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Preparation of a new Interpenetrating polymer networks IPNS from the waste bottles drinking water PET with epoxy resins and used to remove some toxic ions from water

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ABSTRACT

In this Study, a new polymer IPNS was prepared, From The product of the Glycolysis of Poly(ethylene terephthalate) Waste with epoxy resin, IPNS Networks were characterized using infrared spectroscop (IR (to determine the functional groups, The thermal stability of the polymer matrix was evaluated using Differential Scanning Calorimetry) DSC (and the thermogravimetric analysis (TGA), The efficiency of the IPNS was tested to remove some toxic ions from water such as Cd^{+2}, Pb^{+2} In different acidic media and at different time periods using flameless atomic absorption technique that the total loading capacity and efficiency of the ions. The adsorption of ions on the polymer network was studied using the Frendlich and Longmuir isotherms, The results showed that the adsorption process follows the Frendlich equation.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Latest Developments in Materials & Manufacturing.

1. Introduction

Water is an essential source for life and constitutes a large proportion of the globe [1]. The quality of water is important because it is related to human health as well as other living organisms [2], any change in its composition produce pollutant, dangerous and effects on the safety of living organisms [3], Water pollution is either physical, such as heat, radiation, or biological factors resulting from microorganisms, germs, that cause diseases [4]. The chemical pollution, it is caused by waste from domestic sewage [5] and Factory waste represented by dyes, paper and rubber factories, power plants, iron factories, mining, oil, etc.[6], The chemicals polluting the aquatic environment are either compounds such as acids and bases or ions such as toxic heavy ions [7]. This research is concerned with the study of toxic ions that can be defined as Metallic elements have an atomic density four or five times that of water [8], And some of them are toxic even at low concentration, such as trace elements [9]. Heavy ions can be removed from water using several techniques and methods such as chemical precipitation, ion exchange and adsorption [10], It was found that the adsorption technology is more effective, cheap and improves water quality [11]. Polymeric compounds containing two or more reactive groups close to each other that can donate electrons and have the ability to bond with ions of transition elements through stable coordination bonds [12], These groups include (hydroxy-OH group, NH_2 amine group, carbonyl group C = 0, Complexes derived from phosphoric acid H_3PO_4) [13]. Interpenetrating polymer networks IPNs: Its a new technique produced from the physical overlapping of two or more polymers networks, and recently used to remove some heavy metals In this study a new semi IPNs was prepared from glycolysis of PET waste and epoxy resin and evaluated to remove some heavy metals.Fig. 1

2. Experimental materials and methods

2.1. The glycolysis of polyethylene terephthalate

In this study the waste of drinking water bottles (Polyethylene Terephthalate, PET) was used and cuted to the small pieces about 1 or 2 cm, then washed well with distilled water then dried at 50C. A 500 ml of two-neck round flask conducted with thermometer and condenser was used. 5 gm of PET cuted was mixed with 0.25 gm of zinc acetate and 27 ml of ethylene glycol. The mixture was heated up to 180 CO for 6 h with continuously stirring, after the end of

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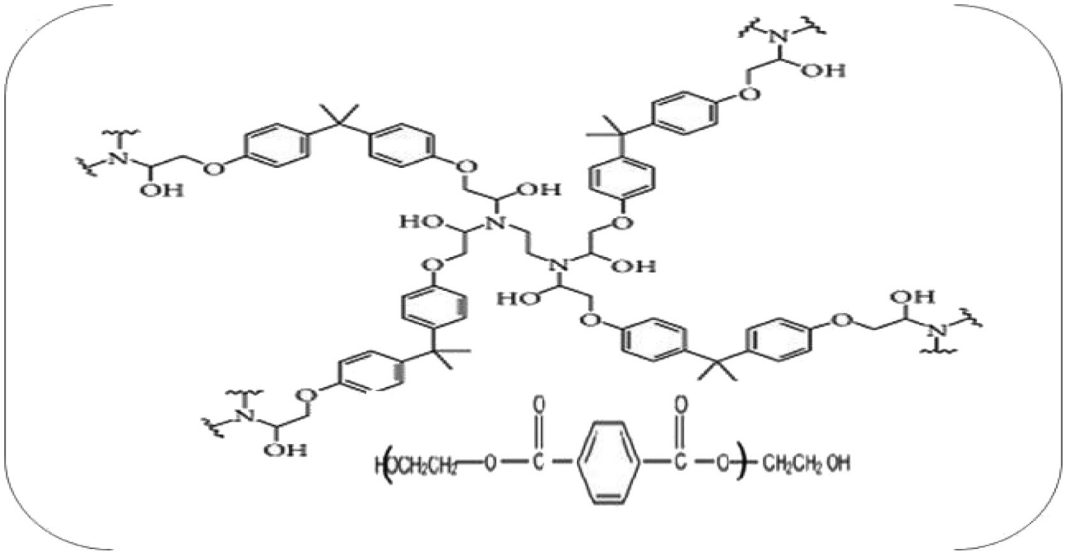

