SORPTION PROPERTY STUDIES OF METHYL CELLULOSE, GUM TRAGACANTH AND HPMC BIO-POLYMERS IN THE UPTAKE OF CU (II) METAL IONS FROM WASTE WATER.

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Abstract : The main objective of this study includes uptake of Cu (II) metal ions from waste water using biopolymers like Methyl Cellulose, Gum tragacanth and Hydroxypropyl methyl cellulose in parts per milligrams of polymer. The main intension of the study is to check the maximum possible absorption of heavy metal ions by using minimal quantity of bio-polymer sample from waste water. Removal of Cu metal ion from aqueous solution using Gaur gum [1] and Xanthan gum [2] has been reported earlier. This work includes sorption property studies, were conducted in order to determine the metal-polymer interaction in solution state. Effective uptakes of Cu (II) metal ions were analyzed at different concentrations at different temperature. Concentrations of each bio polymer samples varied from 0.1mg (0.01%) upto 200mg (20%). Simple titration methods were applied to find out absorption of Cu (II) metal ion from waste water. pH of all polymer mixtures were maintained at neutral range of 6-7 throught the experiment. Certain parameters like density, viscosity, ultrasonic velocities were measured at different temperatures at different concentrations to study the interaction of the bio-polymers with metal ion. Change in density, change in viscosity, change in ultrasonic velocities were noted. All these parameters were found to decrease with increasing temperature. Spectrophotometric study revealed the absorption maximum for each bio-polymer samples containing Cu metal ions. Maximum absorption for these bio polymers observed at 341nm.

***IndexTerms* - Methyl cellulose, Gum tragacanth, HPMC, Absorption, viscosity, Density, Ultrasonic Interferometer.**

I. INTRODUCTION

Sorption is a physical and chemical process by which one substance becomes attached to another. Biosorption is a physico-chemical process that occurs naturally in certain biomass, which allows it to passively concentrate and bind contaminants onto its cellular structure. Pollution interacts naturally with biological systems. It is currently uncontrolled, seeping into any biological entity within the range of exposure. The most problematic contaminants include heavy metals, pesticides and other organic compounds which can be toxic to wildlife and humans even in small concentration. There are existing methods for remediation, but they are expensive or ineffective. Biosorption may be used as an environmentally friendly filtering technique. Hydrogels are three-dimensional chemically crosslinked polymer networks, which are hydrophilic in nature, able to swell in water, increasing substantially their original volume while keeping their integrity. These polymeric materials are promising for environmental applications, in particular, the waste water treatment [3,4,5].

Heavy metals are natural constituents of the earth's crust. Human activities have drastically altered the bio-chemical, geo-chemical cycles and the balance of some of the heavy metals. Heavy metals are stable and tend to accumulate and persist in the environment. They cannot be degraded or destroyed. Aquatic systems are particularly sensitive to pollution possibly due to the structure of their food chains. In many cases, harmful substances enter the food chain and are concentrated in fish and other edible aquatic organisms [6]. As they move from one ecological trophic level to another, metallic species start damaging the ecosystem. It also becomes difficult to track them as they move up the trophic levels. They accumulate in living tissues throughout the food chain and due to biomagnifications, humans receive the maximum impact, since they are at the top of the food chain [7]. Many metallic elements play an essential role in the functioning of living organisms; they also constitute nutritional requirements in some. However, over abundance of the essential trace elements can cause toxicity symptoms or death [8]. There are many sources through which metal pollution of the environment occurs which include geological weathering, industrial processing of ores and metals, leaching of metals from garbage and solid waste dump. Several metals are being widely used in electroplating, tanning and textile industry and are potentially toxic to humans [9]. Therefore the effluents being generated by these industries are rich in metal ions.

The current physico-chemical processes for metal ion removal like precipitation, reduction, ion-exchange, etc. are expensive and inefficient in treating large quantities. They also cause metal bearing sludges which are difficult to dispose off. The natural affinity of biological compounds for metallic elements could contribute to the purification of metal loaded waste water [10]. Biosorption is a feasible option because it is both efficient and cheap. Biosorption, which involves active and non-active uptake of biomass, is a good alternative to traditional processes. Widely available bio-polymers are also being used for sorption mainly because they are a cheap resource [11].

