SYNTHESIS AND CHARACTERISATION OF CARBOXYMETHYL CELLULOSE- GRAFT- (ACRYLIC ACID-CO-ACRYLAMIDE) AND ITS APPLICATION AS ADSORBENT FOR WASTEWATER TREATMENT

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ABSTRACT

In this work , grafting polymerization using gamma radiation from C0-60 source at room temperature (27°C) was employed to produce a novel adsorbent using Acrylamide (AAm), Acrylic acid (AAc) on carboxymethyl cellulose (CMC) for water treatment . The preparation conditions such as effect of Acrylamide (AAm) and Acrylic acid (AAc) concentration and radiation dose on grafting percent were investigated to achieve the optimum grafting percent.

The structure, thermal stability and surface morphology were characterized by Fourier transform infrared spectroscopy (FT-IR) & differential scanning calorimetry (DSC) and scanning electron microscopy (SEM), respectively.

The results show that for the same radiation dose, the grafting percent is increased with increasing the concentration of acrylamide and acrylic acid (1:1) in solution till 30 % where the best grafting percent obtained. The grafting percent increases with increasing irradiation doses. The grafted Carboxymethyl cellulose (CMC-g-AAm/AAc) was examined and optimized for its application as adsorbent for wastewater treatment.

Key words: Carboxymethyl Cellulose, Acrylamide, Acrylic acid, γ-radiation, Graft Polymerization, wastewater treatment

INTRODUCTION

Polysaccharides are ideal ecofriendly materials. They surround us in every conceivable form. They are the most important constituents of food, clothing, structural materials and are also of special usage as adhesive, matrix for controlled drug release, flocculent, etc.

Chemical modifications of polysaccharide result in fine tuning of its properties which opens up the possibility of diverse applications. One of the most effective methods of chemical modification is grafting with synthetic polymeric materials. The resulting hybrid material can have tailor-made properties optimized towards any particular application. (Mishra *et al.*, 2011)

Graft co-monomers by definition, consists of a long sequence of one polymer (backbone polymer) with one or more branches (grafts) of another (chemically different) polymer (Odian, 2004). The process of graft co-monomer synthesis starts with a preformed polymer (polysaccharide in case of grafted polysaccharides). An external agent is used to create free radical sites on this preformed polymer. The agent should be effective enough to create the required free radical sites, at the same time should not be too drastic to rupture the structural integrity of the preformed polymer chain.

Once the free radical sites are formed on the polymer backbone (i.e. preformed polymer), the monomer (i.e. vinyl or acrylic compound) can get added up through the chain propagation step, leading to the formation of grafted chains. The various methods of graft comonomer synthesis actually differ in the ways of generation of the free radical sites on this preformed polymer. Conventionally, chemical free radical initiators (e.g. ceric

ammonium nitrate (CAN)**,** high energy radiation (gamma rays or electron beam) or UV rays in presence of photo sensitizers are used for this purpose.

High energy radiation initiated method (gamma rays or electron beam) is a more convenient method of graft comonomer synthesis. In many cases of synthesis, it is the only method fit as a candidate for commercial production. However, the high energy radiations make no distinction between the bonds to be broken and the bonds essential for structural integrity of the preformed backbone polymer. (Mishra *et al*., 2011)

The chosen polysaccharide for modification, i.e. Carboxymethyl cellulose (CMC), is the most well known and most important type of polysaccharide. Carboxymethyl cellulose sodium salt (CMC) is the first water soluble ionic derivative of cellulose prepared in 1918 and produced commercially in the early 1920's in Germany. It is widely used in pharmaceuticals, detergents, cosmetics, foods, paper and textile industries due to its viscosity increasing and emulsifying properties. However, it may need to be further modified for some special applications (Shafiei *et al*., 2012). The presently accepted structure of CMC has been depicted in Fig. 1.
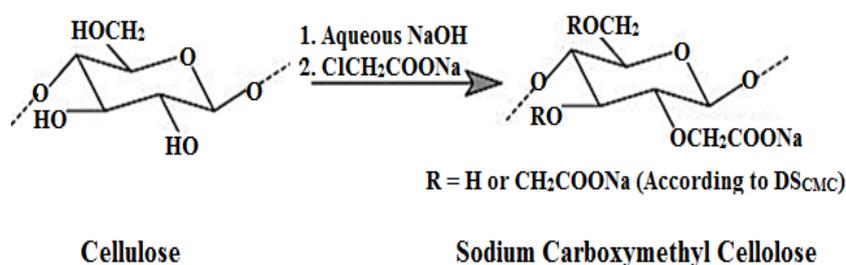
Figure (1): Chemical structure of CMC

By itself or grafted with other water-soluble compounds, CMC is used as an adsorbent for dye sorption from various wastewaters systems (Yan *et al*., 2011; Bao *et al*., 2011).

In this investigation, we have grafted acrylamide chains (AAm) and acrylic acid (AAc) onto the backbone of CMC, thus resulting in formation of 'acrylamide/acrylic acid grafted CMC (CMC-g-AAm/AAc). The synthesis has been carried out by gamma rays, The ability of prepared polymeric material as adsorbent to remove either organic and/or inorganic toxic wastes from wastewater were evaluated in bench scale at optimum conditions.

MATERIALS AND METHODS

1. MATERIALS:

Carboxymethyl cellulose was received from DOW Company for chemicals Supplies, Germany, and was used as received. Acrylic acid (AAc) was obtained from (LOBA-CHEMIE, India), Acrylamide (AAm) from LOBA-CHEMIE, India.

Other chemicals, such as citrate, phosphate buffer salts of analytical reagents, were purchased from El-Nasr Co. for Chemical Industries, Egypt. Distilled water was used to prepare the solutions. All solutions were freshly made at room temperature.