Fig. 1. Chemical composition of epoxy and PET. IPNs.

reaction time the mixture was removed and, 50 ml of distilled water was added, and placed in an ice bath for the two hours until produce the precipitate then dries and grinds well.

2.2. Preparation of polymer Interpenetrating network (IPNS)

A semi-IPNs polymer was prepared from the cured epoxy resin with amine hardener and glycolysis of PET waste, and this was done by mixing of equal amounts of the two materials 5gm for each material, and then placed in an electric oven at a temperature of 100 °C for one hour, To harden (curing) the polymeric network and increase its crosslinking, then reduce the temperature to 70 °C for half an hour to complete the post curing process, Then the IPNs are ready for analytical study.

2.3. Analytical study

The efficiency of the prepared network IPNs to remove some toxic ions such as (Pb^{+2}, Cd^{+2}) was studied:

Table 1
Shows the locations of absorbing packets to the IPN network.

vibration frequency	Functional groups
1012.63 cm^{-1}	C—O—C
1132.21 cm^{-1}	Asym. And sym. Tow peaks
1249.87 cm^{-1}	C—N
1508.33 cm^{-1}	C=C
1456.26 cm^{-1}	Aromatic
2877.79 cm^{-1}	CH_2
2927.94 cm^{-1}	
2962.66 cm^{-1}	
3444.87 cm^{-1}	O—H
3674.39 cm^{-1}	
3734.19 cm^{-1}	

a) **Preparation of standard solutions and method of analytical work** 1000 ppm of stock solutions for the ions Pb^{+2}, Cd^{+2}) were prepared then diluted to (100 ppm) by diluting certain volumes of standard buffer solutions using deionized water

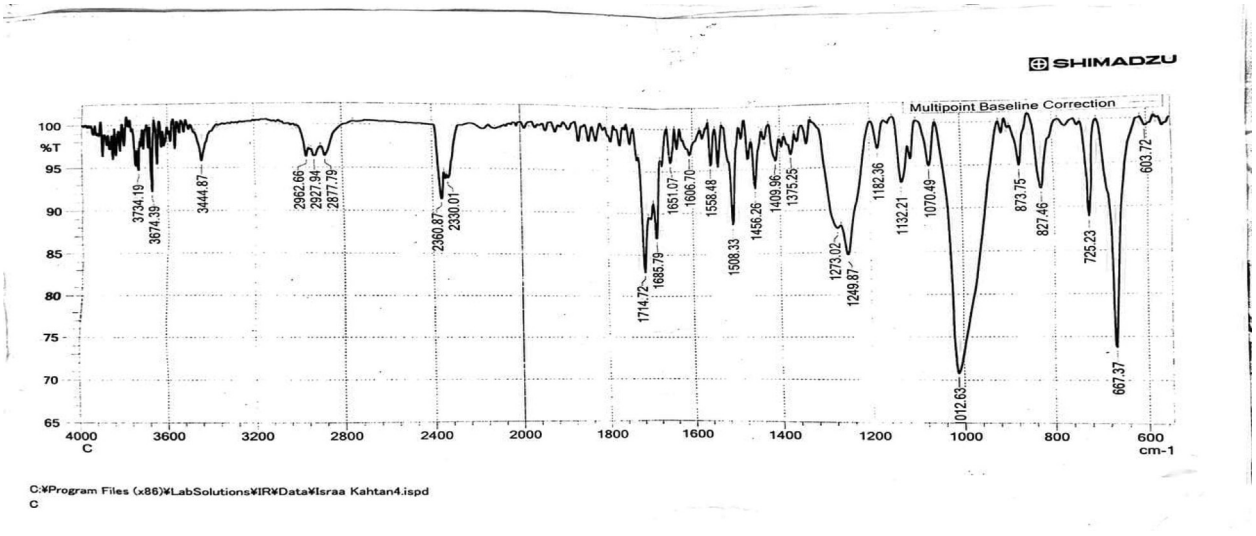

Fig. 2. Shows the infrared spectrum of epoxy resin and hardener.

