

Synthesis of Polyurethane Based on (Resol Novolac Resin- Polyethylene Glycol) Copolymer and Their Analytical Study

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ABSTRACT:

Resol novolac resin was prepared by condensation of novolac resin with formalin solution in the presence of sodium hydroxide as catalyst, then new copolymer were prepared by reaction of this resin with polyethylene glycol. This new copolymer was supported on polyurethane foam as solid phase and applied to separation a mixture of Cr(III) and Cd(II) ions from aqueous solutions prior to the determination by flame atomic absorption spectrometry. The optimum conditions of some parameters effect on recovery of the ions such as acidity, eluent condition, shaking time, and eluent flow rate were investigated. At pH 4.5, the maximum recovery (90%) of Cd(II) by stripping with 40 ml of (1N) nitric acid, while for Cu (II) was 80 % with 50 mL of (2N) nitric acid. On the other hand thermal stability for the prepared polyurethane was evaluated by TGA.

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تحضير ودراسة تحليلية للبولي يوريثان المحضر من (راتنج الريسول نوفولاك – بولي اثيلين كلايكول) المشترك

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قسم الكيمياء- كلية العلوم- جامعة ميسان

الكلمات المفتاحية:

راتنج ريسول نوفولاك
كوبوليمر للبولي يوريثان
عمود الكروماتوغرافي
لتحليل الحراري الوزني

الخلاصة:

حضر راتنج (الريسول – نوفولاك) من تفاعل تكثيفي بين النوفولاك والفورمالين باستخدام هيدروكسيد الصوديوم كعامل مساعد ، ثم حضر كوبوليمر جديد من خلال تفاعل الناتج مع البولي اثيلين كلايكول واسناد الكوبوليمر الجديد على الرغوات الاسفنجية الصلدة، واستخدم الكوبوليمر المسند على البولي يوريثان لفصل مزيج من ايونات الكروم والنحاس من محاليلهم المائية باستخدام مطيافية اللهب الذري .تم تثبيت الظروف المثلى لعملية استرجاع الايونات والمتمثلة بالحامضية ، نوع وتركيز الشاطف ، زمن الرج ، ومعدل جريان الشاطف . من خلال النتائج لوحظ عند الاس الهيدروجيني 4.5 تكون نسبة استرجاع ايون الكاديوم هي 90% عند تركيز 1 نورمالي من حامض النتريك ، في حين نسبة استرجاع ايون النحاس كانت 80 % وبتركيز 2 نورمالي من نفس الحامض . من ناحية أخرى تم دراسة الاستقرار الحراري للبولي يوريثان المحضر باستخدام تقنية التحليل الحراري الوزني.

1. INTRODUCTION

Phenolic resins are some of the oldest synthetic polymers. Phenol - formaldehyde resins which are obtained from phenols and formaldehyde depending on the relative amounts of the reactants and the nature of the catalyst, the reaction produce either thermoplastic resins (novolac) in acidic medium or thermosetting resins (resols) in basic medium⁽¹⁾.

Many research works has been carried out on the preparation and characterization of Phenolic copolymers. Copolymer is found useful applications as adhesive, high temperature flame resistant, coating materials, catalysis and chelating polymers ion or exchange resins^(2,3). Chelating resins have been widely used for separating and treating industrial which contains heavy metal ions, Phenol-formaldehyde resin is suitable for preparing ion exchangers or chelating agents because they have hydrophilic groups, so that phenol-formaldehyde resin has good adsorption for metal ions⁽⁴⁻⁷⁾. According to the World Health Organization (WHO), the heavy-metals of most immediate concern are chromium, nickel, cadmium, copper, lead, mercury and zinc. The removal of heavy-metal ions from industrial and human wastewater is attracting increased attention. many types of polymers such as, phenol formaldehyde resin, poly(acrylic acid) grafted cellulose and macro porous poly(glycidyl methacrylate-co-ethylene glycol dimethacrylate) have been reported for the removal of Cu(II), Cd(II) and Cr(III), an example of these polymers have a porous structure and many hydrophilic groups, which can be used for heavy-metal ion removal⁽⁸⁻¹⁰⁾. Many research using polyethylene glycol at preparation chelating polymers^(11,12). The flame retardancy of toughened phenolic foams was evaluated by limiting oxygen index, and cone calorimeter. Copolymer PEGPs causes an increase toughness of phenolic foams. Moreover, the thermal stability of PEGPs and

the toughened foams was investigated by TGA analysis⁽¹³⁾. Thermal degradation of phenolic /PEG takes place in multiple steps and the thermal degradation, which concurred with the data from the thermal degradation of novolac type phenolic resin/PEG blends by TGA analysis^(14,15). Carbon foams are lightweight materials with high mechanical strength, low thermal expansion coefficient, adjustable thermal conductivity and large external surface area, which make them suitable materials for energy storage, catalyst supports and filters^(16,17). Polyurethane (PU) foams functionalized with colloidal super paramagnetic iron oxide nanoparticles and polytetrafluoroethylene has been reported, which can be used efficiently to separate oil from water⁽¹⁸⁾.

Good chelating sorbent was synthesized by covalently linking carbon Nano-fiber with ion exchange polyurethane with good sorption properties of platinum (IV) and successfully applied for extraction of platinum (IV) from different samples of ores⁽¹⁹⁾. Polyurethane foam was modified by the addition of halogen atoms and amino groups into the foam matrix in order to increase its polarity for the sorption of ionic species with high accuracy of the procedure was verified by the analysis of food, ground water and pharmaceutical samples⁽²⁰⁾.

The aim of this study was planning to synthesis and characterization of new copolymer resin supported on polyurethane foam and study the ability of this foam to up take some metal ions. These foam was synthesized through two steps, first copolymer prepared from resol novolac resin with PEG (molecular weight 600 g per mole) and second polyurethane was prepared from the reaction of copolymer resin with methylene diphenyl diisocyanate. The optimum condition of the efficient to up take the ions by this polyurethane resin was determined and also use this polyurethane to separation of mixed ions by column technique.

2. EXPEREMENTAL

2-1- Chemicals

All the standard chemicals used during this work are listed below , where the purity and the suppliers of those chemical are given as well:

Acetone 99% , Formalin solution 37% , phenol 98 % were supply from Sigma – Aldrich.

Polyethylene glycol (PEG- molecular weight 600 g per mole) , Hydrochloric acid 36% were supply from Riedel-de Haen. Sodium Hydroxide pellet 99% and polymeric methylene diphenyl diisocyanat (PMDI) with NCO content 35% were supply from Aldrich Chem.While metals as nitrate form $\text{Cu}(\text{NO}_3)_2 \cdot 5\text{H}_2\text{O}$ and $\text{Cd}(\text{NO}_3)_2$ supply from Merck – Germany company. These material used with out further purification .

2.2 FTIR –spectroscopic test:

The FTIR spectra of cured resin prepared in this study were performed in shimadzu, FTIR-8400. (Chem.Dep , College of Sci. University of Basrah) .Each spectrum was record in a frequency rang of $400\text{--}4000\text{ cm}^{-1}$ using potassium bromide (KBr) disc.The KBr was previously oven-dried at 300 C^0 to reduce the interference of water.