Raw wastewater used was collected from Abu Rawash treatment plant and was transferred to the laboratory, Fresh grab sewage samples were collected for each experimental run. The characteristics of the raw wastewater were variable. The basic quality parameters for these wastewater samples

were determined according to standard methods for examination of water and wastewater

2. SYNTHESIS

2.1. Preparation of CMC-g-AAm/AAc :

CMC powder (1 gram) was dissolved in (100 ml) distilled water, heated and stirred at 80°C for 30 min to form homogeneous mixture. The different content of AAc and AAm were added and continuously stirred at room temperature for 30 min. The viscous solution was transferred into the glass tube to be irradiated by Co-60 gamma source at room temperature. Radiation dose 25 kGy, after polymerization, the vials broken, the irradiated samples were cut into small pieces. All samples were washed in excess water to remove the unreacted component, then air dried at room temperature. The percentage grafting of this gamma rays assisted synthesized CMC-g-AAm/AAc was evaluated as

$$\text{Grafting (\%)} = \frac{\text{wt. of graft comonomer} - \text{wt. of polysaccharide}}{\text{wt. of polysaccharide}} \times 100$$

2.2. Purification of the graft comonomer by solvent extraction Method

Any occluded acrylamide (AAm) and acrylic acid (AAc) formed by competing homopolymer formation reaction was removed from the graft comonomer synthesized as above, by solvent extraction using a formamide–acetic acid mixture (1:1 v: v) (Fanta, 1973).

3. Characterization

3.1. FTIR spectroscopy:

The Fourier transforms infrared spectroscopy spectra of CMC (A) ,CMC-g-AAm (B), CMC-g-AAc (C) and CMC-g-co-(AAm/AAc) were recorded on Mattson 1000, Unicam infrared spectrophotometer, Cambridge, England in the range 400–4000cm^{-1} using KBr pellets.

3.2 Morphological study (SEM)

An ISM-5400 scanning electron microscope, JEOL, Tokyo, Japan, was used for the morphological observation. For this study CMC was used in powder form and graft copolymers were in granules form, then coated with gold before microscope testing.

3.3. Differential scanning calorimeter (DSC):

DSC measurements were performed using a Perkin –Elmer DSC-7 calorimeter. A heating rate of 10^{0}C/min. was utilized under nitrogen atmosphere. The recorded glass transition temperature was taken as the temperature at which one half of the change in heat capacity has occurred.

4. Adsorption studies

In order to understand the adsorption behavior a number of batch studies have been conducted to investigate the effect of adsorbent dose, contact time and pH. For these studies, wastewater of various concentrations of COD was used and kept separately in glass stoppered conical flasks. Then suitable doses of adsorbent were added to the wastewater. The system is equilibrated by shaking the contents of the flasks at room temperature and quiescent settling period of 30 min was allowed so that adequate time of contact

between adsorbent and the COD is maintained, was analyzed to evaluate the concentration of COD in the treated wastewater. During these trials, the COD of both the raw and treated effluent was determined using the closed reflux colorimetric:

$$\mathrm{R}emoval(\%) = \frac{(C_0 - C_t)}{C_0} \times 100$$

Where, C_o and C_t (both in mg/L) are the initial concentration and the concentration at any time (t), respectively

RESULTS AND DISCUSSIONS

1. Factors effecting on the grafting percent of CMC-g-AAm/AAc

In the present investigation, the effect of concentration of AAc, AAm and gamma irradiation dose were studied, to optimize the reaction conditions

1.1. Effect of monomer concentration on the Grafting percent

The effect of monomer concentration on the grafting percent was carried out by grafting the CMC (Carboxymethyl Cellulose) with acrylamide and acrylic acid as co-monomers for choosing the best monomer concentration with high grafting percent. The optimum amount of acrylamide and acrylic acid for achieving higher degree of grafting was studied by varying the concentration of acrylamide and acrylic acid (5,10,15, 20, 25 and 30 %) and constant the CMC dose (1 %) and irradiation dose(25 KGy).
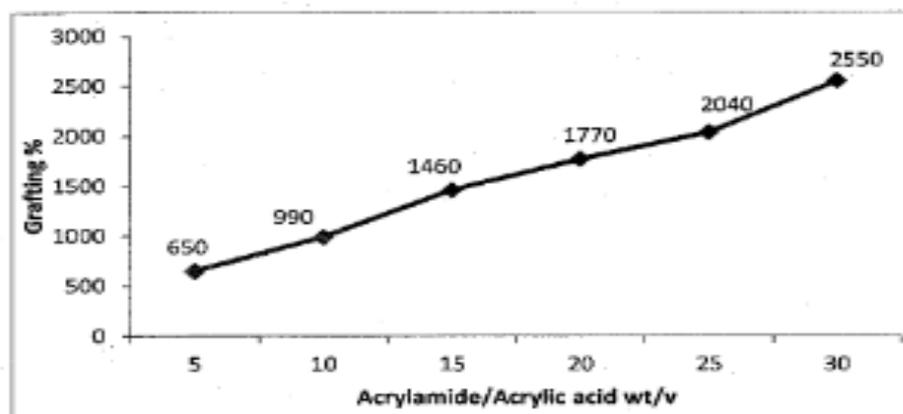
Figure (2): Effect of AAm and AAc comonomers composition (1:1) on the grafting percent of AAm/AAc/CMC at irradiation dose 25kGy.

The relation between effect of acrylamide and acrylic acid co-monomers composition (1:1) on the grafting percent was shown in Figure (2). The grafting percent increases with increasing of acrylamide and acrylic acid concentration in solution till 30 % the best grafting percent obtained.

At high monomer concentration, the monomer radicals increased which enhance propagation with polymer sites and that tends to form more cross-links, which produce high grafting yield.

Also, this increase may be due to increase the diffusion rate of the monomer into the bulk of the substrate (Abd-Alla, 2010) The increase in grafting percent could be associated with the greater availability of monomer molecules in the vicinity of CMC radicals .(Shafiei *et al*., 2012)

Above 30% monomers concentrations the grafted polymers were rigid, hard to cut in small parts and difficult to handle due to increase in the

homopolymerization then increase in viscosity of the medium. So 30% comonomers composition was used as the optimal monomers concentrations.

