APPLICABILITY OF CCRPHF-I COMPOSITE IN ENVIRONMENTAL POLLUTION CONTROL

[1]S. M. Maskey, [2]S.S. Shende

1. S.M.Maskey[1]Yashwantrao Chavan College, Lakhandur-441803, *Sudhirraj2011@gmail.com*
2. S.S. Shende NPW college Lakhani – 441802, *sudhakarshende31@gmail.com*

Abstract: Environmental pollution due to toxic metals is topic of major concern related to pollution control. Arsenic heavy metal is considered to be acute toxic, carcinogenic and mutagenic to living organisms and hence more hazardous, causing various diseases and disorders. For this reason, the water treatment of toxic arsenic polluted water has received an extensive concern and become a hot topic in environmental research. Presence of arsenic in waste water and its various treatment methods are cited in the extreme. The aim of the present investigation is to synthesize Copolymer composite (CCRPHF-I) and to study its applicability in environmental pollution control with respect to arsenic removal efficacy from aqueous solution. This CCRPHF-I composite was characterized using modern techniques like FTIR, SEM and TGA. The arsenic adsorption was investigated using batch experiment method and effect of pH, contact time, adsorbent dosage and initial arsenic concentration on arsenic removal efficiency. The maximum removal of arsenic was observed to be 95.37 %. Thus the composite under study can be successfully used as an efficient adsorbent material for removal of arsenic from contaminated water and can have a variety of potential environmental applications.

Keywords: Arsenic toxicity, Composite, Batch experiments, Adsorption, Environmental application.

Introduction

Contamination of arsenic in drinking water is due to the untreated effluent discharge to water bodies from industries and agricultural field. Arsenic is considered to be acute toxic, carcinogenic and mutagenic to living organisms and hence more hazardous, causing various diseases and disorders such as lung and urinary bladder cancer, muscular weakness, nerve tissue injuries, blackfoot disease etc. The arsenic concentration of 0.05 mg/L in drinking water has been set as permissible limit by World Health Organization (WHO).[1] For this reason, the treatment of polluted water due to toxic arsenic metal has received an extensive concern and become a hot topic in environmental research.[2]

This study is an attempt to synthesize and characterize new copolymer composite with heavy metal adsorbent properties for removal of arsenic from contaminated water. In the present investigation, copolymer RPHF-I was synthesized by using resorcinol (R), Phenylhydrazine (PH) and Formaldehyde (F) reacting monomers. The new Composite CCRPHF-I synthesis using RPHF-I and chitosan . This composite adsorbent has been abbreviated as CCRPHF-I. The purpose of surface modification is to enhance the adsorptive efficacy of copolymer with respect to arsenic removal. The trivalent arsenic adsorption was investigated using CCRPHF-I also effect of pH, contact time, adsorbent dosage and initial arsenic ion concentration was studied using batch experiments. The maximum removal of trivalent arsenic was obtained to be 95.37% using CCRPHF-I. CCRPHF-I composite can be successfully used as an efficient adsorbent material for removal of trivalent arsenic from aqueous solution and can have a variety of potential environmental applications.

Materials And Method

All chemicals used were of analytical grade. Resorcinol, Phenylhydrazine, Formaldehyde (37%) procured from Merck,

Off. Principal
Late. N.P.W. College
Lakhani, Distt. Bhandara

India. Double distilled water was used during all experiments.

Synthesis and Purification of RPHF–I Copolymer

The copolymer (RPHF-I) was synthesized employing the method published earlier. [3,4] The purity of newly synthesized and purified copolymer sample has been tested and confirmed by TLC.[5]

Synthesis of CCRPHF–I composite

5gm of chitosan powder was dissolved in 100 ml of 10% acetic acid, which from whitish viscous gel. It was heated to 40-50°C to facilitate the mixing. 50 gm of RPHF-I was slowly added to this viscous gel and mechanically agitated using rotary shaker at 150 rpm for 24 hrs. The gel coated RPHF-I was then washed with double distilled water and dried. The process was repeated for three times until thick coating of chitosan was formed on the RPHF-I surface. The excess of acetic acid in Chitosan Coated RPHF-I (CCRPHF-I) was neutralized by treatment with 0.5% NaOH solution for 3 hrs. The resultant mixture was then filtered with Whatmann No. 41 filler paper, extensively rinsed with double distilled water, dried in an oven at 55°C for 48 hrs and stored in air tight container.[6]

Characterization of copolymer

The FTIR spectrum of the **CCRPHF-I** Composite is shown in **Fig.a.** A broad band appeared in the range 3742.55 cm^{-1} which is attributed to O-H stretching vibration and the 3391.63 cm^{-1} which is attributed to NH stretching vibration of chitosan molecules.[7] The weak band at 2927 cm^{-1} may be due to methylene C-H stretching vibrations. The band appeared at 1390.06 cm^{-1} result in stretching vibration of $-CH_2OH$ (primary alcohol). Absorption peak at 1632 cm^{-1} correspond to the NH bending. Absorption peak at 1685.64 cm^{-1} may be due to C = O stretching vibration of amide group. The sharp band at 1474.45cm-1 corresponds to a symmetrical deformation of the CH group and at 1547.89 cm-1 corresponds to the N-H deformation of amide. The vibration bands at 1084.32 and 120.48 cm-1 are indicative at C-O-C vibration inside chitosan ring. The three weak peaks appeared in the region 824, 754.90 and 698 cm^{-1} attributed to NH wagging of primary amine.[8]