2.3-Thermogravemetric analysis (TGA):

TGA measurement were evaluated on TGAQ50 V20.13 Build 39. (Chem.Dep , College of Sci. University of Basrah) Dynamic scan were measure in temperature range $25\text{--}700\text{ C}^0$, at heating rate $50\text{ C}^0/\text{min}$. Under nitrogen atmosphere at flow rate 30 ml/min .

2.4-Viscosity mesyremments:

The viscosity of the resins were measured using Brookfield rotary viscometer Type Alpha Series Code V100002 with spindle (Chem.Dep , College of Sci. University of Basrah) at 25 C^0 . An average value of three replicate measurements was reported.

2.5 Synthesis

2.5.1 Synthesis of Novolac .

Novolac were prepared dy reacting phenol with formaldehyde in the molar ratio (1: 0.7) in the presence of Oxalic acid catalyst in three necked flask fitted with a mechanical stirrer , water condenser and thermometer . The reaction mixture was heated under hot plate and allowed to reflux at about 100 C for 2-3 hours . when the resin separated from aqueous phase the reaction was neutralized with phosphoric acid (10%) , filtered , washed several time with hot distteld water in order to remove unreacted phenol. The resin formed contains 4-6 benzene ring per molecule according to litreture ⁽²¹⁾ .

2.5.2. Synthesis of Resol Novalac Resin (RN)

In three necked flask fitted with a mechanical stirrer water condenser and thermometer, (50 mL) of formalin solution was added and heated to about $40\text{--}50\text{ C}$. Then (25 g) of novolac was added gradually mean while sodium hydroxide solution (10%) was added drop wise until the PH was 9.5 . After complete the addition of novolac the reaction mixture still in good mixing and the temperature rice to about $65\text{--}70\text{ C}$ for 3 hrs. , to get viscose material , neutralize with (10%) phosphoric acid in order to separate the product as thick resin , washed several time with hot distilled water inorder to remove unreacted novolac and formalin, then small amount of absolute ethanol was added to solve the resin in order to protect the resin from curing .

2.5.3 Reaction of RN with PEG 600 (RNG)

PEG (10 g) are place in a reaction flask previously with a mechanical stirrer , then (5 g) of uncured RN is added under constant stirring until a homogeneous mixture is obtained subsequently , the temperature is allowed to stay at about $70\text{--}80\text{ C}^0$ and the reaction is stirred for (2hrs.) . The final mixture is obtained as brown viscous material .

2.5.4 Synthesis of Polyurethane

Polyurethane was prepared from RNG resin and PMDI. In a reaction flask equipped with mechanical stirrer (10g.) of RNG resin was placed, then triethylamine (1%) was added with good mixing. Finally (10g.) of PMDI was added gradually, for about (30min.). Then the reaction mixture heated with continuous stirring for (1.5 hrs.) at (50 C⁰). The product is then removed from the stirring and placed in an oven at (100 C⁰) for about (3hrs.) to complete polymerization, post cure at (140C⁰) for 1hrs.

2.5.5- Dry solid content :

The percentage of dry solid content of resin was calculated by the following equation ⁽²²⁾ :-

$$S \% = S_1 / S_2 \times 100 \dots\dots 1$$

Where S₁ and S₂ the weight of the resin before and after dried (3 hrs. At 105 C⁰) respectively.

2.5.6- Free formaldehyde content:

The free formaldehyde content of the prepared resin (novolac and resol novolac) were determined by the hydroxyl amine hydrochloride method. Accurately weighed about 0.003 -0.005 g of the resin sample was transferred into 250 ml beaker and dissolved in 50 ml methanol. Simultaneously the pH value of the solution was adjusted to 3.5 by adding 1 N hydrochloric acid solution. 25 mL of 10 % hydroxylamine hydrochloride solution was added and stirred for 10 min. Finally the mixture solution was titrated with 0.1 Normal (N) sodium hydroxide solution. Free formaldehyde content was calculated by the following equation :

$$\% \text{ FFC} = 3c (V_1 - V_0) / m \text{ (according to ISO 9397 - 1995) } \dots\dots\dots 2$$

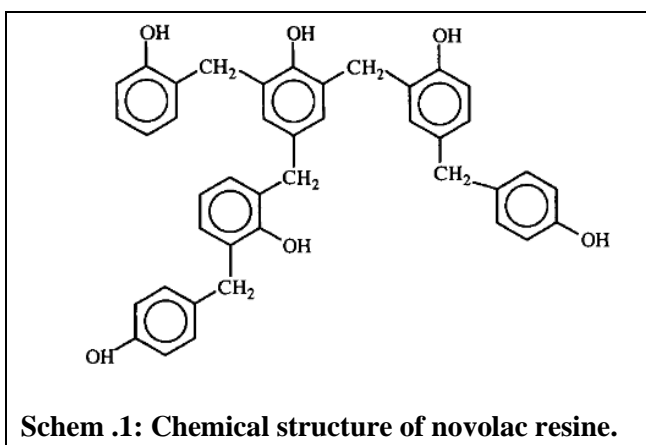
Where V₁ and V₀ are volumes of sodium hydroxide required in the titration for sample and blank respectively. C is the exact normality of sodium hydroxide

solution. m is the weight of sample resin in grams.

3. RESULT AND DISCUSSION

3-1-Reaction Schem:

Novolac are the first synthetic resin to be prepared by acid catalyzed addition – condensation of phenol with formaldehyde⁽²³⁾. and have already been used in practical application. In this research novolac was synthesized using oxalic acid as catalyst and in the ratio of phenol/ formaldehyde 1:0.76. The chemical structure of novolac are listed below with some physical properties.



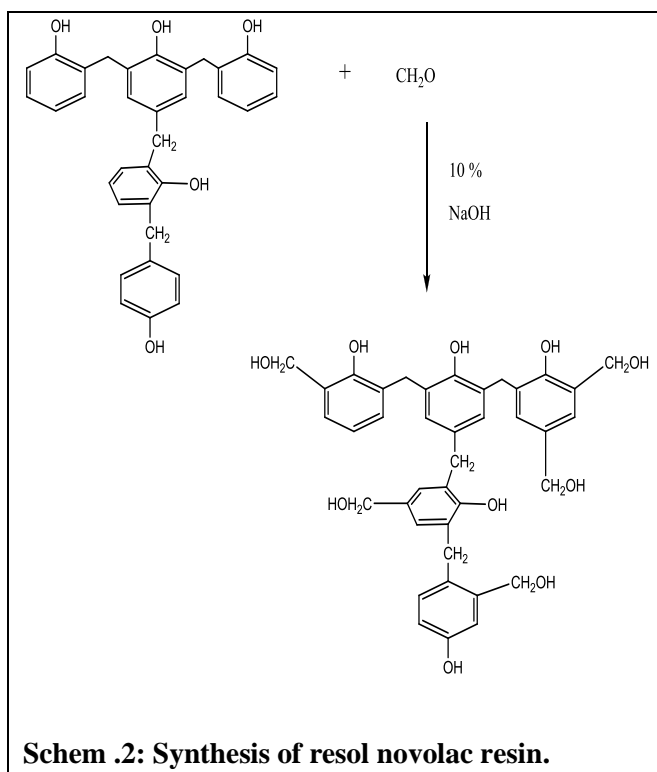
Schem .1: Chemical structure of novolac resin.