1.2. Effect of gamma irradiation dose on grafting percent

Graft copolymerization was studied at various doses of gamma-rays (10, 15,20,25,30 and 35 kGy) by keeping other reaction conditions constant.

The grafting percent of acrylic acid and acrylamide onto CMC was determined as a function of irradiation dose. The effect of gamma irradiation doses on the grafting percentage of AAm/AAc /CMC with constant monomer concentrations were investigated and shown in Figure (3)
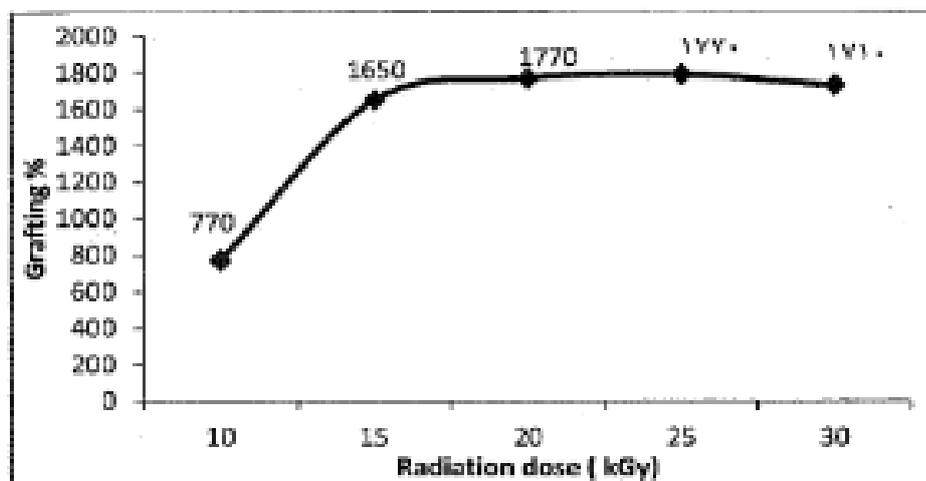
Figure (3): Effect of irradiation dose on the grafting percent of 30 % AAc/AAm on CMC

As shown in figures (3) the grafting percent rise with increase in irradiation dose up to 20 kGy, due to increasing the number of free radicals formed in polymer by irradiation dose, which increase the grafting reaction, therefore affect the kinetics of the grafting reaction and consequently the length of the grafted chains (Abd-Alla, 2010) The tendency to level off at high irradiation dose, due to the termination reaction of the grafting process takes place much faster than propagation ones, which would lead to lower degree of grafting (El-Salmawi *et al*., 1997).

Homopolymer formation at higher doses of δ-rays which compete with the grafting reaction for available monomer could lead to decrease in the grafting percent (Shafiei *et al*., 2012).

It could be concluded that the best grafting yield of acrylamide and acrylic acid onto CMC was obtained under the following optimum conditions: Irradiation dose 20kGy and 30 % AAC/AAm co-monomers composition (1:1).

2. Characterization:

2.1. FTIR spectroscopy:

The grafting of CMC with different monomers was confirmed by a FTIR spectrum. Figure (4) shows FTIR spectra of CMC (A) as a blank, CMC-g-AAm (B), CMC-g-AAc (C) and CMC-g- AAm/AAc
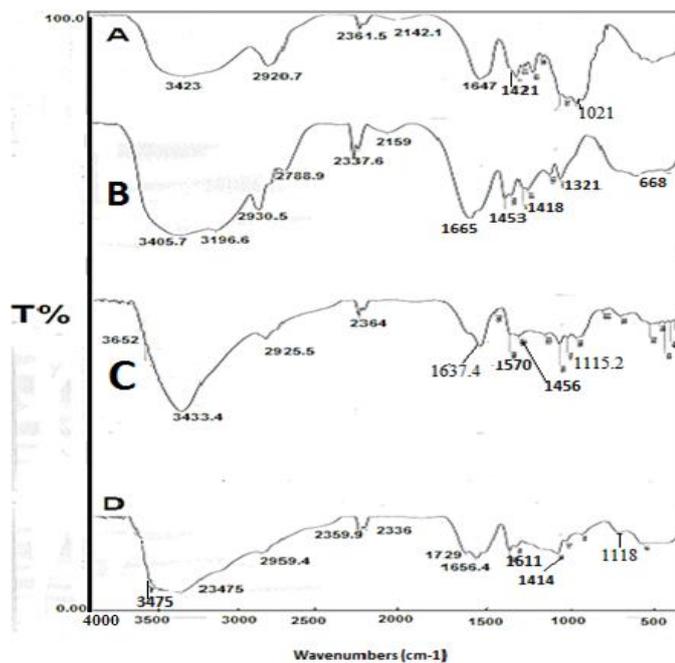
Figure (4): FTIR spectra of CMC (A) ,CMC-g-AAc (B),CMC-g-AAm(C) and CMC-g- co-(AAm/AAc)

From the FTIR spectra of CMC (Fig 4.a), it is evident that it shows a broad absorption band at 3423 cm^{-1} due to the stretching frequency of the – OH group in CMC. The C–H stretching vibration band at 2920.7cm^{-1}. The presence of a strong absorption band at 1647 cm^{-1} confirms the presence of carbonyl group of COO^- group. The bands around 1421 cm^{-1} are assigned to – CH_2 scissoring and the band at 1021 cm^{-1} is due to –CH–O–CH_2 stretching**,** (Biswal & Singh, 2004). In CMC -g-AAm (Fig 4. b), a broad absorption band at 3405 cm^{-1} for the N–H stretching frequency of the NH_2 group and NH wagging vibrations occurring at 686cm^1. A band around 1665 cm^{-1} is due to (C=O stretching) in amide group. The bands around 1418 and 2930 cm^{-1} for

the C–N and C–H stretching vibrations. Other bands at 1453 and 1321 cm^{-1} are attributed to CH_2 scissoring and CH_2 twisting, (Biswal & Singh, 2004)

In CMC-g-AAc (Fig 4. c), (FTIR) data show a band at 1637.4 cm^{-1} in which is due to grafting of C=O from AAC which increase the intensity of the peak (Said *et al*., 2004).

