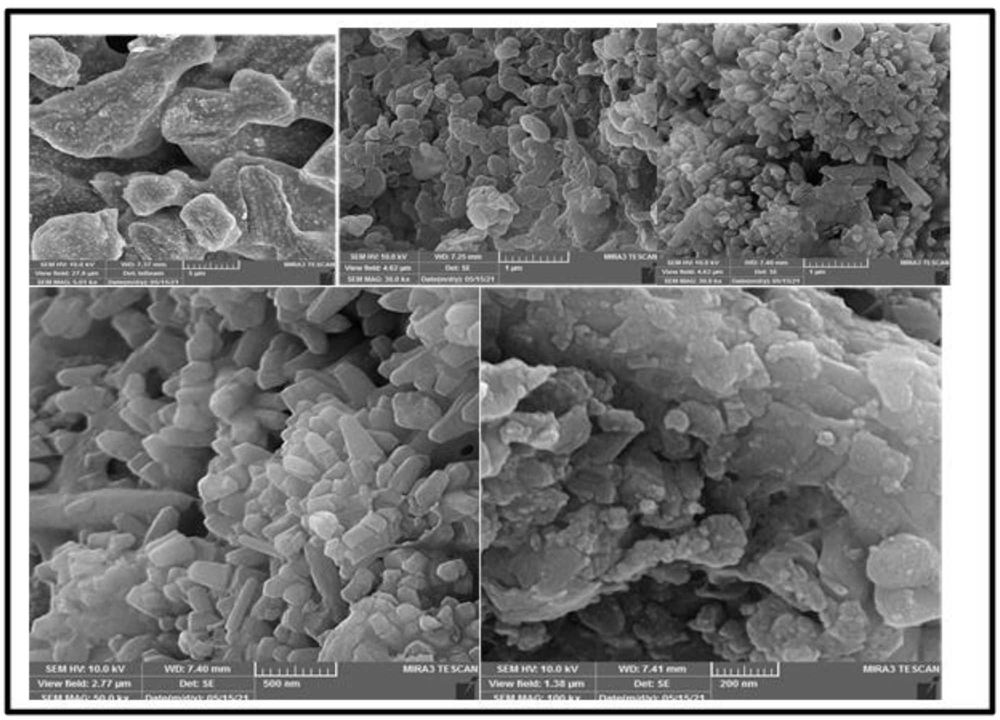


Figure (8) shows the SEM micrograph for AL-PVC

VI. Coagulation study

- **Preparation of Turbid Water**:-

The investigation will use bentonite because it is widely available and abundant. To prepare water with turbidities (50 and 100) NTU , The bentonite was sieved and milled. For all tests, the sieve fraction below 200 m was maintained. The initial suspensions were blended with deionized water for five minutes at a speed of 500 rpm. After that, the suspensions were let to settle in for 20 minutes. After this procedure, the supernatant is filtered to get rid of the big, non-suspended particles. The coagulation experiments was conducted using a conventional jar test setup.

- **Coagulation experiment**:-

In each of the previous studies, the ideal slow stirring time and velocity were identified. The suspension's pH was changed by adding either 0.1 M NaOH or 0.1 M HCl. The processor was set to 100 rpm paddle speed and contains turbid water or synthetic water with varying pH and turbidity values. Following the addition of the polymer, the water was quickly mixed for 1 minute at 200 rpm and then slowly mixed for 15 minutes (at 15 rpm). The pipette's open end was positioned 3 cm below the liquid's surface as the supernatant was removed for turbidity measurement . The instrument's sensitivity allows it to detect turbidity as low as 0.02 NTU. (Nephlometric Turbidity Units). [31]

- **Treatment with prepared compound as coagulants:-**

After the prepare compound were added to the jars, which contained turbid water , One minute of vigorous mixing at 200 rpm and fifteen minutes of gradual stirring at 15 rpm were completed. The agglomerates were allowed to settle for fifteen minutes. Using a turbidity meter, the supernatant's turbidity was assessed after being pipette-withdrawn from a 3 cm depth. The device's sensitivity enables the determination of turbidity as low as 50 NTU (Nephlometric turbidity units).The removal efficiency of the studied parameters in these experiments was calculated by applying the following formula[32] :

$$\text{Removal efficiency} = (((T_o - T_i))/(T_o)) \times 100$$

Where , T_o (NTU) is the initial turbidity of solution, T_i (NTU) is the final turbidity of solution.