II. EXPERIMENTAL

2.1 Materials and Methods

All chemicals were reagent grade. Methyl cellulose(MC), Gum tragacanth(GT), Hydroxypropyl methyl cellulose (HPMC) were obtained from Himedia laboratories, Mumbai, India and used without additional purification. Distilled water was used throught the study. Digital pH meter (Systronics, MK-IV) used for pH study. Ultrasonic Interferometer for liquids F-81 (Mittal Enterprises) was used for the estimation of ultrasonic velocity. Spectrophotometric analysis was performed using Vis Double Beam Spectro 1203, Systronics.

2.2 Polymer sample preparation

1000ppm Stock solution of Cu was prepared by $CuSO_4.5H_2O$. To each of the bio-polymer mixtures, 10ml of 1000ppm Cu solution and 10ml of waste water was added. Initially, bio-polymer-metal ion mixtures along with waste water were mixed thoroughly with the help of magnetic stirrer. The bio-polymers such as Methyl cellulose, Gum tragacanth and HPMC with different quantities that are 20%(200mg), 15%(150mg), 10%(100mg), 5%(50mg), 1%(10mg), 0.5%(5mg), 0.1%(1mg), 0.05%(0.5mg), 0.01%(0.1mg) were mixed in the same way. After proper mixing, the resulting biopolymer mixtures were taken for further studies. For Spectrophotometric study 5ml of ammonia was added to each of the biopolymer mixtures.

III. RESULTS AND DISCUSSIONS

3.1 Interaction of bio-polymer mixtures with Cu (II) metal ion:

3.1.1 Study of absorption of Cu:

Initially the simple titration method was applied to determine the absorption properties of bio-polymers. Solution containing 10ml of 1000ppm Cu (II) metal ion was titrated against 0.003N Hypo solution using starch indicator at lab temperature (30^0C). Hypo solution was standardized with 0.003N standard $K_2Cr_2O_7$ solution. Strength of $CuSO_4$ (N_{CuSO4}) was calculated using formula

$$N_1V_1 = N_2V_2 \quad (1)$$

Where N_1 is the strength of $CuSO_4$, V_1 is volume of $CuSO_4$ solution, N_2 is the strength of Hypo solution and V_2 is volume of Hypo solution. By this, amount of only Cu can be calculated as

$$N\, CuSO_4 * Molar\ weight\ of\ Cu * 1000\ in\ ppm. \quad (2)$$

Where N *$CuSO_4$* is the strength of $CuSO_4$. Titration of 10ml of 1000ppm $CuSO_4$ solution against 0.003N Hypo solution was considered as blank titration. Solution that containing a few ml of only 1000ppm of $CuSO_4$ considered as blank solution of Cu. Amount of only Cu present in 1000ppm of $CuSO_4$ solution (blank solution) was found to be 202ppm at lab temperature. Then different concentrations of bio-polymer mixtures, which contain Methyl cellulose, Gum tragacanth, HPMC mixtures along with heavy metal ion solution, were tested for absorption of Cu (II) metal ion in the same way at lab temperature of 30^0C. Details of the observations have given in the Table 1.

Table 1. a.) Absorption of Cu (II) by methyl cellulose mixtures at 30^0C.

Concentrations of MC (%)	20% MC	15% MC	10% MC	5% MC	1% MC	0.5% MC	0.1% MC	0.05% MC	0.01% MC
Amount of Cu at 30^0C (ppm)	57	70	78	80	82	88	95	102	109

b.) Absorption of Cu (II) by Gum tragacanth mixtures at 30^0C.

Concentrations of Gum tragacanth (%)	20% GT	15% GT	10% GT	5% GT	1% GT	0.5% GT	0.1% GT	0.05% GT	0.01% GT
Amount of Cu at 30^0C (ppm)	-	6	15	18	23	36	57	80	95

c.) Absorption of Cu (II) by HPMC mixtures at 30^0C.