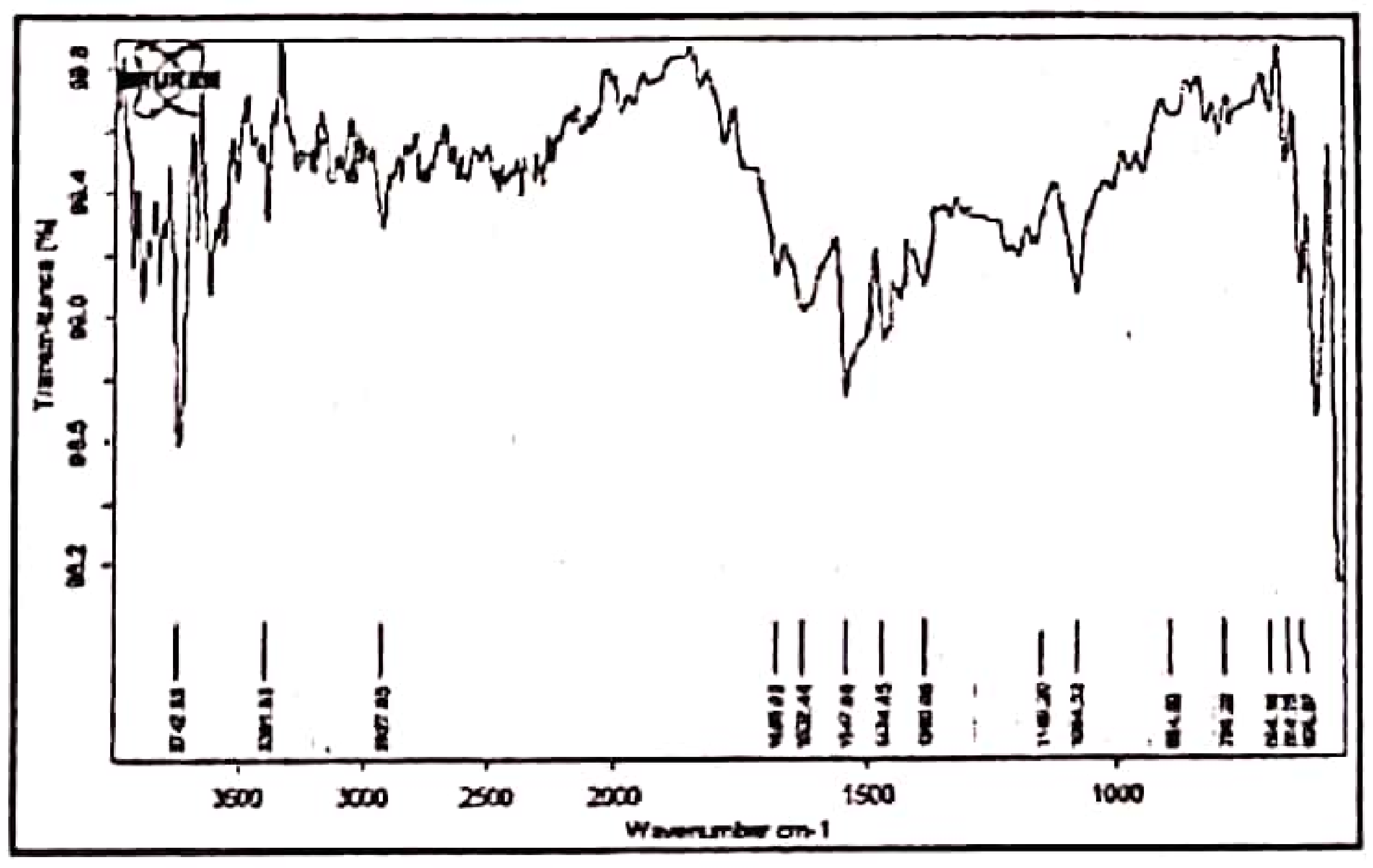

Fig. a:- FTIR Spectrum of CCRPHF-I

Fig.b. Represents the SEM image of CCRPHF-I obtained using an accelerating voltage of 15 KV at x3500 magnification. SEM image of CCRPHF-I that clearly revealed that wide variety of globular microspheres are present. Microspheres were formed in the form of large beads with irregularity and polydispersity.[9, 10] The sizes of microspheres are found to be 3.01μm, 1.98μm, 2.52μm and 1.06 μm. The image indicates a transition state of material between the amorphous and crystalline. However, more predominantly, the material is amorphous because of surface modification of copolymer by chitosan.[11, 12]