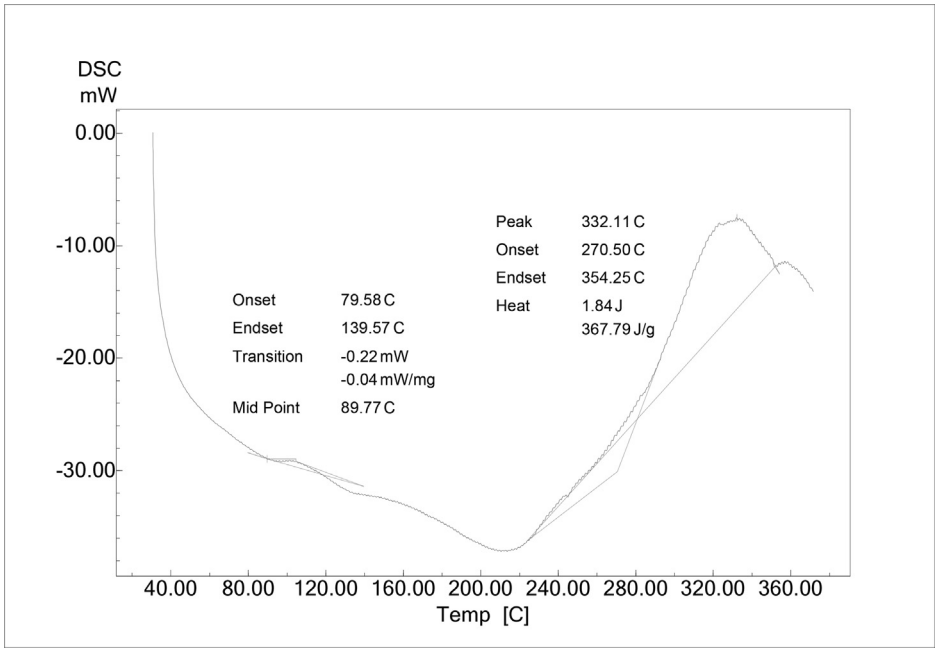

Fig. 3. Shows the IPNS. calorimetric differential scanning spectrum.

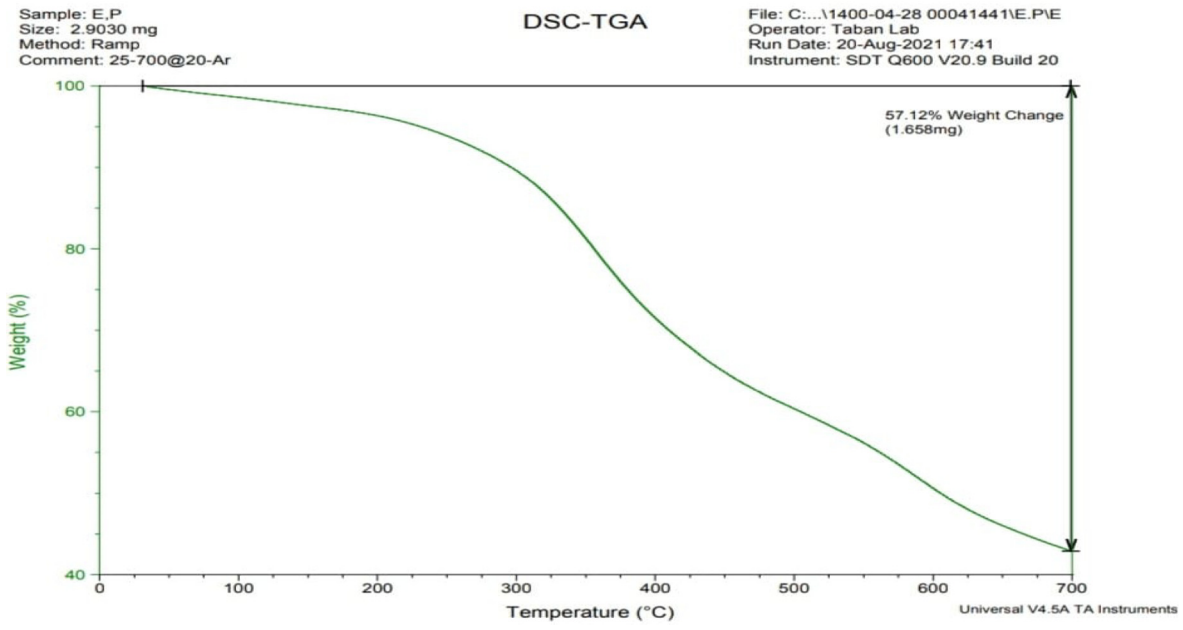

Fig. 4. Shows the thermogravimetric spectrum of IPNS.