Concentrations of HPMC (%)	20% HPMC	15% HPMC	10% HPMC	5% HPMC	1% HPMC	0.5% HPMC	0.1% HPMC	0.05% HPMC	0.01% HPMC
Amount of Cu at 30^0C (ppm)	114	129	141	146	149	154	158	161	162

It was confirmed that different concentrations of methyl cellulose, gum tragacanth and HPMC mixtures could effectively absorb Cu (II) metal ion from water. Thus we can use these bio-polymer mixtures for the effective removal of Cu (II) metal ion from waste water. At 30^0C maximum absorption of Cu (II) metal ion was observed for 20% each bio-polymer. According to the intension of this study it was observed that, minimal amount of biopolymer mixtures i.e., 0.01% (0.0001gms) of biopolymer mixtures could absorb 109ppm of Cu metal ion using methyl cellulose mixture, 95ppm of Cu metal ion using gum tragacanth mixture and 162ppm of Cu metal ion using HPMC mixture, out of 202ppm at lab temperature. The absorption of Cu metal ion using different concentrations of biopolymer mixtures goes on increased as polymer concentrations decreased. i.e., 20% < 15% < 10% < 5% < 1% < 0.5% < 0.1% < 0.05% < 0.01% . The experiment was stopped at 20% (0.2gms) of each bio-polymer mixture because it was difficult to carry out the experiment since the thickness of the mixture becomes too high after 0.2gms.

3.1.2 pH Study

pH of blank Cu solution and different concentrations of biopolymer mixtures were noted at lab temperature (30^0C). Neutral pH of 6-7 was observed in blank solution as well as in every bio-polymer mixtures. pH of blank solution of Cu was found to be 6.57 at lab temperature. pH values of various methyl cellulose, gum tragacanth and HPMC mixtures at lab temperature are mentioned in Table 2.

Table 2. a.) pH values of methyl cellulose mixtures at lab temperature.

Concentrations of MC (%)	20% MC	15% MC	10% MC	5% MC	1% MC	0.5% MC	0.1% MC	0.05% MC	0.01% MC
pH values at 30^0C	7.01	6.68	6.66	6.8	6.75	6.55	6.69	6.54	6.61

b.) pH values of gum tragacanth mixtures at lab temperature.

Concentrations of Gum tragacanth (%)	20% GT	15% GT	10% GT	5% GT	1% GT	0.5% GT	0.1% GT	0.05% GT	0.01% GT
pH values at 30^0C	6.66	6.58	6.5	6.71	6.26	6.34	6.2	6.49	6.16

c.) pH values of HPMC mixtures at lab temperature.

Concentrations of HPMC (%)	20% HPMC	15% HPMC	10% HPMC	5% HPMC	1% HPMC	0.5% HPMC	0.1% HPMC	0.05% HPMC	0.01% HPMC
pH values at 30^0C	6.32	6.45	6.3	6.29	6.31	6.4	6.3	6.42	6.28

3.1.3 Density and Viscosity study of biopolymer mixtures

Density and viscosity measurements were carried out for Cu blank solution and also for different concentrations of methyl cellulose, gum tragacanth and HPMC mixtures. At 30^0C we found that density of Cu blank was $0.395*10^3$ (kg/m^3) and its viscosity was 0.277mm^2/sec. Density and viscosity values of various concentrations of biopolymer mixtures at lab temperature are shown in Table 3. Both density and viscosity were decreased as we move from higher concentration (20%) to lower concentrations (0.01%) of each biopolymer mixtures. Mass of the substance goes on decreases from 20% to 0.01% of each biopolymer mixtures. As a result value of density decreases.

Thickness of the substance decreases from higher concentrations (20%) to lower concentrations (0.01%). So internal resistance of the mixture decreases. We know that, a liquid with high internal resistance to flow is described as having high viscosity. A liquid with low internal resistance to flow is described as having low viscosity. Therefore decrease in viscosity was observed from higher concentrations (20%) to lower concentrations (0.01%) of MC, GT and HPMC mixtures.

Table 3. a.) Density and viscosity values of methyl cellulose mixtures at 30^0C.

Concentrations of MC (%)	20% MC	15% MC	10% MC	5% MC	1% MC	0.5% MC	0.1% MC	0.05% MC	0.01% MC
Density at 30^0C [10^3 (kg/m^3)]	0.3967	0.3965	0.3963	0.396	0.3959	0.3958	0.3956	0.3955	0.3955
Concentrations of MC (%)	20% MC	15% MC	10% MC	5% MC	1% MC	0.5% MC	0.1% MC	0.05% MC	0.01% MC
Viscosity at 30^0C (mm^2/sec)	8.4772	5.4848	2.362	1.7464	0.4307	0.4001	0.3743	0.3673	0.3602

b.) Density and viscosity values of gum tragacanth mixtures at 30^{0}C.