Appearance : slightly yellow.

Melting point : 88-95 C⁰.

Free phenol : less than 1%.

During the curing of novolac, hexamethylenetetramine is frequently used as curing agent⁽²⁴⁾ however the resultant curing products usually tend to contain amine derivatives and the unreacted curing agent as impurities, which often lead to coloration and degradation of the products, also the final product is free of reactive group. Here in this research new method used to convert novolac to new resin containing methylol group (-CH₂OH) which undergoes self condensation during heating by reacting novolac resin with excess of formaline solution in the presence of sodium hydroxide as catalyst. The reaction pathway was shown in schem 2.



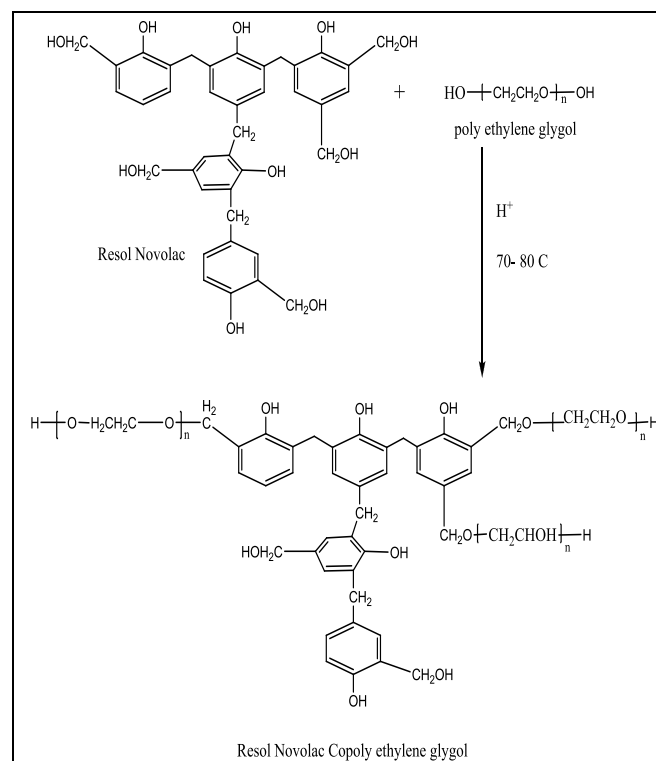
Apperance : very thick bbrown in color.

Dry solid content : 51 % 3 hurs at 105 C⁰.

Gel time : 21-25 min.

Viscosity : 321 mpa.s .

The apperance of this resin are thick viscuse soluble in alcoholic solvents. This resin under heat curing convert to brittle phenolic resin which fusible and not soluble in most organic solvent , so inorder to modified this resin flexeble aliphatic chain well be introduce in the back bone of this polymer .Here new copolymeric material prepared by reaction of this resin with polyethylene glycol (PEG- with molecular weight 600g/mole) in the presence of diluted sulphuric acid as catalyst. The reaction are shown in schem 3.



This resin have the following specification:

Viscosity : was 452 m pas.

Apperance : brown viscuse material.

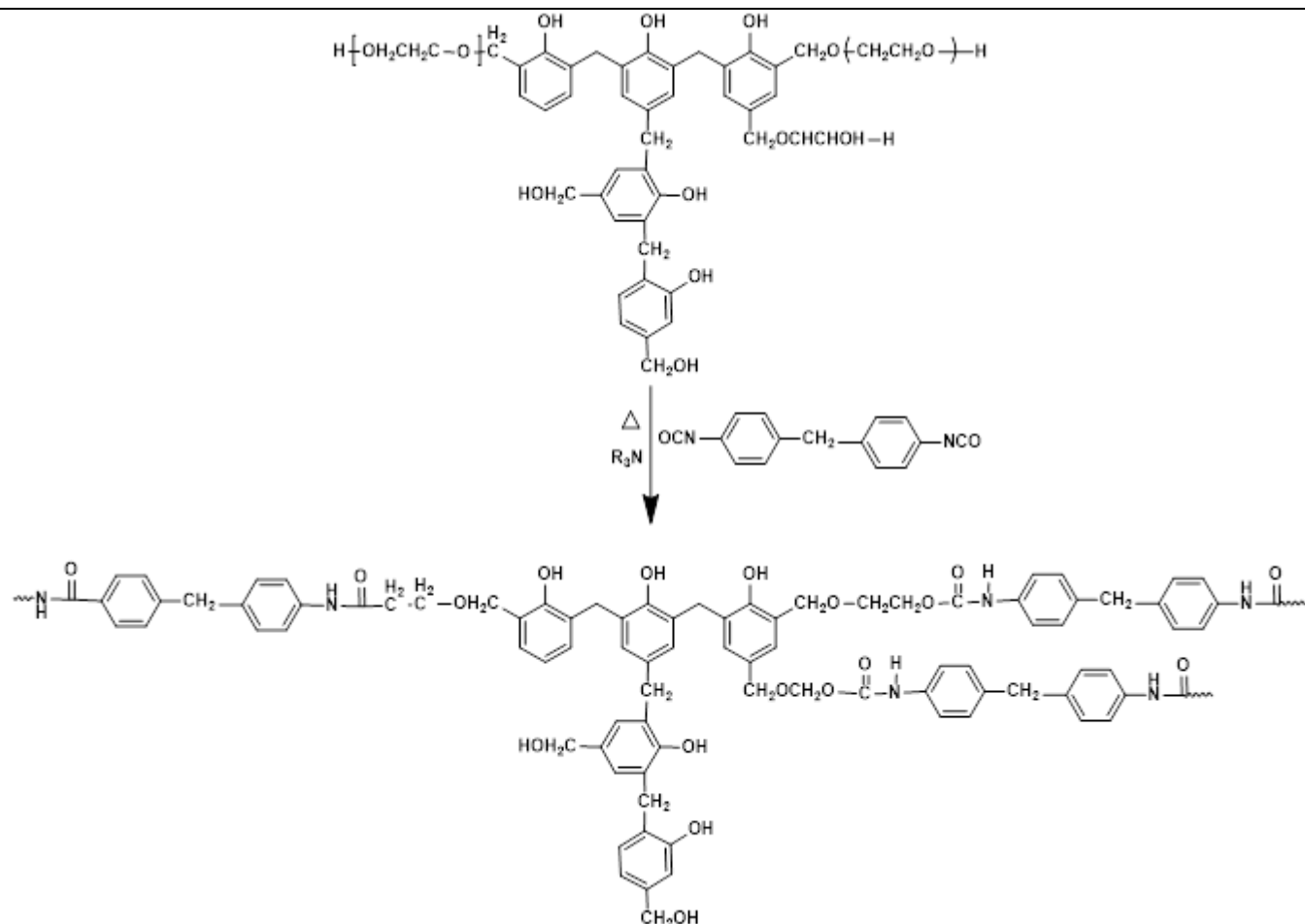
Density : 1.121 g/ cm³.

Solubility : soluble in most polar organic solvents .

Dry solid content : 55 % . 3hrs at 105 C⁰

Gel time : 32-37 min. at 100 C⁰.

Finally this copolymer will be converted to new polyurethane as shown in schem 4, and use its as new material to study the ability to take up some polution elements from aqueouse solution.