The peaks at 1456 cm^{-1} and 1115.2 cm^{-1} are related to the stretching vibration and symmetrical stretching of -COO groups (Pourjavadi *et al*., 2010).

In CMC-g- AAm/AAc (Fig 4. d), The band at 3475 cm^{-1} observed was attributed to the NH stretching of the AAm unit, which overlaps the OH stretching band of the CMC polymer, the peak at 2959 cm^{-1} is ascribed to the C-H stretching of the CMC. The peak at 1729 cm^{-1} is attributed to the carbonyl stretching of the carboxylic acid groups (Suo *et al*., 2007)

The band at 1611 cm^{-1} is due to the C=O asymmetric stretching in the carboxylate anion that is reconfirmed by another sharp peak at 1414 cm^{-1}, which is related to the symmetric stretching mode of the carboxylate anion.The peak at 1018cm^{-1}, ascribed to the C-O-C stretching,(Suo *et al* .,2007).A comparison of the four spectra of FTIR show that the characteristic absorption bands of AAc and AAM repeating units appear in the spectrum of the Co-monomer, and this confirms the grafting, Comonomerization of AAc and AAc monomers onto the CMC backbone

2.2. Scanning electron microscopy (SEM) analysis

Scanning Electron Microscope (SEM) has been a primary tool for characterizing the surface morphology and fundamental physical properties of

an adsorbent surface. It can be used to determine the particle shape, porosity, and appropriate size distribution of an adsorbent,

Fig (5) shows the surface morphology of CMC (A), CMC-g-AAm (B), CMC-g-AAc (C), and CMC-g- AAm/AAc (D).
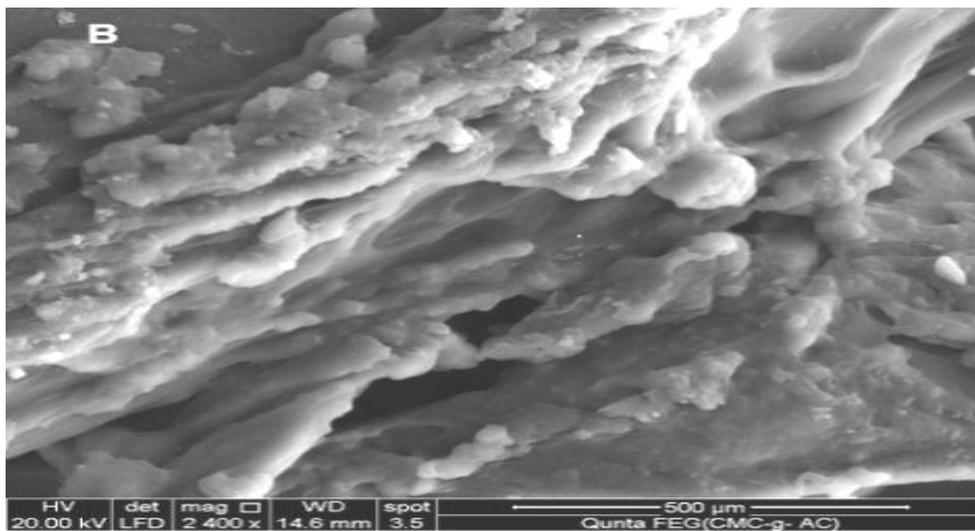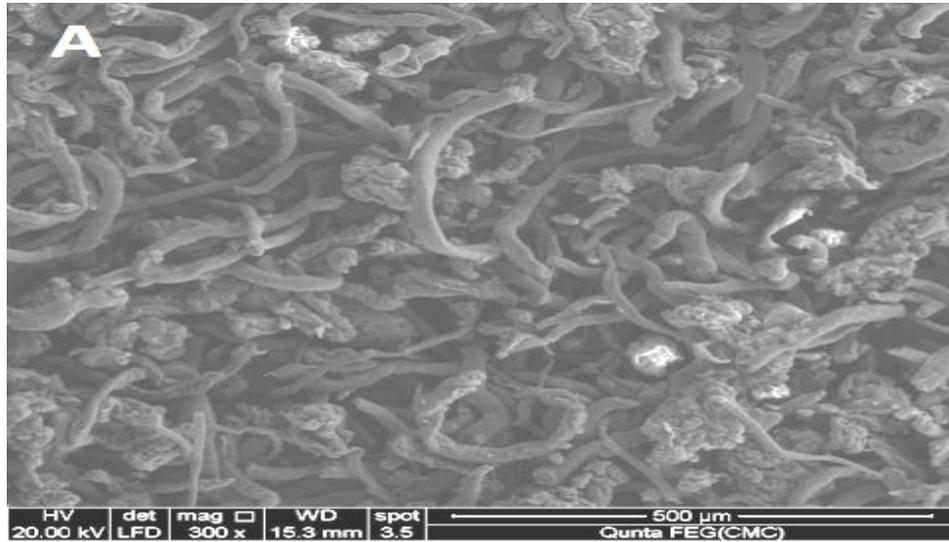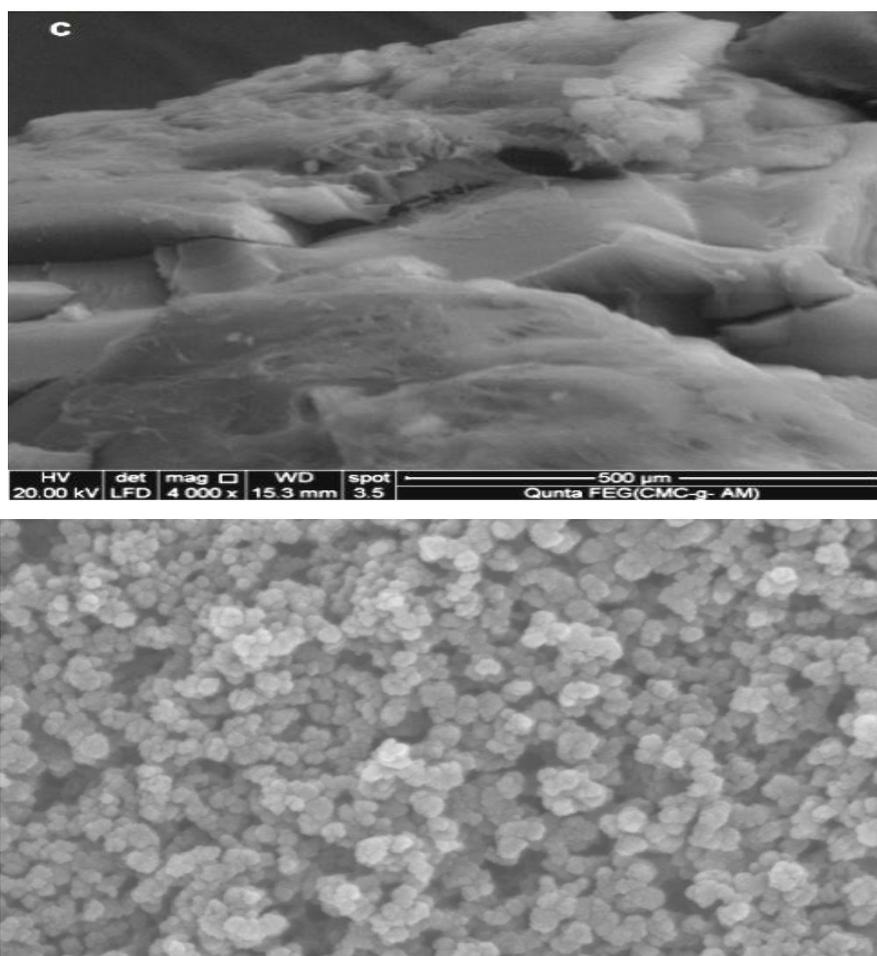
Figure (5): SEM of CMC (A), CMC-g-AAm (B), CMC-g-AAc (C) and CMC-g-AAm/AAc (D).