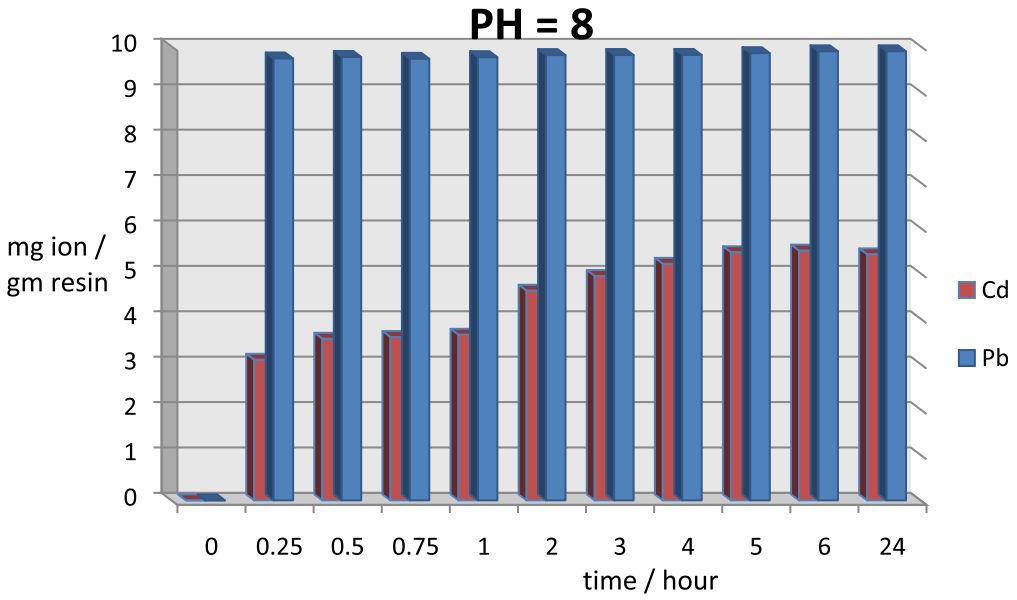

Fig. 5. Shows the relationship of load capacity of IPNS with time at pH = 8.

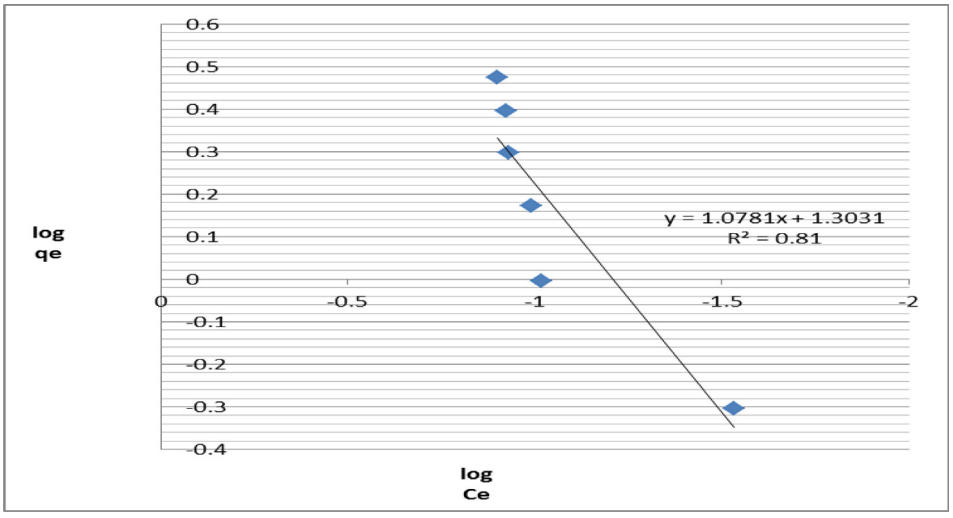

Fig. 6. Freundlich adsorption isotherm for the element lead.

b) **Analytical measurements:**

(0.1) gm of the IPNs was put it in volumetric flask flask of and add to it 10 ml of 100 ppm ion at different pH (2, 4, 6, 8), Then the volumetric flask were placed in the shaker at a rate of 200 cycles/minute at 25 °C and for different periods of times (1/4, 1/2, 3/4, 1, 2, 3, 4, 5, 6, 24) hrs, After time completion, the solutions were filtered and remainning ions tested using the flameless atomic absorption technique.