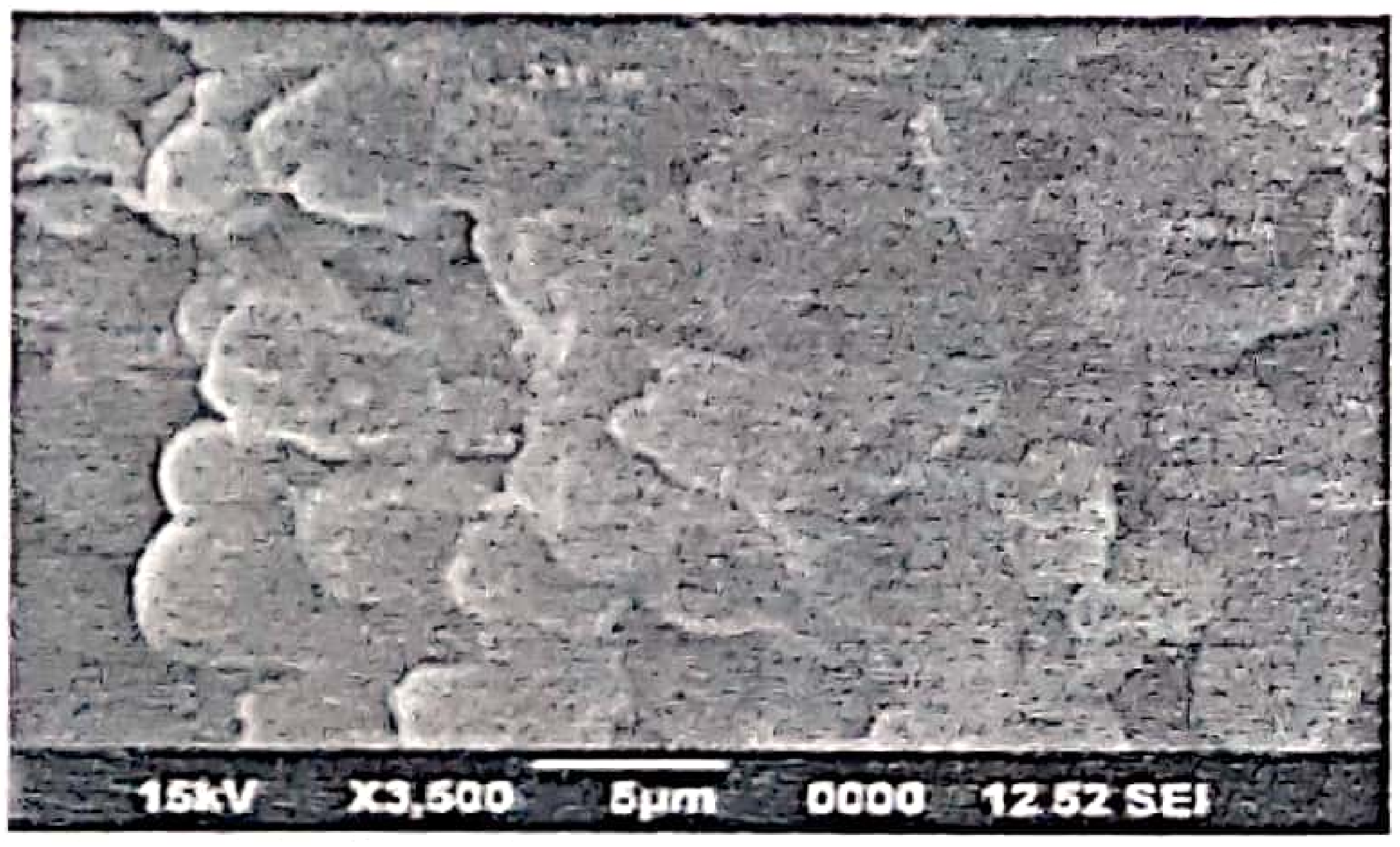

Fig.b:-SEM Image of CCRPHF-I

The TGA curve of **CCRPHF-I** has shown in **fig.c.** it can be seen from figure that three consecutive weight loss steps were observed in CCRPHF-I. The first weight loss was about 50 to 150^{0}C. The derivative peak observed at temperature 67.23^{0}C with a weight loss of 3 %which may be due to the removal of water molecule (moisture).[13] The second weight loss was at about 250 to 529C. The derivative peak observed at temperature 350.86^{0}C with a weight loss of 13 % which may be due to the some volatile matter and scission of the ether linkage in the chitosan backbone. In the third stage, the weight loss in the temperature range of 500 to 700^{0}C. The derivative peak observed at temperature 598.93^{0}C with a weight loss of 37 % which may be due to the thermal decomposition of glucosamine residue present in chitosan.[14] After 700^{0}C, the TGA curve is almost flattened due to the nondecomposible.[15]