Concentrations of Gum tragacanth (%)	20% GT	15% GT	10% GT	5% GT	1% GT	0.5% GT	0.1% GT	0.05% GT	0.01% GT
Density at 30^{0}C [10^3 (kg/m^3)]	0.3957	0.3957	0.3957	0.3956	0.3955	0.3955	0.3955	0.3953	0.3952
Concentrations of Gum tragacanth (%)	20% GT	15% GT	10% GT	5% GT	1% GT	0.5% GT	0.1% GT	0.05% GT	0.01% GT
Viscosity at 30^{0}C (mm^2/sec)	0.379	0.3757	0.3744	0.3674	0.3601	0.3586	0.3508	0.3443	0.3365

c.) Density and viscosity values of HPMC mixtures at 30^{0}C.

Concentrations of HPMC (%)	20% HPMC	15% HPMC	10% HPMC	5% HPMC	1% HPMC	0.5% HPMC	0.1% HPMC	0.05% HPMC	0.01% HPMC
Density at 30^{0}C [10^3 (kg/m^3)]	0.3965	0.3964	0.3963	0.3959	0.3955	0.3954	0.3954	0.3953	0.3953
Concentrations of HPMC (%)	20% HPMC	15% HPMC	10% HPMC	5% HPMC	1% HPMC	0.5% HPMC	0.1% HPMC	0.05% HPMC	0.01% HPMC
Viscosity at 30^{0}C (mm^2/sec)	1.1769	1.0806	0.5483	0.5182	0.3134	0.2984	0.2946	0.2876	0.2852

3.1.4 Study of Ultrasonic sound velocity of biopolymer mixtures

Determination of ultrasonic sound velocity was carried out for blank solution of Cu and for various concentrations of MC, GT and HPMC mixtures at lab temperature using Ultrasonic Interferometer for liquids F-81 (Mittal Enterprises). Ultrasonic sound velocity of blank solution of Cu was 2144m/s at lab temperature. The obtained values of ultrasonic sound velocity for various concentrations of methyl cellulose, gum tragacanth and HPMC mixtures are given below in Table 4. No characteristic changes observed in the values of ultrasonic velocity for different concentrations of biopolymer mixtures.

Table 4. a.) Ultrasonic sound velocity for MC mixtures at 30^{0}C.

Temperature (^{0}C)	*Ultrasonic Velocity (m/s) of MC mixtures*								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	1863	1985	1735	1879	1735	1808	1742	1898	1735

b.) Ultrasonic sound velocity for GT mixtures at 30^{0}C.

Temperature (^{0}C)	*Ultrasonic Velocity (m/s) of GT mixtures*								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	1597	1806	2004	1707	1598	1681	1622	1707	1624

c.) Ultrasonic sound velocity for HPMC mixtures at 30^{0}C.

Temperature (^{0}C)	*Ultrasonic Velocity (m/s) of HPMC mixtures*								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	1611	1623	1594	1606	1599	1575	1563	1619	1602

3.2 Temperature study

3.2.1 Effect of temperature on Absorption of Cu (II) metal ion

Study of effect of temperature on absorption of Cu, pH values, density, viscosity and also on ultrasonic sound velocity were conducted. Both blank solution of Cu and various concentrations of biopolymer mixtures containing Cu (II) metal ions were tested for the same. Temperature was increased from lab temperature to slight higher temperatures. That was from 30^0C to 60^0C. Absorption of Cu (II) metal ion from waste water was found to decrease with increasing temperature for all the biopolymer mixtures even for Cu blank solution. As we increase the temperature the rate of reaction increases. Particles can react only when they collide. By heating, particles move faster and collide more frequently. That will speed up the rate of reaction. Fig.1shows the effect of temperature on absorption of heavy metal ion for blank solution of Cu.

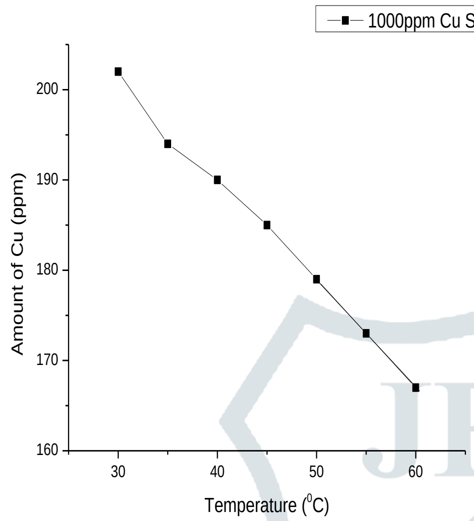

Fig.1 Effect of temperature on absorption of Cu blank.