3. Results and discussion

A. Infrared analysis

The functional groups of IPNs was characterized using infrared spectroscopy as showed in the Fig. 2 and listed in Table 1.

B. Thermal analysis:

The thermal stability of IONS was evaluated using differential scanning Calorimetry (DSC) and thermogravimetric analysis (TGA).

1) Differential Scanning Calorimetry:

The (DSC) themogram of IPNs was recorded as shown in Fig. 3 within the temperature range (40–360) °C, and showed that the presence of a glass transition Temperature Tg = 89C for epoxy, the presence of a exothermic peak started at 300C due to the degridation of polymeric matrix.

2) Thermogravimetric analysis:

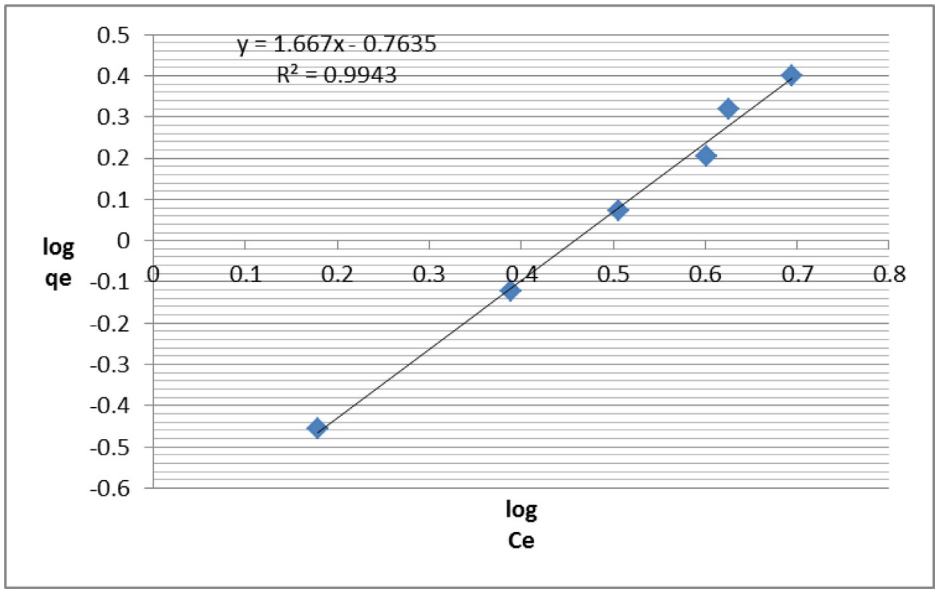

Fig. 7. Freundlich adsorption isotherm for the element Cadmium.