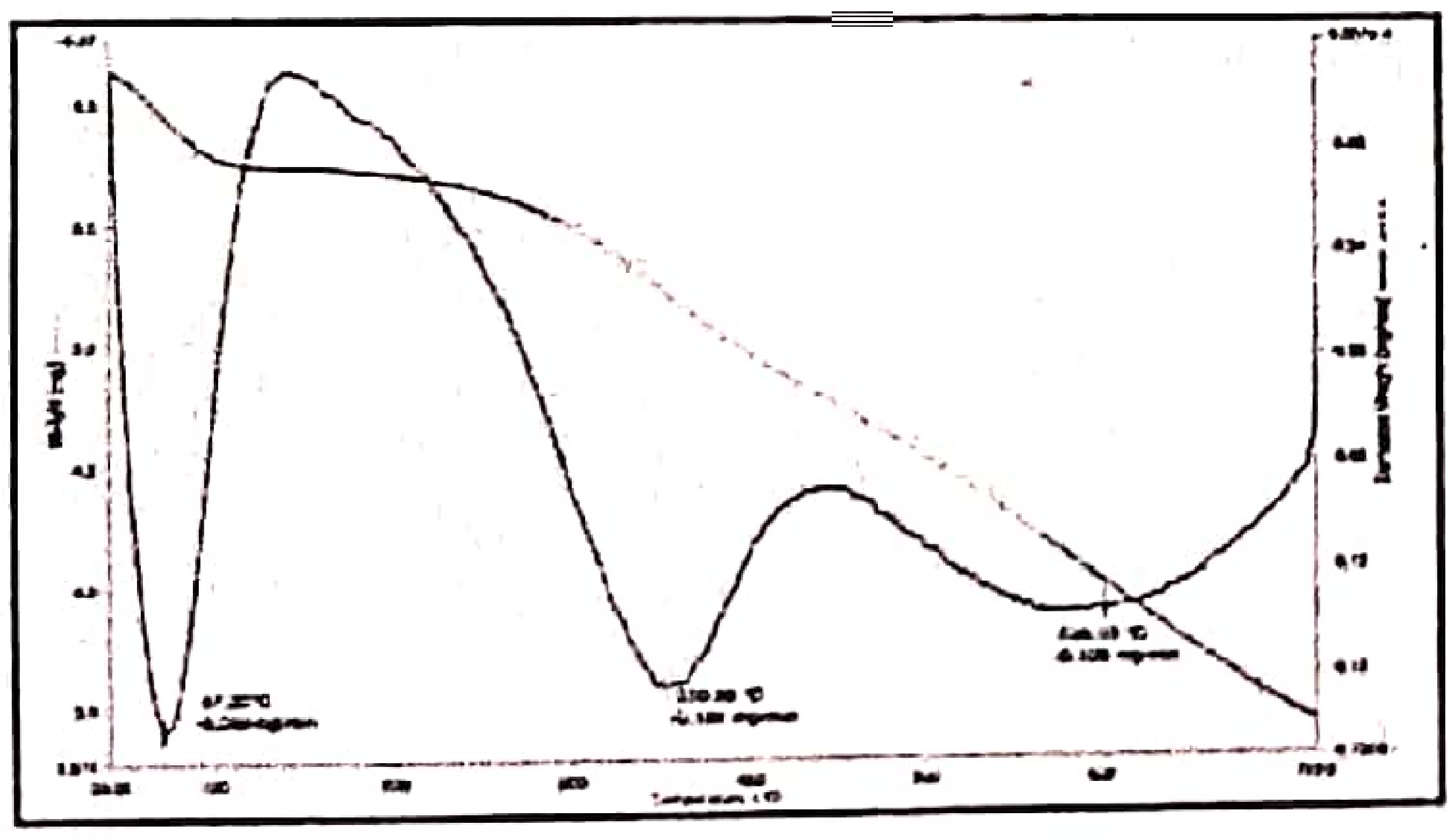

Fig. c:- TGA Curve of CCRPHF-I

Adsorption of As(III) on CCRPHF-I

Effect of pH on As(III) ion removal

The influence of pH on the percentage sorption of As(III) is shown in **fig.d.** Optimum at pH 5 for the adsorbent i.e. CCRPHF-I with at remove 95.35 % of As(III) ion.