Surface morphology of CMC before grafting shows a granular structure, which has been changed to fibrillar form after grafting acrylamide, morphology is also changed drastically when grafted onto CMC. Thus, comparison of these figures reveals that grafting has taken place (Biswal and Singh 2004).

Pure CMC is characterized with a rough surface, CMC-g-AAm(B), demonstrates a smooth surface with low surface porosity.

Fig 5 (C) shows the surface morphological structure of CMC-g-AAc, The pores in CMC-g-AAc can be one of the regions of water permeation and interaction sites with external stimuli in the graft polymers (Pourjavadi *et al*., 2010).

Fig 5 CMC-g- AAm/AAc(D) which appears as coarse surface with many pores. The crosslinked network of CMC-g- AAm/AAc has different surface morphology, coarse surface with grains and surface is crowded.. It is evident that the CMC structure has changed when the AAc/ AAm introduced into the polymer.

2.3. Differential scanning calorimetry (DSC):

Differential scanning calorimetry (DSC) technique was used to study the effect of the addition of different concentrations of acrylamide and acrylic acid to CMC on glass transition temperature (Tg) and melting temperature (Tm) phenomena of the grafted polymer. The glass and melting transition temperatures of pure CMC (A), CMC-g- AAm(B),CMC-g-AAc (C) and CMC-g-AAm/AAc (D) at 20 kGy are shown in fig (6).
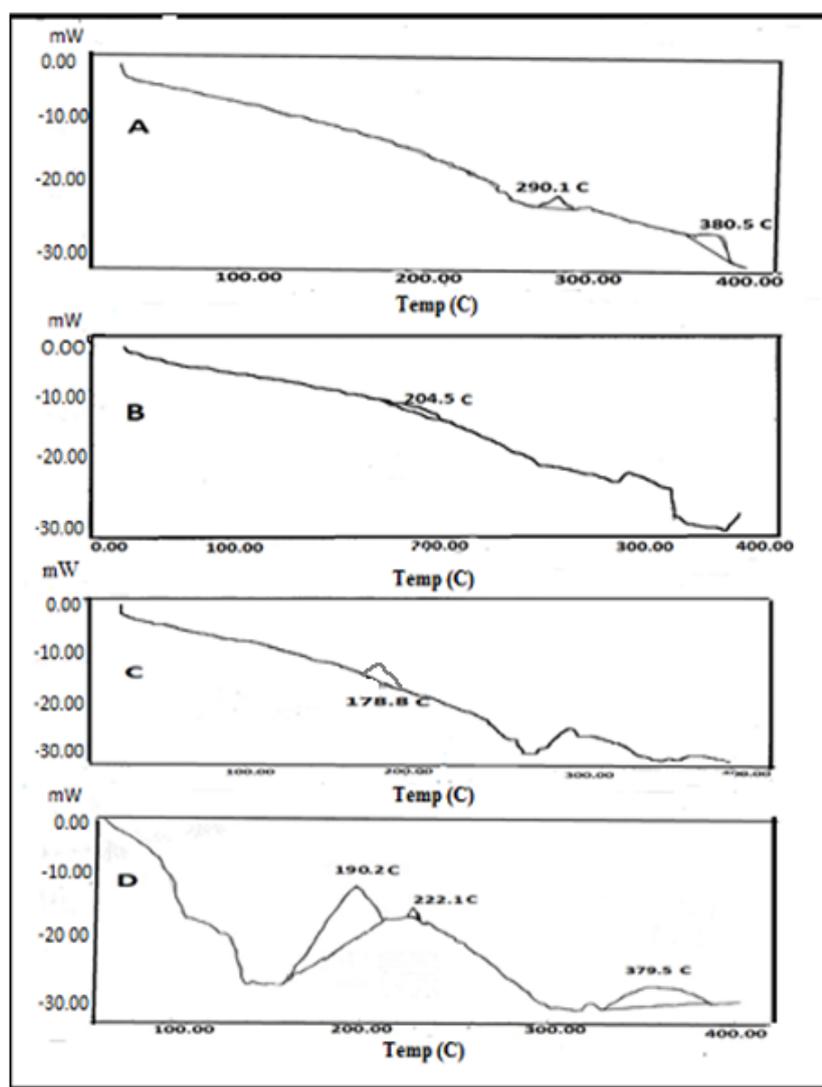
Figure (6): DSC curves of CMC (A), CMC-g- AAm(B),CMC-g-AAc(C) and CMC-g-AAm/AA(D)