Schem .4: Proposed structure of polyurethane repeating unit production from copolymer and MDI.

3-2-FTIR-analysis :

Fourier transformation Infrared spectroscopy is an important and common technique to idetermaind the active group , the chemical structare , chain orientation and composition of different compounds which may be organic , inorganic and polymers ⁽²⁵⁾ . This spectroscopy is an important to examinne the polymers, it allows the analysis of structural features like functional groups (hydroxyl, carbonyl,amines, urethane and aromatics ets), and chain consitution .

FTIR spectra was used by forming KBr film.For novolac resin the Figure (1) show significant peaks at 3345 cm^{-1} due to $-\text{OH}$ stratching vibration , 2919 cm^{-1} for CH_2 stretching vibration. C-C aromatic double bond in the region 1642 and 1596, absorption beak in the region 1439 due to CH_2 bending while C-C double bond bending vibration at 1361 cm^{-1} ,while at $818,756\text{ cm}^{-1}$ was due to asym.stretching of aromatic C-C-OH and CH out of plane.The spectrum was shown in Figur (1).

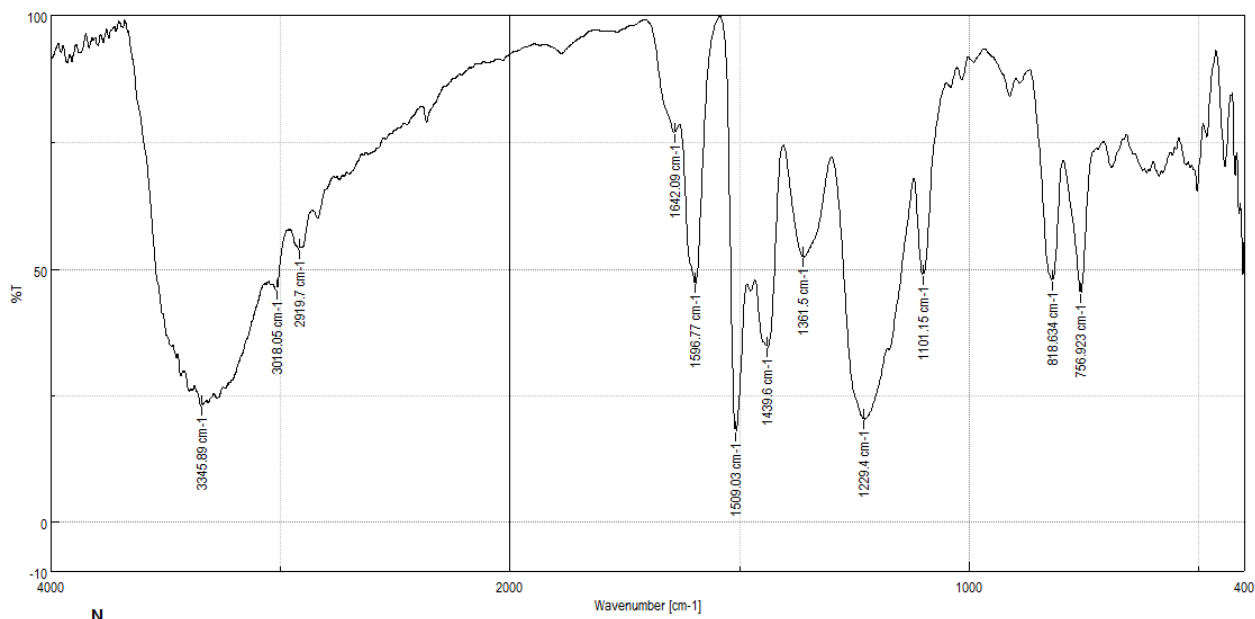


Figure 1: FTIR spectrum of novolac.

In the case of resol novolac resin the spectrum was shown in Figure 2. , some absorption bands appear at 3430 cm^{-1} due to the -OH stretching vibration, more intense band at 2924 cm^{-1} was attributed to CH_2 , also band at

1602 cm^{-1} related to C-C double bond. Anew band appear at 1030 cm^{-1} due to C-O-C which is not exist in the spectrum of novolac. Figure 3. Show the FTIR spectra of novolac and resol novolac prepolymers.

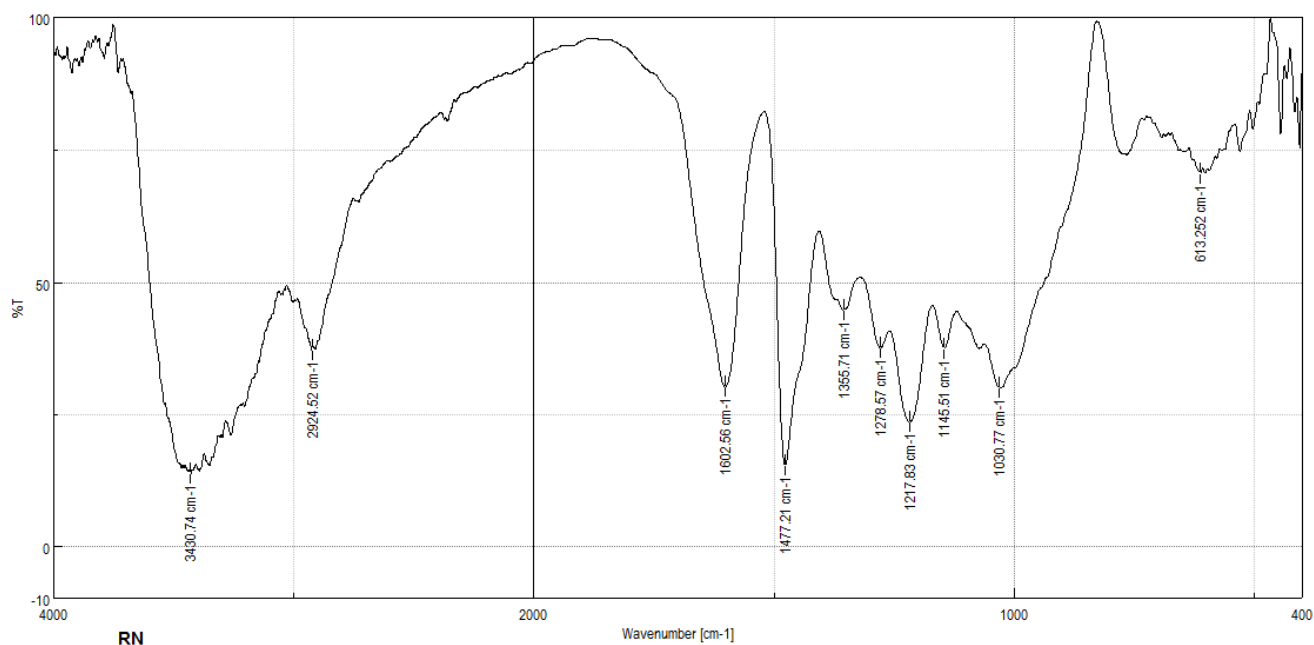


Figure 2: FTIR spectrum of resol novolac.