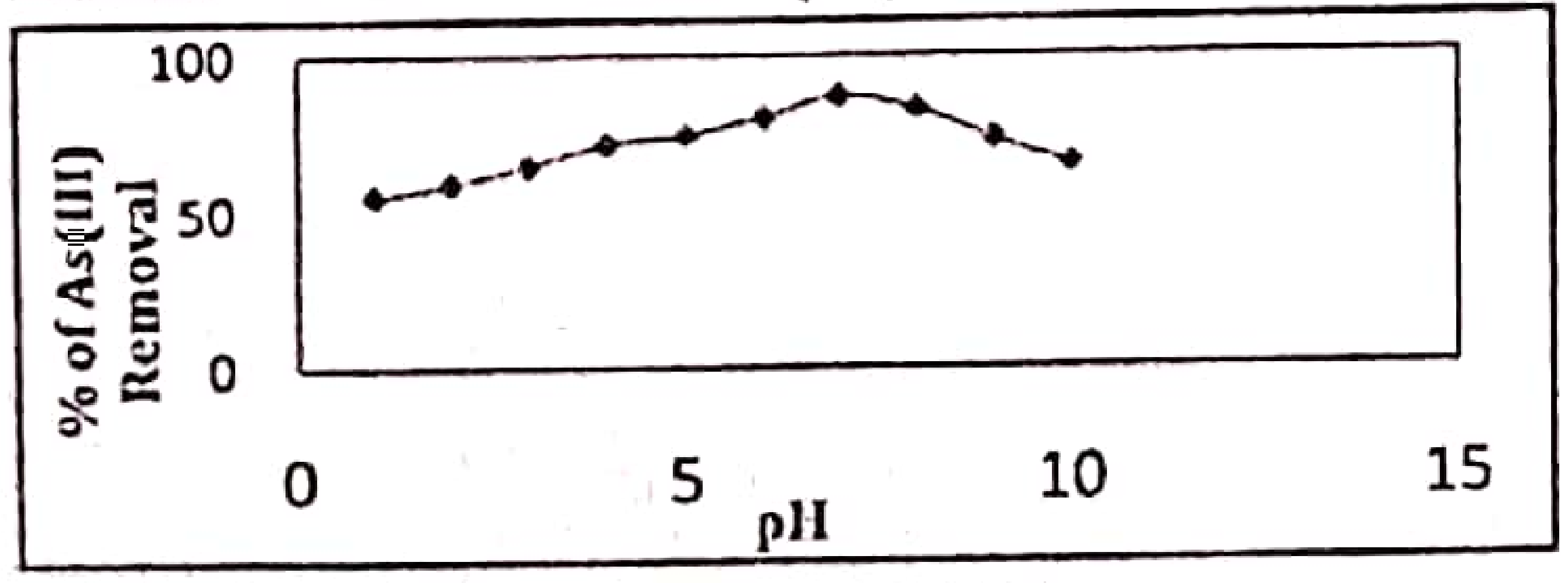

Fig.d. Effect of pH on As(III) ion removal

Effect of contact time on As(III) ion removal

The effect of contact time on percentage of adsorption of arsenic (III) ion is shown in **fig.e.** Thus optimum contact time for CCRPHF-I composite was found to be 120 min. Hence CCRPHF-I have required a shorter contact time.