- **Effect of pH on residual turbidity :-**

In order to investigate the efficiency of coagulation, a number of jar experiments was performed. prepared compound **AL-PVC**, with turbidities of 50and 100 NTU under various pH conditions Using pH values of for each turbidity value,: 2, 3 , 4 , 5 , 6, 7, 8,9 and 10, Because the active components in coagulant extract frequently carry a charge, the pH of the water has a significant impact on coagulation activity. [33,34] . it has been hypothesized that coagulation activity is increased at excessive pH values, i.e. lower and higher pH values (2, 10). The coagulation experiments were performed at pH levels ranging from 2 to 10 in order to track the impact of pH. The optimum coagulation activities have been shown to be either at severely acidic or basic pH values, according to research shown that coagulation activity is increased at excessive pH levels, both lower and upper pH levels (2, 10). The coagulation experiment was performed out in pH ranges between 2 and 10, to track the impact of pH . Best coagulation activity have reportedly been found at either severely acidic or basic pH values. But near the neutral pH zone, or at values between 6 and 8, low coagulation activity has been seen. In terms of coagulation activity, greater pH values produce great outcomes [35]. After each coagulation experiment, molar doses of acid or base are added to the cleared water to change the pH readings, respectively.

For the same reason, prepared polymers **AL-PVC**, gave an improvement in the efficiency of removing turbidity from water at acidic pH2, respectively. 20.9%, in 50 NTU turbidities and,87.66%, in 100NTU As shown in Figure (9)