Differential scanning calorimetry (DSC) curve of CMC have one exothermic peak at about 380^0C and others at relatively higher temperatures due to the decomposition of the main chain (cleavage of glycosidic linkages). In the DSC curve of CMC-g- AAm(B), The peak at 204.5^0C is for crystalline melting of acrylamide branched grafted polymer (Biswal and Singh 2004).

DSC curves of CMC-g-AAc(C) having one exothermic at (178^0C) is for crystalline melting of acrylic acid branched.

In the grafted product CMC-g-AAm/AAc(D), the characteristic peaks are represented to acrylamide and acrylic acid, were shifted to high temperatures. The peak at 222.1^0C is for crystalline melting of acrylamide branched shifted from 204.5^0C and peak at 190.2^0C for crystalline melting of acrylic acid branched shifted from 178.8^0C due to H-bond formation between carboxyl groups and amides, formation of H-bond increases the physical cross-linking points of the copolymer and thickening the solution of copolymers, (Zhang ,2009)

2.4. Adsorption study in wastewater:

Effect of adsorbent dose, stirring/contact time and pH for removal of Chemical oxygen demand (COD) was studied for the optimal conditions.

2.4.1. Effect of pH on removal percent of COD:

pH of solution is a very important parameter that affects the properties of adsorbate and adsorbent as well as the adsorption process in aqueous solutions. To evaluate the effect of pH on the adsorption capacity of these grafted polymers, the adsorption experiments were carried out in solutions having different pH values (4, 5, 6, 7, 8, 9 and 10).
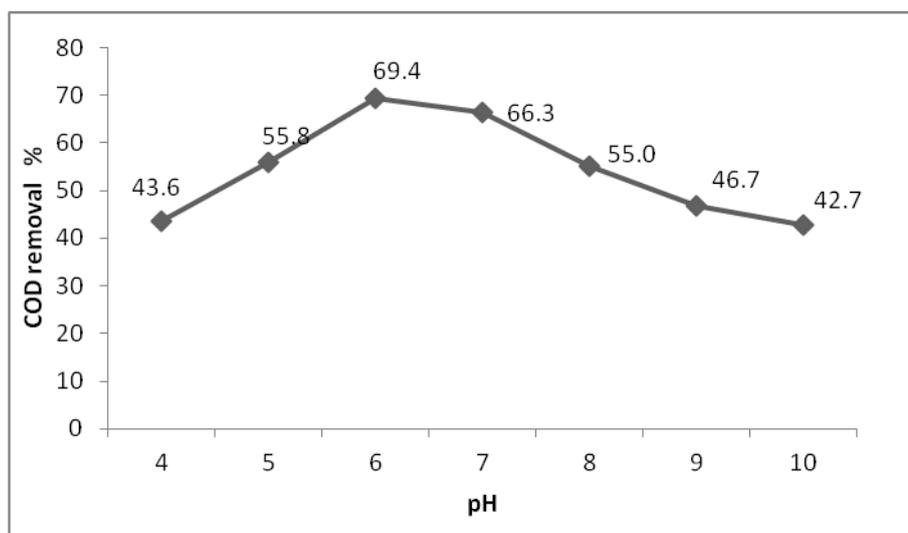
Figure (8): Effect of pH on COD Removal percent

The relation between effects of pH on Removal percent of chemical oxygen demand was shown in Figure 8.

The removal percent of COD increase with the increase of pH from 4 and 5 (at acidic medium) till 6.7 and then starts to decrease at 8, 9 and 10 (at basic medium).

The optimum pH was observed to be 6 and 7 for the adsorption process, the maximum COD removal was observed to be 69.4 and 66.3 percent at the pH value of 6 and 7, respectively. This was due to the electrostatic interaction between the Chemical oxygen demand (COD as an adsorbed molecule and the grafted CMC as an adsorbent surface (El-Naas *et al*., 2010). Effectively, as the pH in alkaline medium (8-10), the electrostatic repulsion force increase then the dispersion between the adsorbate and grafted CMC surface occurred and subsequently a decrease in the removal was observed, This is in

agreement with the findings of (Njoku and Hameed 2011), In conclusion, pH 6 was used as the optimum pH during further experimental work.