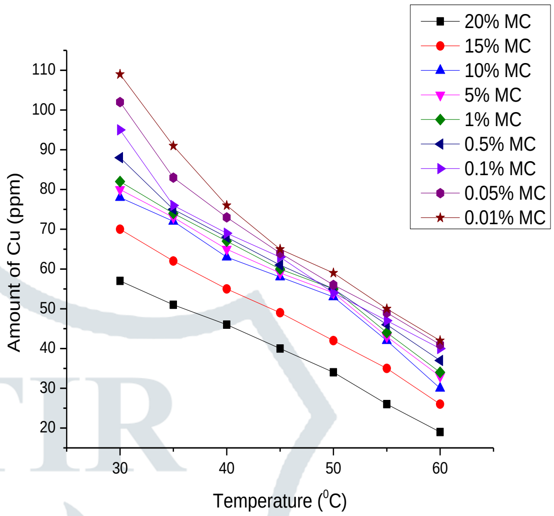

Fig.2 Effect of temperature on absorption of Cu using MC mixtures.

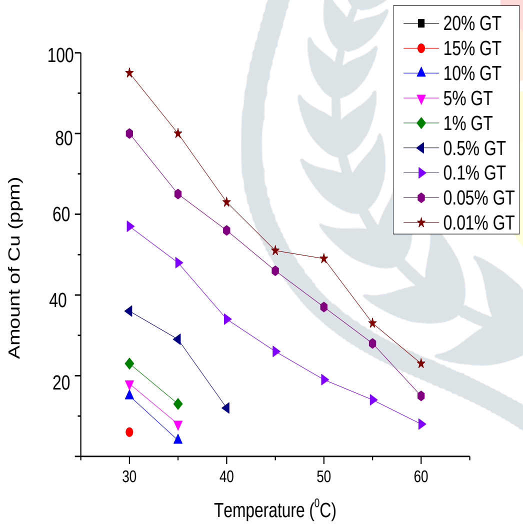

Fig.3 Effect of temperature on absorption of Cu using GT mixtures.

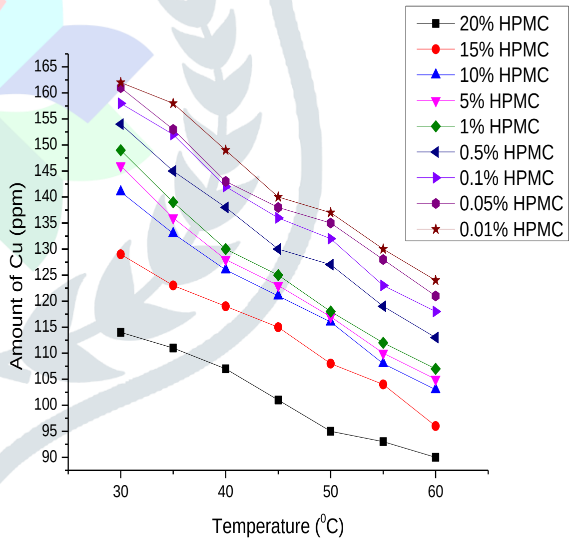

Fig.4 Effect of temperature on absorption of Cu using HPMC mixtures.

Effect of temperature on absorption of Cu (II) metal ions using different concentrations of Methyl cellulose mixtures (Fig.2), Gum tragacanth mixtures (Fig.3) and HPMC mixtures (Fig.4) have shown above. From graph it is clear that temperature has greater effect on reaction rate of different concentrations of MC, GT and HPMC mixtures resulting in, decreasing temperature curve. After 60^0C, absorption was found to be constant and there was negligible difference in absorption. Hence temperature study has stopped at 60^0C for all the mixtures.

3.2.2 Effect of temperature on pH values

pH of blank Cu solution and other biopolymer mixtures were slightly decreased with increase in temperature. Neutral pH range (6-7pH) was noticed in every mixture even though the pH values decreased. Temperature plays a significant role on pH measurements. As the temperature rises, molecular vibrations increase which results in the ability of water to ionize and form more hydrogen ions. As a result, the pH will drop. pH values of blank Cu solution at different temperatures and effect of temperature on pH values of different concentrations of MC, GT and HPMC mixtures are given in Table 5.