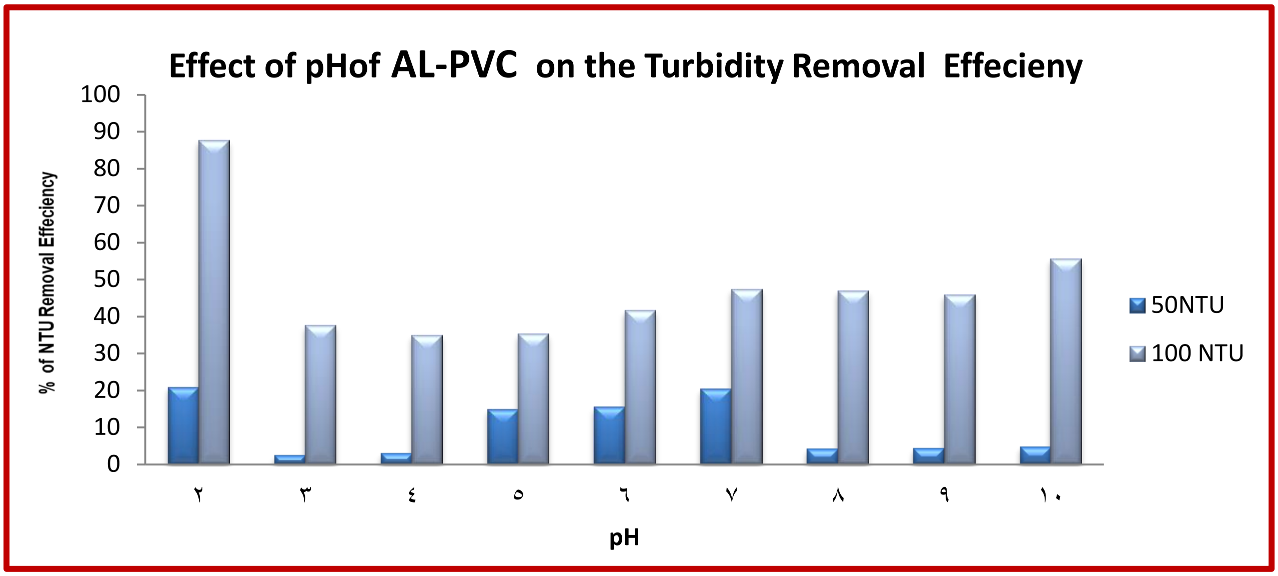


Figure (9) Turbidity removal efficiency of AL-PVC as function of pH

- **. Effect of the prepared polymer dosage on residual turbidity :-**

Several doses for prepared compound**, AL-PVC** (0.01-0.4) g were utilized to destabilize suspending bentonite with 50, and 1000 NTU . Better coagulation and a greater decrease in turbidity can be achieved with coagulant assistance. So that it is possible to create larger flocks by adding coagulant help to make more particles sediment in addition to speeding up the sedimentation if low turbidity is desired. In this research, This kind of water-based most coagulant aid, which has a strong positive charge, speeds up flock formation and accelerates sedimentation by bridging. [36]. The Optimum dosage of modified polymer **AL-PVC** as a coagulant aid was obtained 0.01 g in50 NTU and100 NTU Figure (10). the efficiencies of the turbidity removal respectively 84.04 and 89.46%

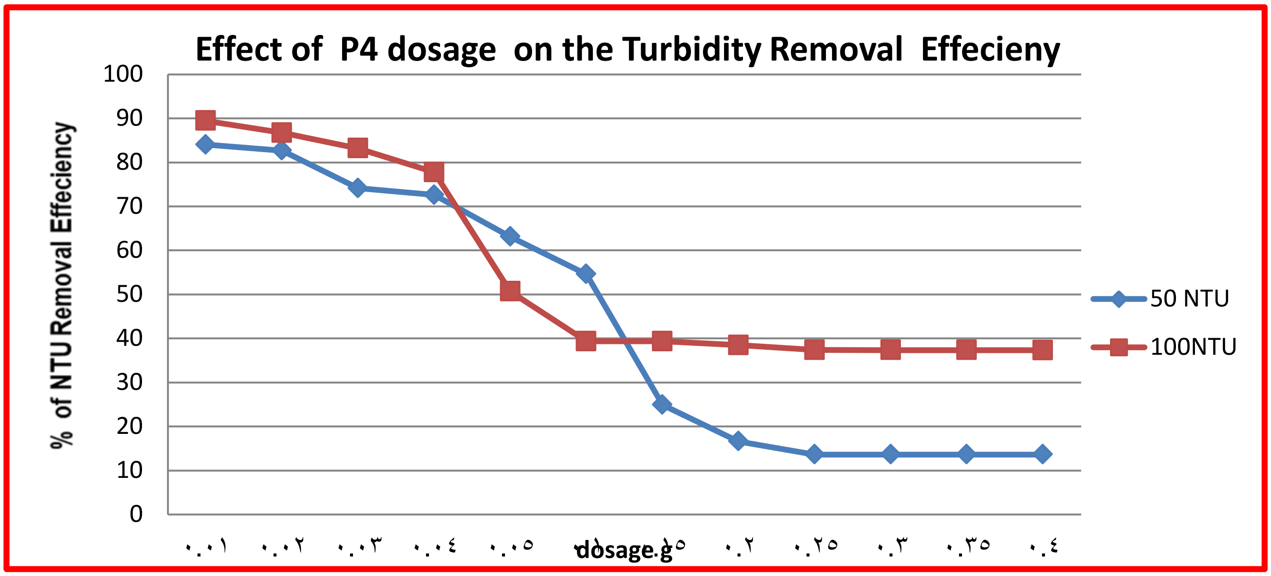


Figure (10) Effect of AL-PVC dose on Turbidity Removal Efficiency

- **Effect of flocculation timing on remaining turbidity :-**

By changing the flocculation time from 10 to 60 minutes at the ideal pH and dosage, the influence of flocculation time on remaining turbidity was investigated., for 50 NTU and 100 NTU turbidities. The final results are displayed in Figure (11), the optimum flocculation time for **AL-PVC** is 10 min. demonstrates that turbidity removal efficiency in perfect conditions were 97.06% and 96.82% for 50 NTU and 100 NTU turbidities, respectively