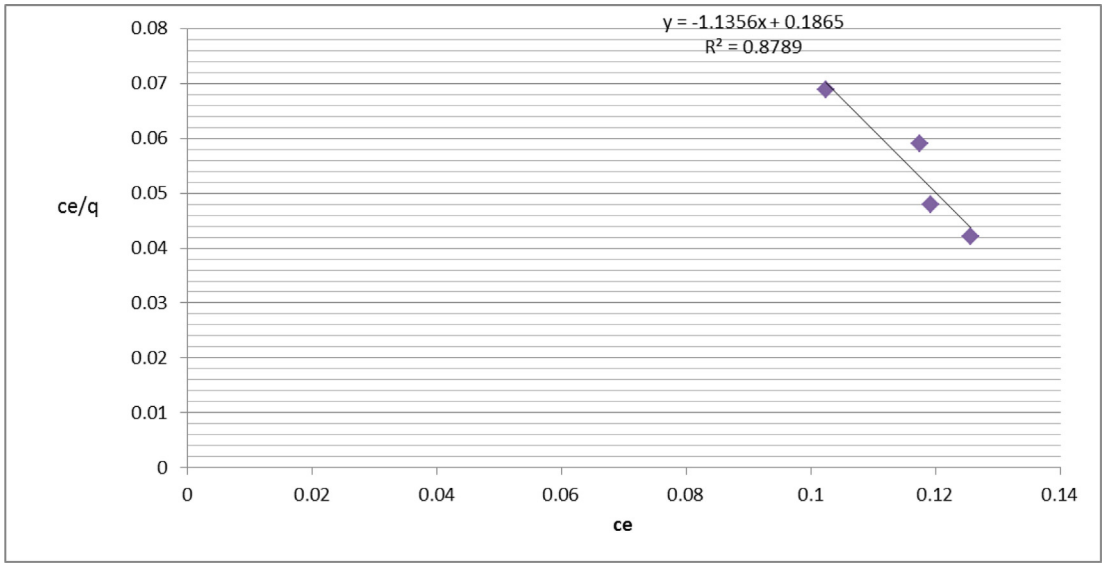

Fig. 8. Langmuir isotherm for the element lead.

The (TGA) thermogram of the IPNS was recorded a within the temperature range (25–700) in the presence of nitrogen. In Fig. 4 showed that the presence of several degradation stages , the weight loss less than 100C due to the loss of water molecules. It is also noted that 42% char content due to the presence of aromatic rings in Both the epoxy and the polyethylene terephthalate on the other hand, we note that 50% of the polymeric network decomposes at 400 °C.Fig. 5

C. Relationship of load capacity with time and acidity function:

The relationship of the load capacity of the IPNS network with each of the acid function and time was studied, When examining the samples in an atomic absorption spectrometer without flame, it was found that the acidity function PH = 8 gave the best results, as shown in the figure below:

D. Study of the adsorption process:

1) Freundlich adsorption isotherm.

The Figs. 6 and 7 represent the adsorption isotherm according to Freundlich's equation.

2) Langmuir adsorption isotherm.

the Figs. 8 and 9 represent Langmuir isotherms for the studied ions of lead and cadmium.

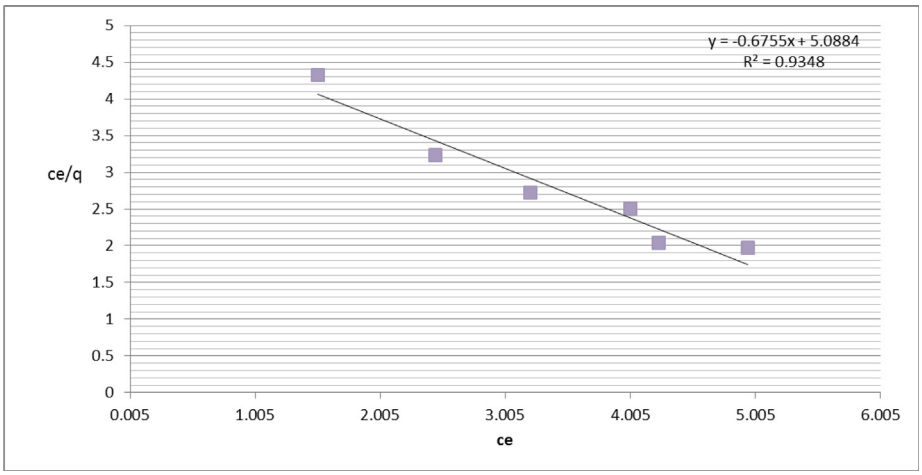

Fig. 9. Langmuir isotherm for cadmium.

4. Conclusion

1. the prepared polymeric network (IPNs) is cheap price, as (50%) of them are from the decomposition processes of water bottle waste .
2. the IPNs is thermally stable .
3. High efficiency of adsorption of ions (Cd^{+2} , Pb^{+2}) depending on the acidity function (pH) .
4. The Ministry of Water Resources (General Authority for Irrigation and Drainage Projects) and the Ministry of Health and Environment (Environment Directorate) can benefit from it.
5. The new polymeric network is used in the purification and treatment of wastewater in chemical factories, pharmaceutical plants and tanning plants, and treatment of this water leaving it before it is discharged into the river to get rid of heavy toxic ions.

CRediT authorship contribution statement

Israa Qhtan Abdul Amir: Writing – original draft, Supervision, Software. **Salah Shaker Hashim:** Conceptualization, Methodology, Visualization. **Sajid H. Guzar:** Validation, Writing – review & editing, Investigation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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