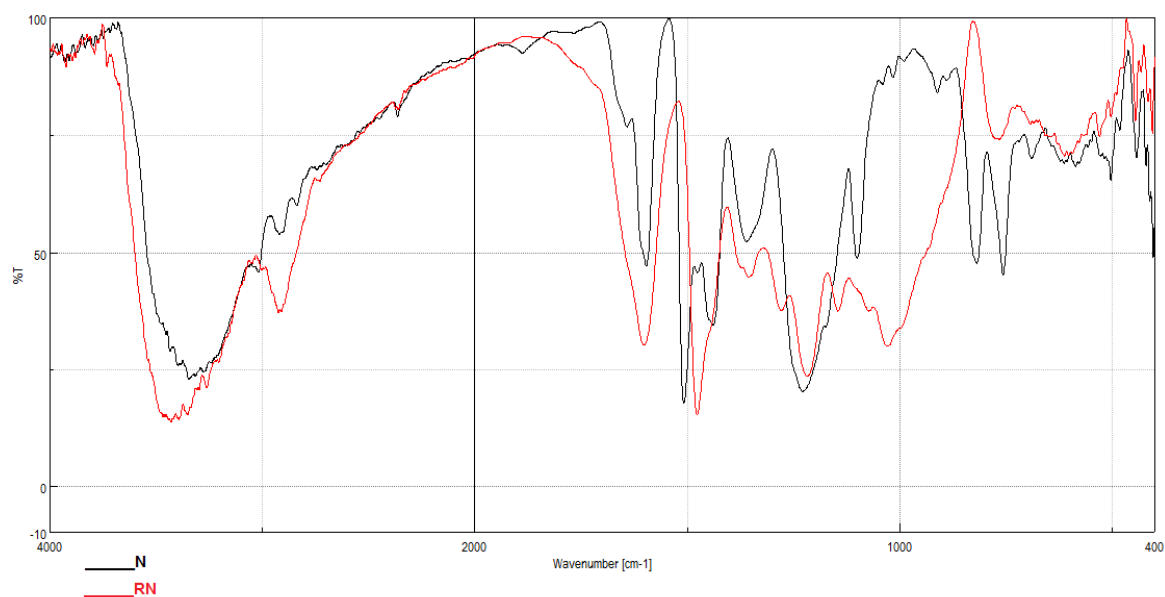


Figure 3: FTIR spectra of novolac and resol novolac prepolymer.

Finally the spectrum of prepared polyurethane foam in this study showed absorption peak at (1716 cm^{-1}) due to $(\text{C}=\text{O})$ stretching of urethane linkage obtained from the reaction of (NCO) groups present in MDI with (OH) groups present in the copolymers, while the absorption peak at 3323 cm^{-1} due to (N-H) units in the polyurethane chains. The other observed peaks in the FTIR spectrum were assigned as (2901 cm^{-1}) for (C-)

H) symmetric stretching of CH_2 groups, also there is absorption peak at (1512 cm^{-1}) is indicative of urethane linkage $(\text{C-N-H})^{(26)}$. Finally peak at (1599 cm^{-1}) due C-C aromatic double bond. Absorption band at 2275 cm^{-1} appears in this spectrum indicate to unreactive some of isocyanate groups. The spectrum of the copolymer and polyurethane was showing in Figures 4-6.

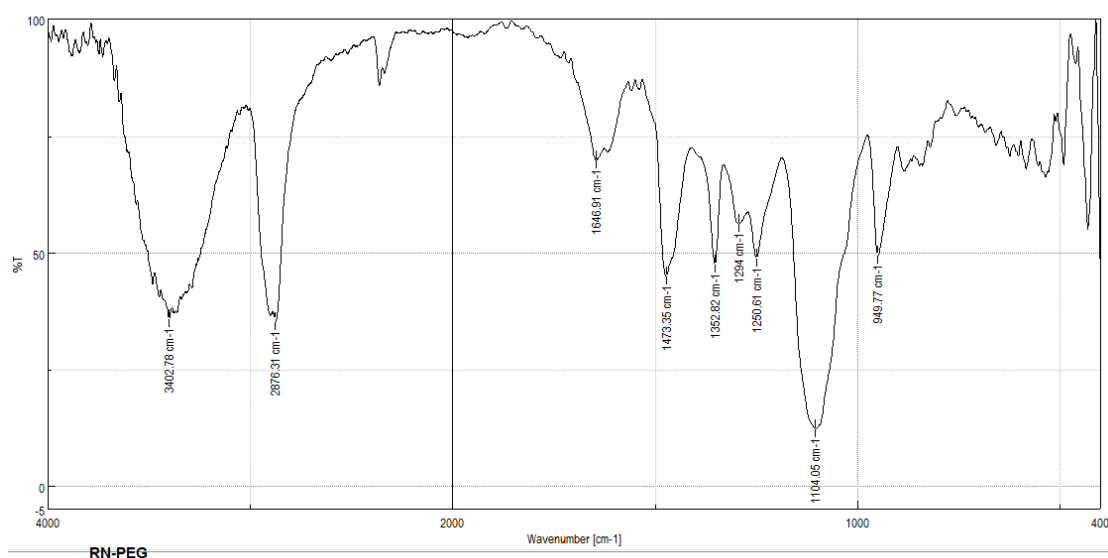


Figure 4: FTIR spectrum for prepared copolymer.

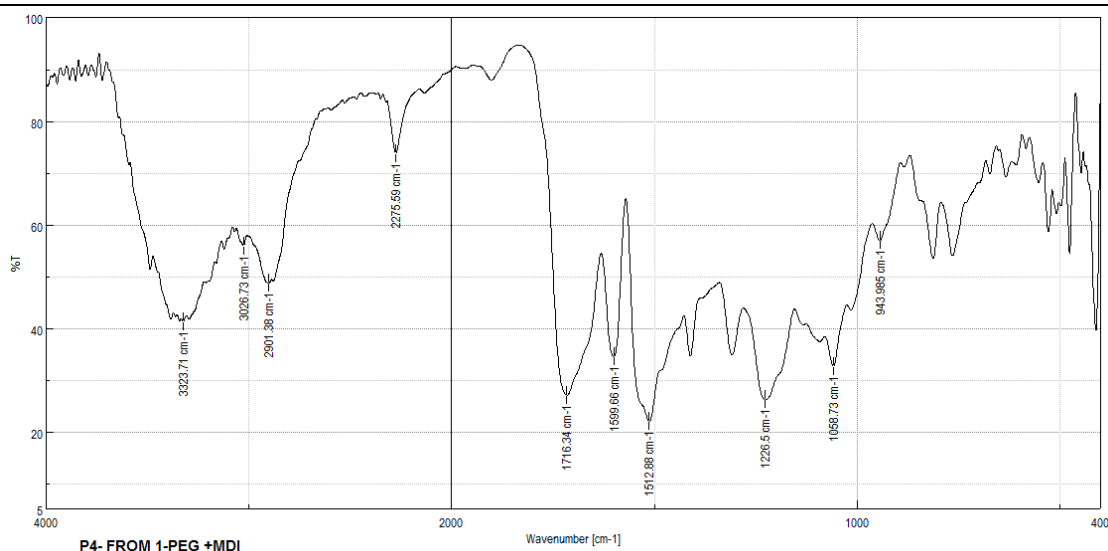


Figure.5: FTIR spectrum for prepared polyurethane.