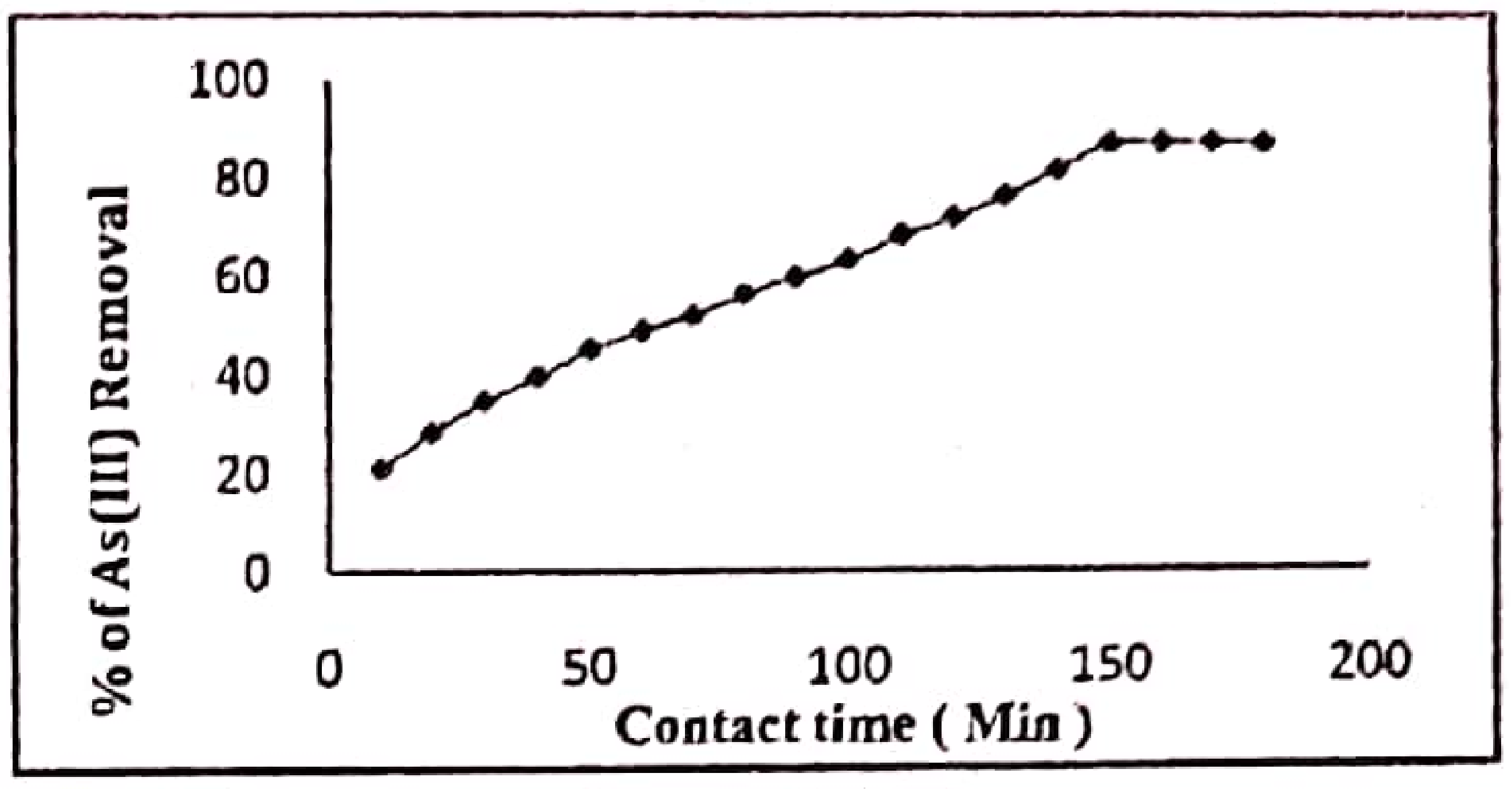

Fig.e.: Effect of Contact time on As(III)

Effect of adsorbent dose on As(III) ion removal

The dependence of As(III) adsorption was studied by varying the amount of CCRPHF-I from 0.5 to 10 gm/lit. The influence of absorbent dose on the percentage of removal of As(III) is shown in **fig.f.** From the figure, it can be observed that the removal efficiency of As(III) ion increases by increasing the CCRPHF-I dose up to a certain limit and then it remains constant. The CCRPHF-I dose increased from 0.5 to 5 gm/lit, with increase rate for removal efficiency of As(III) from 21.42% to 95.37%.

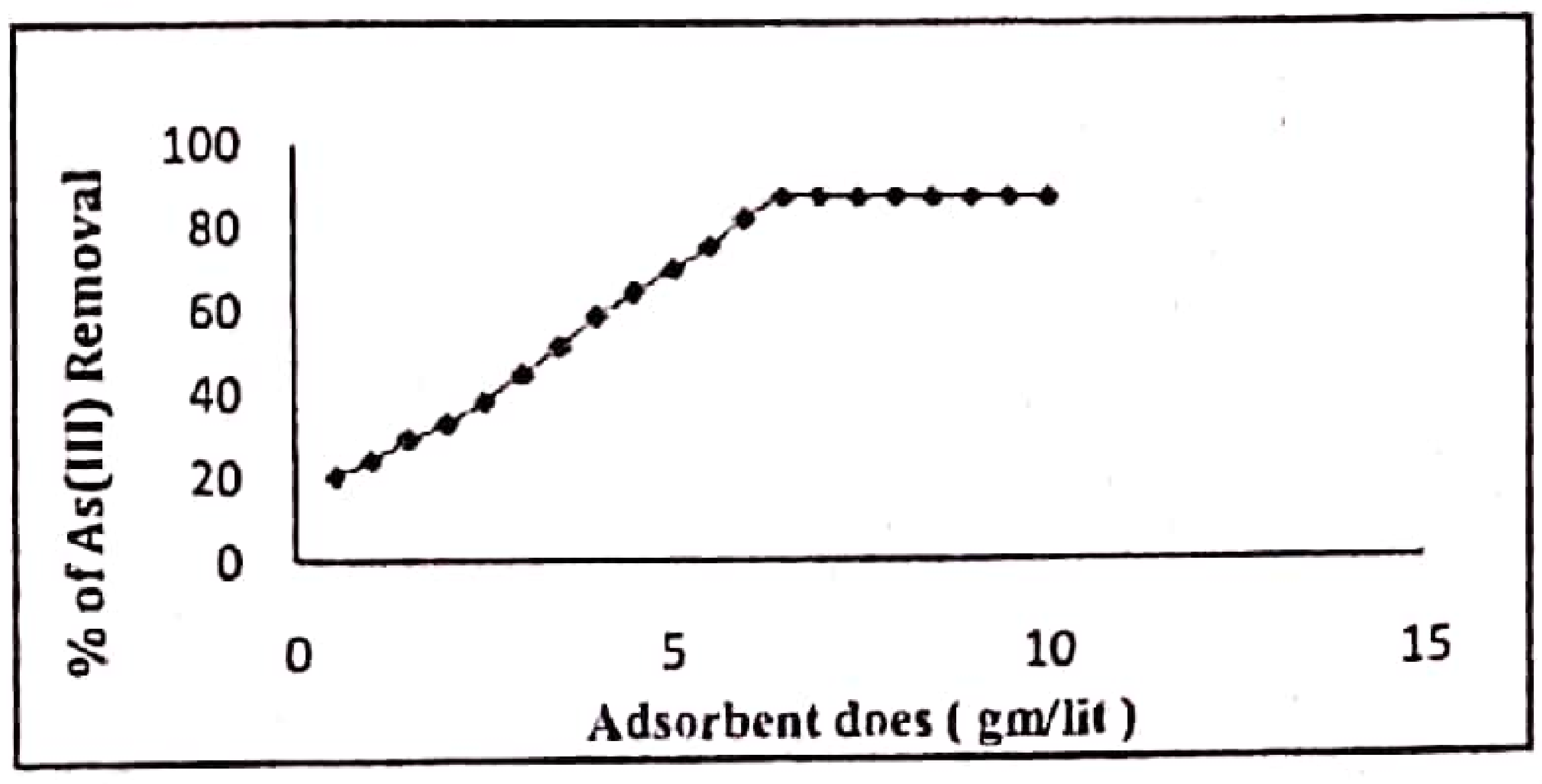

Fig.f: Effect of Adsorbent dose on As(III

Effect of initial Arsenic (III) ion concentration

. The result is shown in **fig.g.** From the figure, it is clear that the percentage of As(III) removal was found to decrease from 98.13% to

63.50% as the initial concentration of As(III) ion increased from 10 to 100 mg/lit for CCRPHF-I.