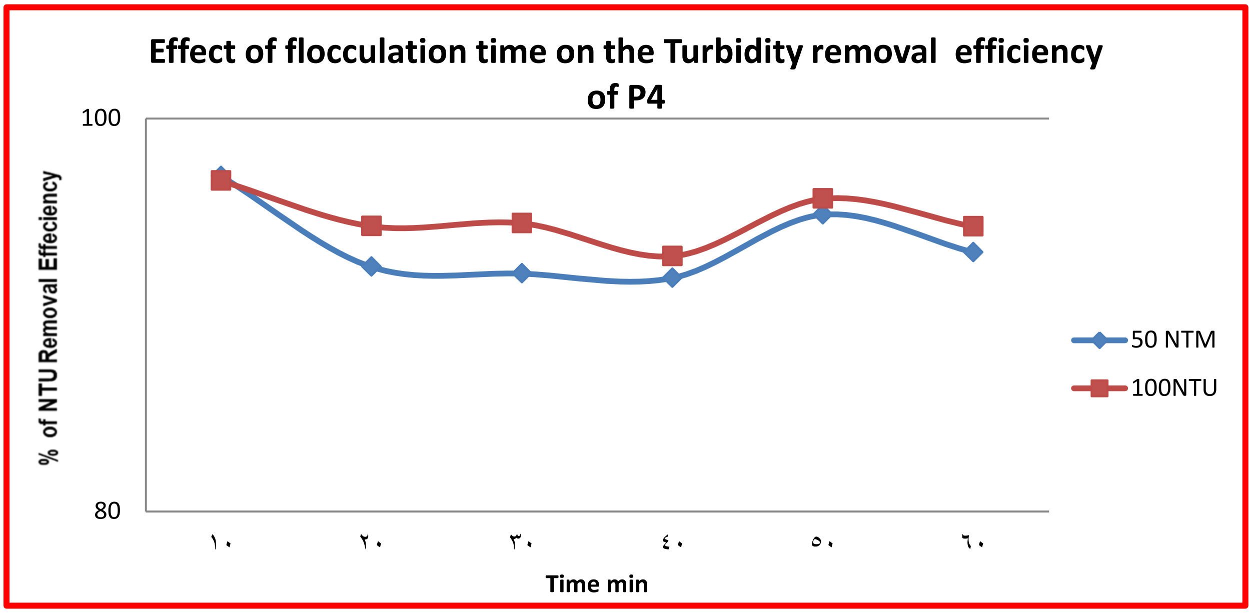


Figure (11) Turbidity removal efficiency of AL-PVC as a function of flocculation time

The floc size did, however, gradually diminish and performed poorly at removing turbidity over time. This was the outcome of Due to the breakdown of the colloids generated in suspension, the flocs' inadequate capacity to settle was the cause of this [37]. **AL-PVC,** coagulants were found to have remarkable turbidity reduction efficacy. The fact that the number of particles available for the coagulation decreased as the reaction progressed is shown by the abrupt decrease in turbidity with time (10–20 min) (for **AL-PVC**). The combination bridging mechanism or the floc mechanism may be to blame for this [38,39]. structure with a high capacity for polymeric cations to bind between layers.