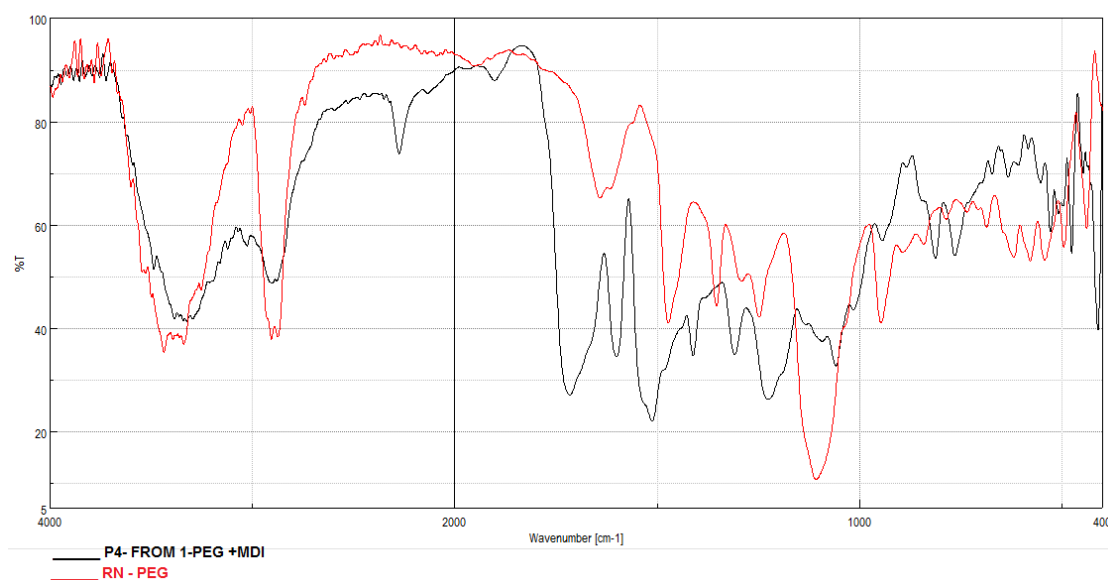


Figure 6: FTIR spectra of copolymer and polyurethane.

4-2-Water absorption test.

The gravimetric method using in static immersion test as a standard method (ASTM D 570) used to calculate water absorption of polymer. PU foam immersed in distilled water at 25°C for (24 hrs.). Weight change was calculated by the following equation

$$E_{sw} = (W_e - W_0) / W_0 \times 100 \% \quad \dots\dots\dots 3$$

where E_{sw} is the water uptake ratio of the PU foam

W_e : weight of the PU foam after immersion in water for 24 hrs.

W_0 : dry weight of PU foam before immersion in water

$$E_{sw} = 99.3\%.$$

5-2-Thermal Analysis TGA/DSC

The important applications of polymers is by the ability to predict product lifetime is valuable because the costs of premature failure in end use can be high⁽²⁷⁾. Thermal analysis (TGA) provides good method for accelerating the lifetime testing of polymers which monitors weight changes in material as temperature changes offers viable alternative to oven aging⁽²⁸⁾. In the TGA method, the material was heating at several different rates through its decomposition region.

From the resultant thermal curves, the temperatures for a constant decomposition level are determined. The TGA technique is particularly useful for the following types of measurements like, Thermal stability, oxidative

stability, decomposition kinetics, filler content of materials, moisture and volatile content. So from the thermograms (TGA and DSC) showed in figure (7), the TGA result indicates the decomposition temperature of the copolymer was (294°C) while the char content at 500°C and 600°C were 51% and 43% respectively. On the other hand the temperature of 50% weight loss was 511°C. In the case of DSC results, there is more exothermic peak indication several reaction between remaining methylol group or hydroxyl group present in the copolymers to form ether linkage, while the remaining two exothermic peaks at 328°C and 432°C due to the reaction of remaining hydroxyl group and isocyanate group and for the cyclization of remaining unreactive isocyanate groups respectively.

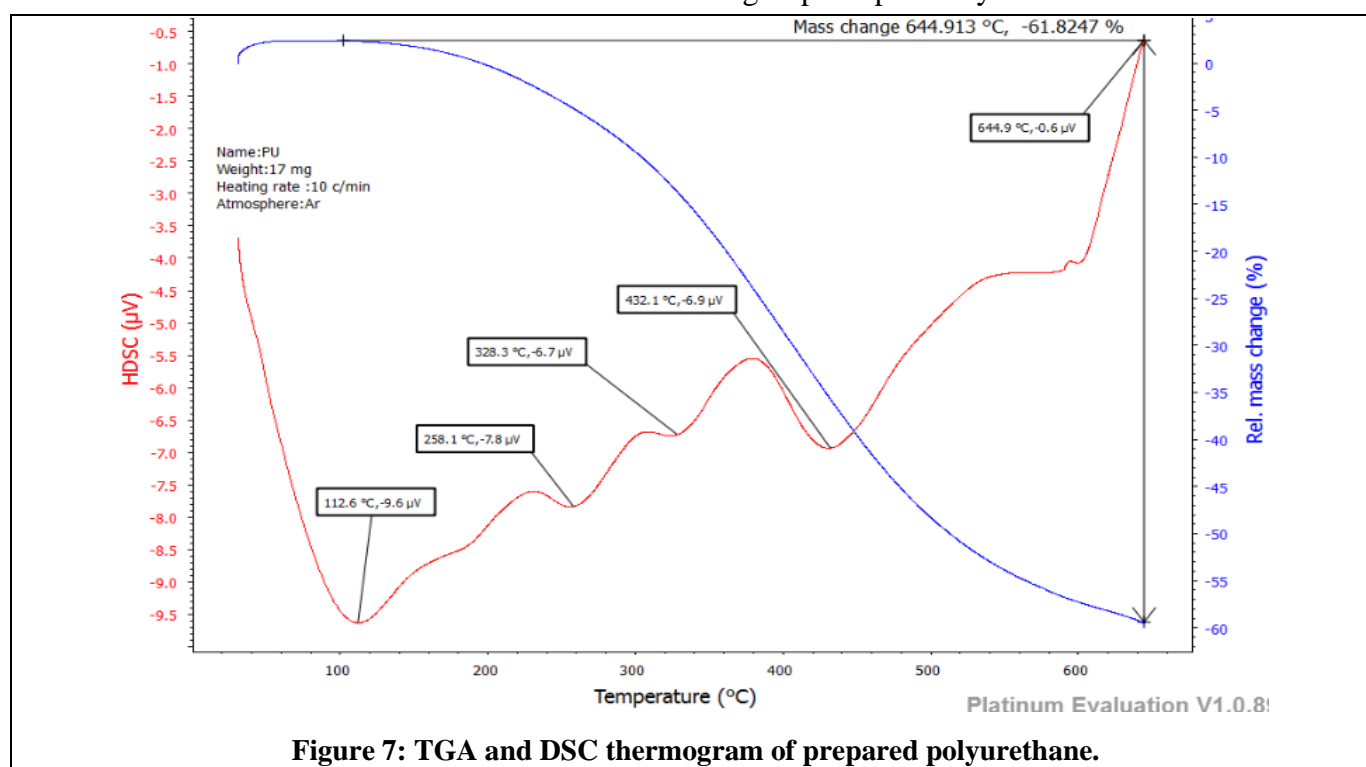


Figure 7: TGA and DSC thermogram of prepared polyurethane.