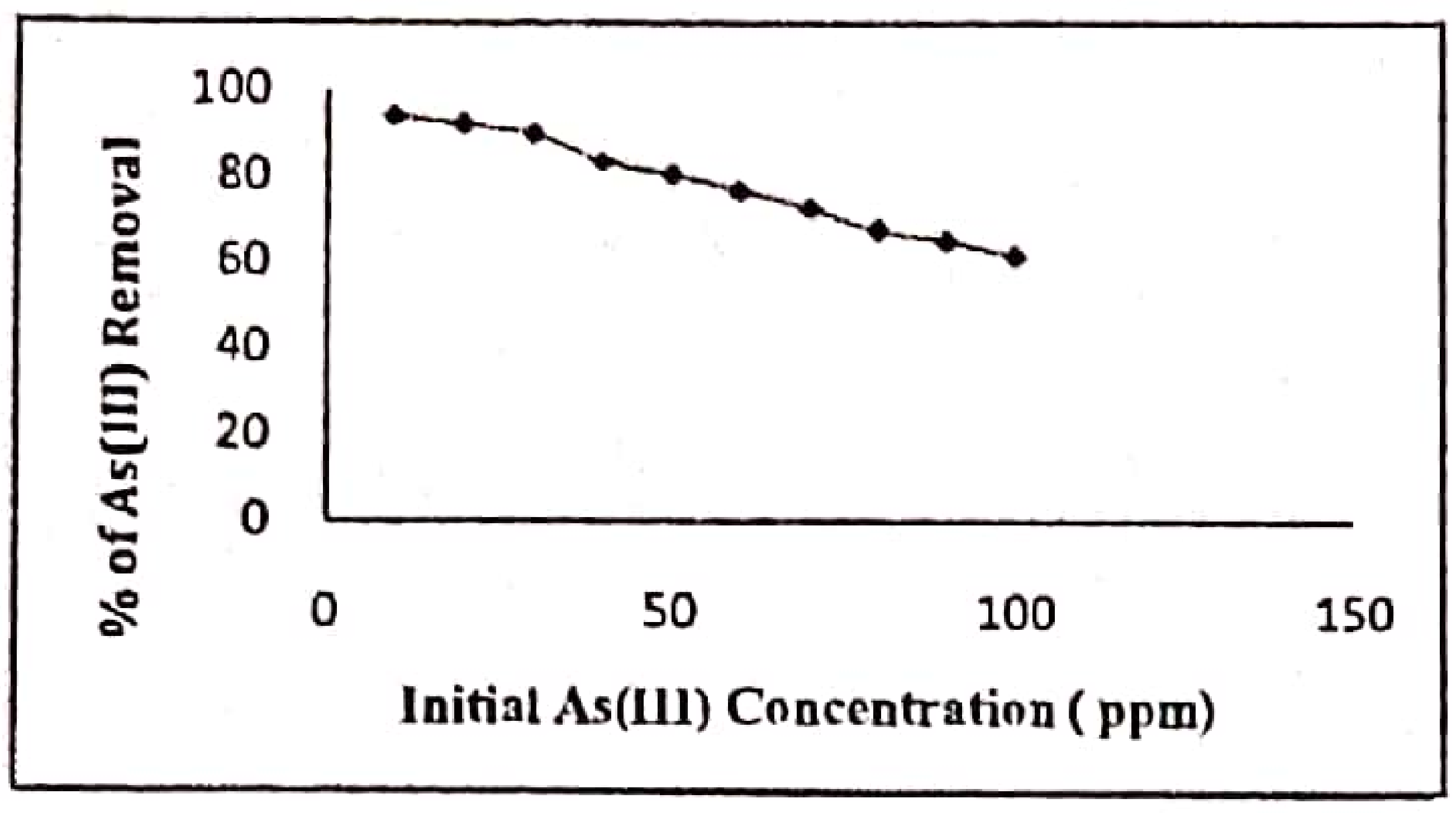

Fig. g: Effect of initial concentration of As(III)

Adsorption Isotherms

The equilibrium data are well fitted in Langmuir linear plot of Ce/Qe versus C_e and it suggests the applicability of the Langmuir isotherms. The values of adsorption efficiency 'Q_m' and adsorption energy 'b' were determined form the slope and intercept of the plots shown in **Fig.h** . The values of 'Q_m' and 'b' for CCRPHF-I were respectively found to be 15.15 mg/g and 0.2727. To confirm the favorability of the adsorption process, the equilibrium parameter that is separation factor (R_L) for CCRPHF-I is determine and found to be in fraction in the range of 0 to 1 indicating that the adsorption process is favorable for this adsorbent for the removal of As(III).[16]