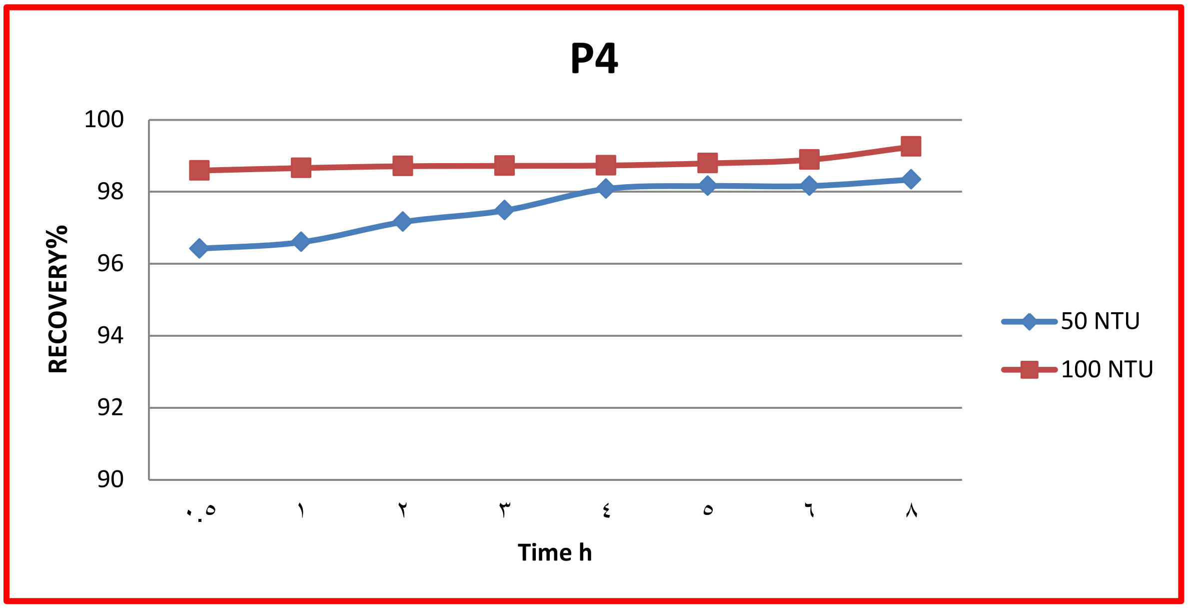
- **Desorption studies** :-

Desorption research will make it possible to extract bentonite from the examined polymers and shed light on the nature of the adsorption process. Additionally, it will support the regeneration of the polymers so they can be employed once more to adsorb bentonite.In a batch experimental setup, regeneration of the adsorbed bentonite from the investigated polymers was investigated. In a desorption medium containing 10 ml of 3

M HCl, an appropriate dose of polymers loaded with bentonite under ideal circumstances was added, and the medium was shaken at a rate 200 rpm and 25 °C, of. As previously noted, the turbidities of the bentonite in the aqueous phase were monitored. Bentonite is liberated from the solid surface into the desorption medium when 3 M HCl is used as a desorption agent. The outcomes suggested that it is possible to regenerate beads using powerful acids. It is clear that as the pH drops, the interactions between the connected beads and the bentonite weaken. Adsorption can be reversed entirely. The polymers were reloaded after being repeatedly rinsed with 3 M HCl and demineralized water [40].

- **Desorption study for modified polymers:-**

For all batch desorption experiments were performed by suspending all modified polymers for 10 and 50 NTU turbidities respectively, on optimum weight and , with 200 rpm on a shaker at 25 degrees Celsius, in 10 ml of 3 M HCl. The mixture was filter using Whatman filtration paper No. 42 after continuous time periods (0.5–24 hours), and the filterate was examined by Turbid meter for the turbidity contents. [40]. The recovery percentage of bentonite from all modified polymers at different contact time The present results show that recovery percentage of bentonite increased initially with the increasing of the contact time.



Figure(12) Bentonite recovery from AL-PVC polymer and the impact of contact duration (3 M HCl).