4. METAL ION UPTAKE OF POLYURETHANE FOAM STUDY

4-1- Batch method :

Batch method used to determine the ability of uptake ions percentage and distribution coefficient (K_d) of Cu(II) and Cd (II) ions of polyurethane. Figure (10) shows the result of this study. Weight (0.1 g) of unloaded polyurethane

foam put in glass conical flasks with (10 mL) of 50ppm metal ion solution was shaken for 6hrs. in mechanical shaker at room temperature. Metal ion solution at different pH values which was adjusted by adding HCl (0.1M) or NaOH (0.1M) using pH meter. After equilibrium, two phases were separated by filtration and an aliquot of filtration was determined ions concentration by atomic absorption model (AI-

1200) (F.A.A).The calibration curves for metal ions were plotted by analyzing a series of standard solutions of metal ions as shown in Figures 8 and 9. The unknown concentration was calculated from using equations 4 :

$$\text{Uptake ions} = (C_a - C_b) V / W \times 100 \quad \dots\dots\dots 4$$

where C_b , C_a are initial and final concentration respectively, v refer to volume of solution while W was weight of polymer. Values of uptake ions percentage show in Figure. (8).

$K_d = (\text{concentration of metal ion in organic phase}) / (\text{concentration of metal ion in aqueous phase}) \dots\dots\dots 5$

The results distribution coefficient (K_d) are illustrated in Table (1).

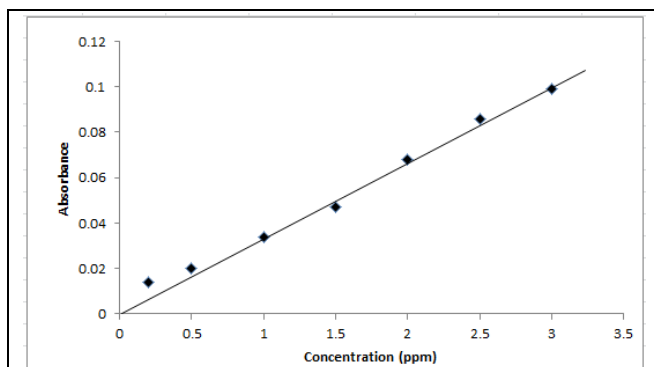


Figure 8: Standard calibration curve for Cd^{+2} at wavelength (228.8 nm) and correlation coefficient R^2 0.9979

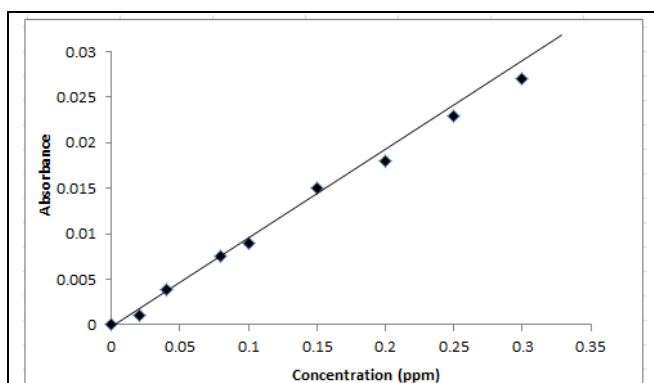


Figure 9: Standard calibration curve for Cu^{+2} at wavelength (324.7 nm) and correlation coefficient R^2 0.9993.

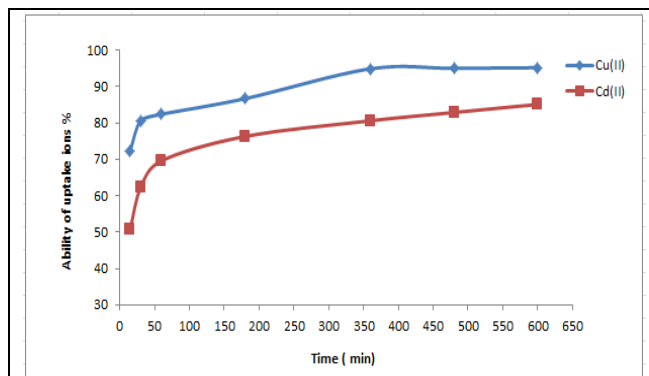


Figure 10: Percentage of uptake ions as a function of time at pH 4.5.

From the Figure (8) show the high ability uptake ions from solution ions by the PU foam and reached the steady state at six hours when the acid medium was (pH 4.5).

Table 1: Distribution coefficients of ions on the PU foam resin at pH 4.5.

Ions	Concentration of HNO_3 (N)	Distribution coefficient K_d
Cu(II)	1	219
	2	90
Cd(II)	1	82
	2	35

4-2- Column method

The polyurethane resin was grounded, submerged in deionised water. The unloaded PU resin was packed into a glass column (12 x 0.4 cm) diameter. The aqueous solution containing mixture ions (Cu^{+2} , Cd^{+2}) at equal concentration (50 ppm) was passed through the column at limited flow rate, using HNO_3 as elution at optimum concentration, then collected equal quantity of eluent to determine ions in AAS. All solutions were prepared freshly by dilution of stock solution with deionised water. Serial standard solutions were prepared at different concentrations to draw calibration curve for each metal.

$$\text{Recovery of ions (\%)} = (C_{\text{recovered}} / C_{\text{removed}}) \times 100 \dots\dots\dots 6$$

$C_{\text{recovered}}$: concentration of ions recovered from the resin column (ppm).

C_{removed} : concentration of ion removed from solution ions(ppm)

4.3- Analytical Study of column separation

4-3-1 Effect of Concentration and Type of Eluent

Different concentrations of the two eluents (HCl and HNO_3) were used to retained the ions on PU foam resin. From figure (11) obtained that percentages of recovery ions were less when using HCl eluent than HNO_3

under pH(4.5). When HCl eluent highest percentages of recovery ions (84% at 1.5 N HCl) and (82% at 1N HCl) for Cu(II) and Cd(II) ions respectively. Thus, HNO_3 had a better elution performance due to its oxidative action and stronger dissolution ability than HCl. Also the highest percentages of recovery ions were (98% at 1N HNO_3) and (89% at 2N HNO_3) for Cu(II) and Cd(II) ions respectively. So that HNO_3 used with two concentrations (1N and 2N) to separation mixture of Cu(II) and Cd(II) ions.