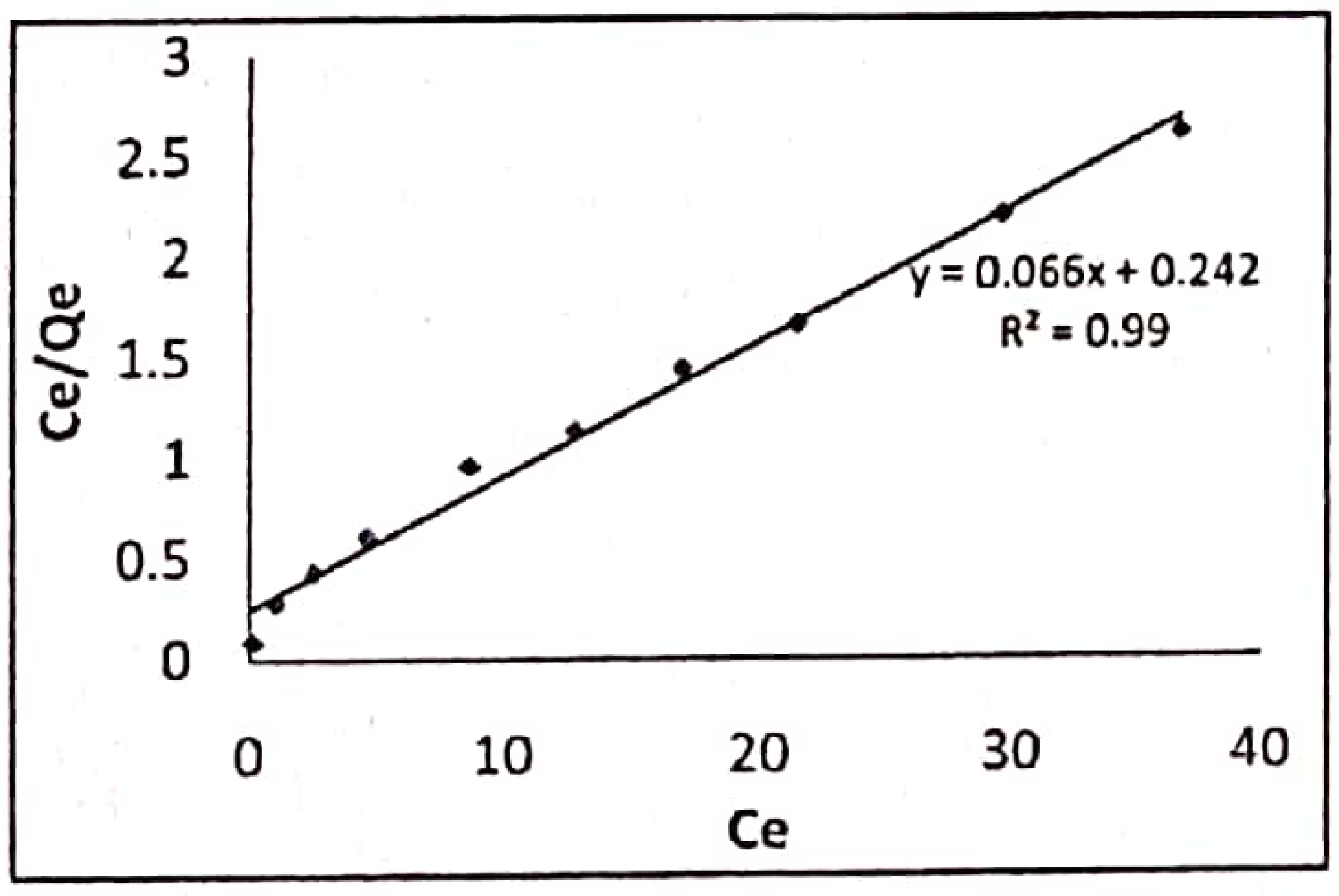

Fig h : Langmuir isotherm CCRPHF-I

Conclusion

RPHF-I copolymer is successfully synthesized with a good yield . Chitosan coating was successful on the surface of RPHF-I to get surface modified copolymer and they are abbreviated as CCRPHF-I. Characterization of CCRPHF-I adsorbent has been done employing the techniques like FTIR, SEM and TGA. CCRPHF-I was studied for testing of its adsorption efficacy towards removal of As(III) ion from contaminated water. Batch equilibration method was adopted for these studies. Results of batch experiment studies proved excellent efficiency of the newly obtained material for removal of As(III) from contaminated waste water. The excellent capacity of the CCRPHF-I under present investigation is supported by correlation coefficient values 0.990 for Langmuir isotherm. The values of adsorption efficiency (Q_m) and adsorption energy (b) calculated from linear Langmuir isotherm is in good agreement for favorable adsorption process for the adsorbent - adsorbate pairs under consideration in the present investigation. In this way adsorbent under consideration in the present research work is suitable for the treatment of water and wastewater with special reference to abatement of toxic metal ions that is As(III) and has potential application in environmental pollution control.

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Authored by

S. S. SHENDE

From

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