2.4.2. Effect of dose of grafted CMC on the removal percent of COD:

Different doses of grafted CMC **(20, 40, 60, 80,100,120 and 140 mg/l)** were added in conical flasks and kept it on shaker (250 rpm) for 150 minutes and pH 6.
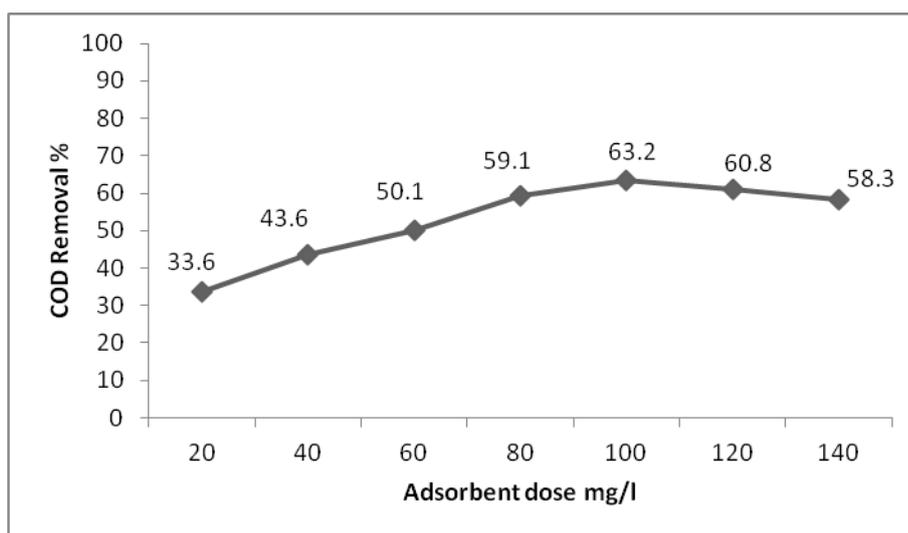
Fig (9): Effect of Adsorbent doses on COD removal percent

The relation between adsorbent dose and COD removal was shown in Figure 9.

The removal of COD increases with increasing the doses of the grafted CMC from 20 mg to 80 mg and then started to decrease at high dose (120 and 140 mg) of grafted CMC. It was observed that maximum COD removal of 63.2% was obtained using 100 mg of grafted CMC. This can be explained by the fact that increases in grafted CMC dose increases removal of COD till 100

mg and by the increasing the dose of CMC super saturation solution obtained which not complete soluble in water (turbid solution).

This can be attributed to the fact that increases in adsorbent doses increases surface area for adsorption. Further increase in the adsorbent doses does not affect the COD removal. It may be because of the fact that high amount of adsorbent sites may not come properly in contact of adsorbate, This observation is accordance with the findings of (Kulkarni , 2013). So,100 ppm is found to be optimum dose with COD removal of 63.2 percent

2.4.3. Effect of contact time on the removal percent of COD:

For studying this effect, 1000 ml of the wastewater was taken in conical flak. The adsorbent dose of 100 mg for COD was added, the samples were kept on shaker (250 rpm) and pH 6. The samples were analyzed after each 20 minutes interval and results are depicted in Fig 10.
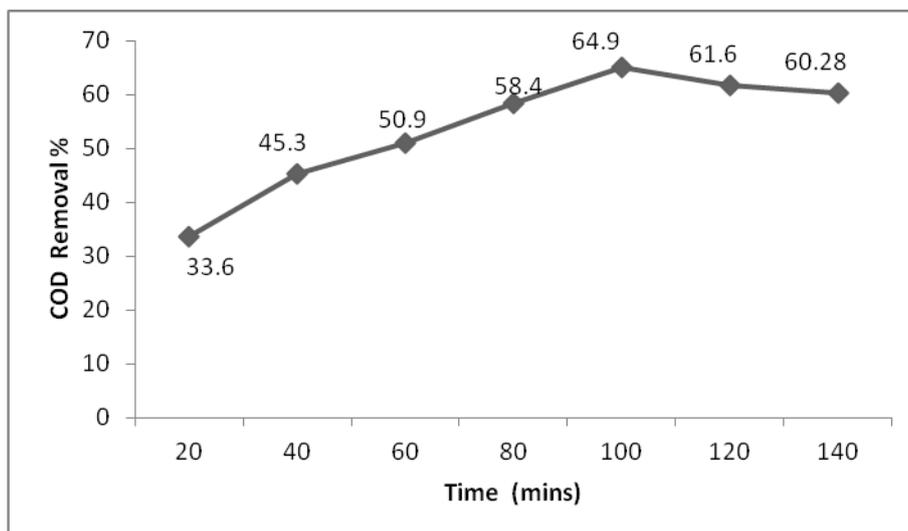
Figure (10): Effect of Contact Time on COD removal percent

The relation between effect of contact time on COD removal percent was shown in figure 10.

The removal of COD increase with increasing the contact time from 20 mins to 100mins and then started to decrease with increasing contact time. Hence, 100 minutes and attains the optimum value of 64.9 percent.

It is obviously clear that the diffusion of grafted CMC inside the solution leads to good adsorption efficiency as a results of the high surface area available to different pollutants, and as the process proceeds, a state of equilibrium will be established due to saturation of active sites on the surface with the pollutants, so as the contact time increased, the adsorption efficiency will not affected.

This also may be due to the attainment of equilibrium between the adsorbent and adsorbate, that shown good agreement with (Kulkarni, 2013).

after the lapse of time the occupied sites were starting to repel the adsorbate molecules in the bulk phase and that the driving force for these molecules to reach the vacant surface sites and get adsorbed was becoming weaker,(Ho *et al*., 1995) discussed that the decrease in removal rates was due to the predominance of pore diffusion of adsorbent particles in order to create new sites onto the inner surface of the sorbent material.

Faster initial adsorption rates were also attributed to the solute being adsorbed onto the surface of the adsorbent particles until surface saturation was reached (Ahmad and hameed , 2009).

Hence 100 minutes contact time, pH 6 and 100mg of the adsorbent dose per 1000 ml of effluent are the optimum parameters for COD removal

Treatment of Wastewater at Optimum CMC –g-AAm/AAc

After the determination of the optimum dose, contact time and pH of CMC-g-AAc/AAm towards COD reduction, these optimum parameters are applied to raw wastewater to evaluate the efficiency of Chemical Oxygen Demand, Biochemical Oxygen Demand, Total suspended solides, Total Kjeldahl nitrogen, Ammonia nitrogen, Oil and grease, Phosphate and sulfides from raw wastewater.