For compound AL-PVC after four hours, maximum recovery of bentonite were observed shown in Figure (12)

❖ Treatment of raw water samples by the modified polymers :-

To examine the polymers' capacity to reduce raw water's initial turbidity, additional jar experiments were performed. water sample taken from the Shatt al-Arab near the University of Karma On March 20, 2022 at nine in the morning with high initial turbidity 132 NTU . A 50ml of turbid river water was treated with an optimum amount of polymers ,and pH , polymer dosage and flocculation time as discussed previously. Figure.(13) shows the water turbidity removal efficiency of polymers . A large difference in the removal efficiency of polymers has been detected. It was recorded a good removing of turbidity of about, 95.90% at 0.01 g

the turbidity removal efficiency of the raw water sample taken from the Shatt al-Arab near the University of Karma at the turbidity of 132 NTU And in the most optimal conditions. The settlement velocity was notably quick at this quantity These findings demonstrate the produced polymers' efficacy in reducing the turbidity of river water with a high initial turbidity (132 NTU), It was noticed that agglomerates develop quickly and in big sizes during the second phase of the coagulation flocculation process (slow agitation). They formed filaments and were brittle .This could be attributed to high concentration of colloidal particles , Because they act as the nuclei for the coagulation, colloidal particles' concentration in water has a significant influence. Even when the colloids are balanced, if the concentration of colloids in the water is low, there aren't enough particles to guarantee good flocculation. Another disadvantage of fluids with few colloids is that it is simple to add coagulant and ultimately reverse the load of the particles rather than neutralizing it.

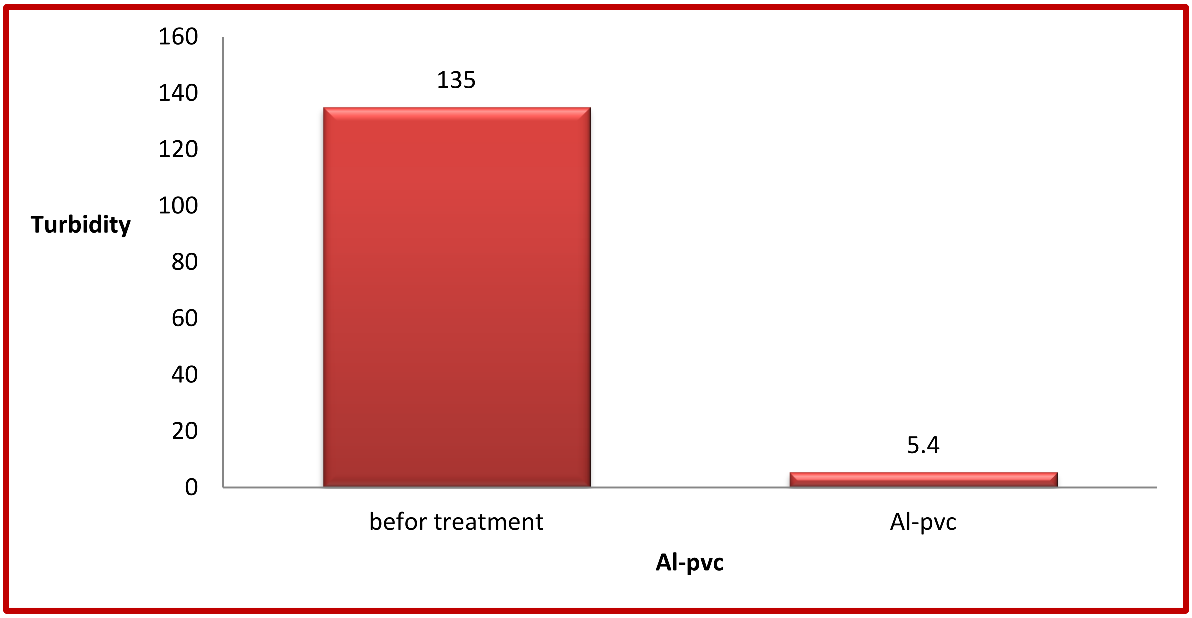


Figure (13) Effect of polymer doses on the amount of residual turbidity in the water sample taken from the Shatt al-Arab near the University of Karma at the turbidity of 132 NTU And in the most optimal conditions

V-Conclusions:-

The present study leads to the following conclusions:

the recycling polyvinyl chloride pipes successfully considered as raw material that may be reuses in different applications.Polymeric compounds prepared from waste polyvinyl chloride pipes were used to remove water turbidity had the highest efficiency to remove .It is one of the green chemistry methods to reduce pollution.

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