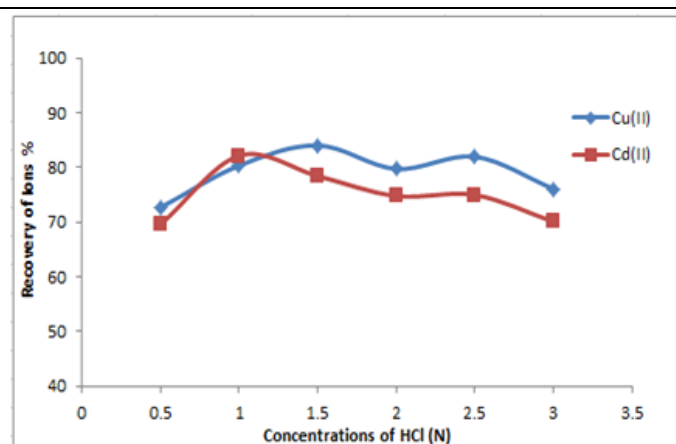


Figure 11: Percentages of Recovery ions at different concentrations (HCl) and (HNO_3)

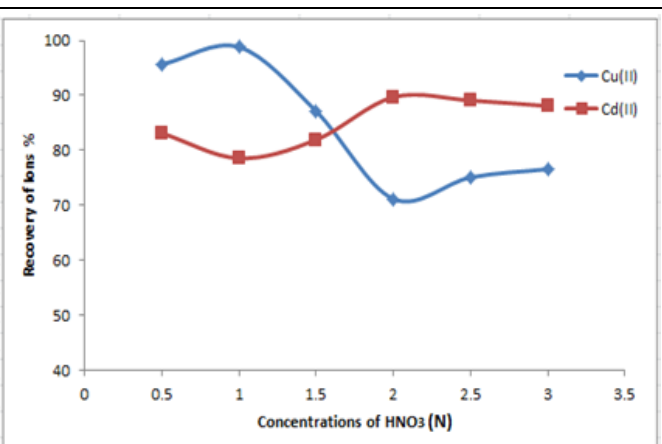
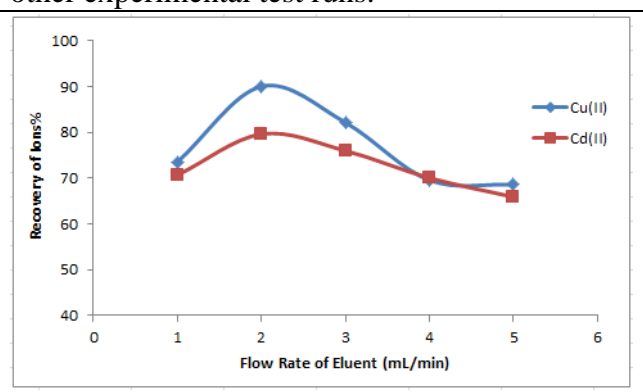


Figure 12: Percentages of Recovery ions at different flow rate (HNO_3) eluent.

4-3-2-Effect of Eluent Flow Rate

The flow rate of (1N HNO_3) elution was a significant effect on percentages of recovery ions. From results as shown in figure. (12) observed that the percentages of recovery ions increases between 1 and 2 mL/min., and then decrease with increasing flow rate of eluent. The maximum percentages of recovery ions were 90% and 79% for Cu(II) and Cd(II) ions respectively at 2mL/min., flow rate. Thus, the optimum flow rate was selected for elution in other experimental test runs.



4-3-3-Effect of pH

The pH is an important factor in the study of recovery metal ions in analytical studies because of the competitive reactions between ions and $[\text{H}^+]$ ions in solutions ⁽²³⁾. The function pH was adjusted at (2.5, 4.5, 6.5, 8.5 and 10.5) for 50 ppm mixture solution Cu(II) and Cd(II) ions. The resulting shown in Figure (13) show that the optimum pH for percentages of recovery (>90%) of metal ions was 4.5,. When pH value lower than 4.5 the percentage of recovery ions were decreased too, due to the competition between $[\text{H}^+]$ ions for active sites on the PU resin and the metal ions. While the increase in the value of pH occurs precipitation of metals ions so that percentages of recovery ions will be decrease.

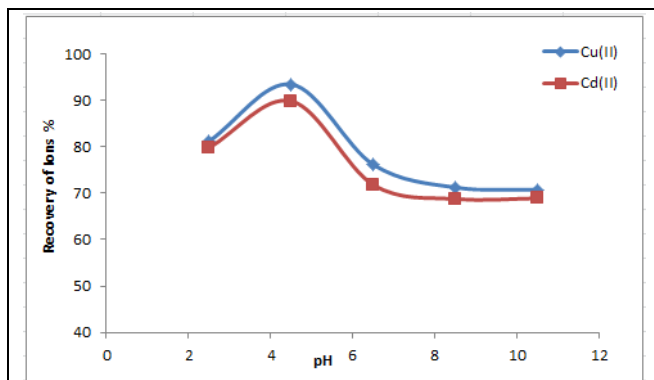


Figure 13: Percentages of Recovery ions at different pH metal ions.

5. SEPARATION OF MIXED IONS BY COLUMN

From the results shown in the Table (1), the PU foam resin can be used to separation mixture of copper and cadmium ions with high efficiency at optimum pH.

The synthesis PU foam resin (10 g) was putted in the colum used to separate a mixture of bivalent metal ions based on the K_d values shown in table (1) .Then adjusting the appropriate conditions for the separation (i.e flow rate , type of eluent and pH value). Mixture (20 mL) of both Cu(II) and Cd(II) ions (10 mL ,50 ppm of each metal ion solution) at pH 4.5 passed through the column at a flow rate of 2 ml/min. The Percentages of Recovery ions was carried out with HNO_3 solution. Firstly the cadmium was eluted by 40 mL,1N HNO_3 elution, and then copper eluted by 50 mL , 2N HNO_3 . The plot of the percentages of recovery ions eluted of metal ions vs. elution volume is shown in Fig (14) . Good curve achieved at 90% for Cd(II) and 80 % for Cu(II) , respectively.

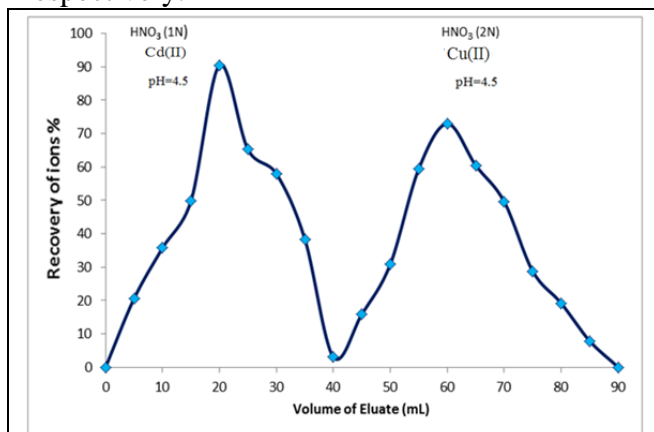


Figure 14: Separation of Cu(II) and Cd(II) mixture ions by PU foam resin.

6. CONCLUSIONS

The novolac resin prepared in this study can be converted to heat cure prepolymer (resol novolac resin) by reacted with formaldehyde in basic medium , and then the resol novolac react with polyethylene glycol through condensation polymerization in acid medium and finally react with MDI to produce new polyurethane foam. These resin were characterized by FTIR which indicate the proposed structure of the repeating units of these polymers and also some physical properties will be determined. Thermal behavior of the polyurethane foam can be evaluated by TGA/DSC technique and from the result show the foam resin have more than decomposition temperature. On the other hand The synthesized PU foam resin obtained percentages of recovery ions. The present investigation shows that chelating PU foam resin can be employed for recovery ions and separation of mixed ions. Batch and column methods used for separation of metal ions from synthetic bivalent mixture of Cu(II) and Cd(II) ions 90% for Cd(II) and 80 % for Cu(II) , respectively . These polymer gives high separation efficiency , good regeneration and simplicity; therefor , this resin can be used in other samples mixtures.

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