Three wastewater samples from Abu Rawash treatment plant was taken and then treated it with grafted CMC at optimal conditions using the batch technique which were used to describe the adsorption process.Then calculated the removal percent for the average of three samples.

Table (1): Summary of the main influent parameters after the treatment at optimal conditions

Test	Unit	Raw W.W	Treated			Average	Removal
			1	2	3		
PH		7.3	7.2	7.4	7.3	7.300	
COD	mg/l	236	58	76	78	70.66±11.02	70.056
BOD	mg/l	163	56	61	99	72.00 ± 23.5	55.828
TSS	mg/l	173	31	22	17	23.33±7.10	86.513
TN	mg/l	33.3	15	20.2	16.4	17.20 ± 2.50	48.348
NH4-N	mg/l	17.2	10.5	12.1	10	10.86 ± 1.10	36.822
TP	mg/l	5.2	2.5	1.8	2	2.10 ± 0.36	59.615
OIL&GREASE	mg/l	33.8	16.7	23.7	16.9	19.10 ± 3.9	43.491
H$_2$S	mg/l	4.8	1.9	2.7	3.8	2.80± 0.95	41.667

The following observations can be concluded from Table1, with respect to the physical and biochemical properties of the samples, after adsorption process using the newly produced adsorbent, modified carboxymethyl cellulose.

Comparing the result obtained from Table, it can be observed that the pH at all samples were within the 7.2, 7.3 and 7.4.

From the experimental result in Table, with respect to COD in waste water before and after treatment, it can be observed that the COD was reduced from 236 mg/l to 58 mg/l for the first sample and 76 mg/l for second sample and 78 mg/l for the third sample with average removal percent 70 %.This show the efficiency of the modified CMC.

The BOD in the feed waste water was reduced from 163 mg/l to 56 mg/l for the first sample and 61 mg/l for the second sample and 99 mg/l for the third sample with average removal percent 55.8 %

The results obtained showed that there was a remarkable decrease in the amount of total suspended solids after treatment. It was reduced from 173 to 31, 22 and 17 for the samples with average removal percent 86.5 %

The TN reduced from 33.3 to 15, 25.2 and 16.4, with average removal percent 48.3 % Experimental results from Table 1 showed that the TN was relatively removed.

The result obtained from the experiment shows that the Ammonia was decrease from 17.2 mg/l to 10.5 mg/l, 12.1 mg/l and 10 mg/l with average removal percent 36.8 % after the adsorption.

From the experimental result in Table, phosphate reduced from 5.2 to 2.5, 1.8 and 2, with average removal percent 59.6 %

The results obtained showed that there was a remarkable decrease in the amount of Oil& Grease after treatment. It was reduced from 33.8 mg/l to 19.1 mg/l, 23.7 mg/l and16.9 mg/l with average removal percent 43.4 %

The Sulfides reduced from 4.8 mg/l to 1.9 mg/l, 2.7 mg/l and 3.8 mg/l , with average removal percent 41.6 %

CONCLUSION

Acrylamide and acrylic acid grafted carboxymethyl cellulose (CMC-g-AAm/AAc) has been synthesized by gamma radiation from C0-60 source at room temperature (27°C), the structural characterizations

by FTIR spectra have indicated the presence of AAm/AAc units in the products. The study of FTIR spectra, Scanning Electron Microscope (SEM) and Differential scanning calorimetry (DSC) analysis provide that the graft copolymerization takes place. The main factors affecting the grafting percent such as monomers concentrations and irradiation dose were studied. The optimum reaction conditions were found to be Irradiation dose 20kGy and 30 % AAC/AAm comonomers composition (1:1).

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تحضير وتوصيف كاربوكسي ميثيل السليلوز المطعم بالاكريلاميد وحمض الاكريليك وتطبيقه لمعالجة مياه الصرف الصحي

[٣]

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المستخلص

يهدف هذا البحث إلي دراسة تطعيم كاربوكسي ميثيل السليلوز بواسطة الاكريلاميدوحمض الاكريليك عن طريق البلمرة باستخدام اشعة جاما من مصدر الكوبالت–٦٠. ودراسة تاثير تركيز كل من الاكريلاميد وحمض الاكريليك وجرعة التشعيع للحصول علي نسبة التطعيم المثلي.

تم توصيف (كاربوكسي ميثيل السليلوز\ الاكريلاميد\ حمض الاكريليك) المعدل بواسطة مطياف الاشعة تحت الحمراء(FT–IR) والميكروسكوب الاكتروني الماسح (SEM) ومسعر المسح التبياني(DSC).

وأظهرت النتائج ان عند نفس جرعة التشعيع تزداد نسبة التطعيم بزيادة تركيز كل من الاكريلاميد وحمض الاكريليك وايضا كلما زادت جرعة التشعيع.

تم استخدام (كاربوكسي ميثيل السليلوز\ الاكريلاميد\ حمض الاكريليك) المعدل كسطح ممتز لمعالجة مياه الصرف الصحي عند الظروف المثالية للتفاعل تبين ان قيمة الرقم الهيدروجيني المثالية هي ٦ وجرعة كاربوكسي ميثيل السليلوز المعدل ١٠٠ ملي جرام/ لتر وأن زمن التلامس هو ١٠٠ دقيقة وكانت نسب كفاءة الازالة في المواد الصلبة العالقة (٨٦%)، ٧٠ % من الأكسجين الكيميائي المستهلك، ٥٥،٨ % الاكسجين الحيوي المستهلك، ٤٨،٣% نتروجين الكلي، ٣٦،٨% الامونيا، ٥٩،٦ % فوسفات، ٤٣،٤ % زيوت وشحوم،٤١،٦% كبريتيد

الكلمات الاستدلالية: كاربوكسي ميثيل السليلوز– الاكريلاميد– حمض الاكريليك– معالجة مياه الصرف.