Table 5. a.) Effect of temperature on pH values of Cu blank solution

Temperature	30	35	40	45	50	55	60
pH of Cu blank	6.57	6.53	6.5	6.45	6.38	6.31	6.26

Temperature (^{0}C)	**b.)** Effect of temperature on pH values of MC mixtures								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	7.01	6.68	6.66	6.8	6.75	6.55	6.69	6.54	6.61
35	6.96	6.61	6.6	6.71	6.74	6.51	6.32	6.49	6.47
40	6.91	6.55	6.59	6.69	6.73	6.48	6.22	6.41	6.15
45	6.88	6.54	6.56	6.58	673	6.36	6.21	6.33	6.15
50	6.77	6.5	6.49	6.49	6.65	6.3	6.2	6.3	6.13
55	6.68	6.44	6.49	6.45	6.61	6.27	6.17	6.24	6.11
60	6.57	6.38	6.43	6.32	6.6	6.18	6.12	6.23	6.06

Temperature (^{0}C)	**c.)** Effect of temperature on pH values of GT mixtures								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	6.66	6.58	6.5	6.71	6.26	6.34	6.2	6.49	6.16
35	6.58	6.51	6.42	6.63	6.17	6.32	6.2	6.41	6.15
40	6.47	6.44	6.39	6.54	6.11	6.25	6.14	6.37	6.13
45	6.26	6.39	6.26	6.51	6.08	6.22	6.12	6.29	6.11
50	6.09	6.23	6.19	6.4	6.02	6.16	6.11	6.16	6.06
55	6.05	6.15	6.17	6.33	6	6.11	6.1	6.11	6.03
60	5.99	6.09	6.12	6.21	5.99	6.06	6.09	6.07	6.02

Temperature (^{0}C)	**d.)** Effect of temperature on pH values of HPMC mixtures								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	6.32	6.45	6.3	6.29	6.31	6.4	6.3	6.42	6.28
35	6.29	6.42	6.29	6.27	6.26	6.35	6.28	6.35	6.25
40	6.25	6.36	6.23	6.24	6.21	6.32	6.26	6.32	6.24
45	6.24	6.33	6.22	6.17	6.21	6.28	6.25	6.22	6.22
50	6.21	6.27	6.2	6.14	6.2	6.26	6.24	6.2	6.2
55	6.19	6.19	6.19	6.08	6.18	6.15	6.19	6.16	6.17
60	6.11	6.12	6.17	6.03	6.13	6.14	6.18	6.1	6.13

3.2.3 Effect of temperature on Density values of bio-polymer mixtures

Density changes with temperature because volume changes with temperature. As temperature increases, the volume usually increases because the faster moving molecules are further apart. Thus increasing the volume decreases the density. Change in density values with increasing temperature for Cu blank is given below. (Fig.5). The temperature effect on density values are shown, for different concentrations of methyl cellulose mixtures (Fig. 6), Gum tragacanth mixtures (Fig. 7) and HPMC mixtures (Fig. 8) below. We noticed that, there was no much difference in density values even though different concentrations of biopolymers were used. In Fig.6, most of the lines seem to be overlapping this is because, there was very negligible difference in density between different concentrations of methyl cellulose mixtures whereas in case of GT and HPMC mixtures, remarkable differences has observed.

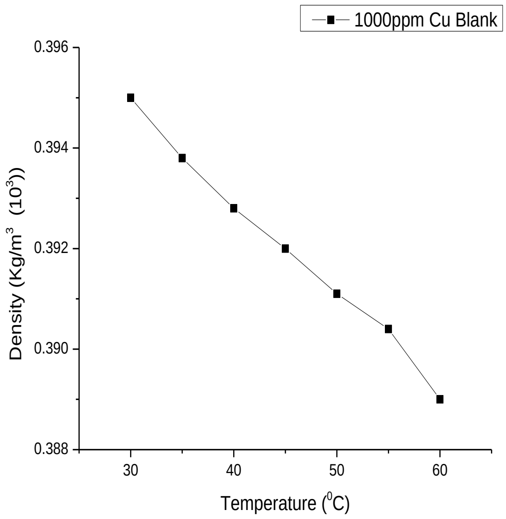

Fig.5. Effect of temperature on density of Cu blank.

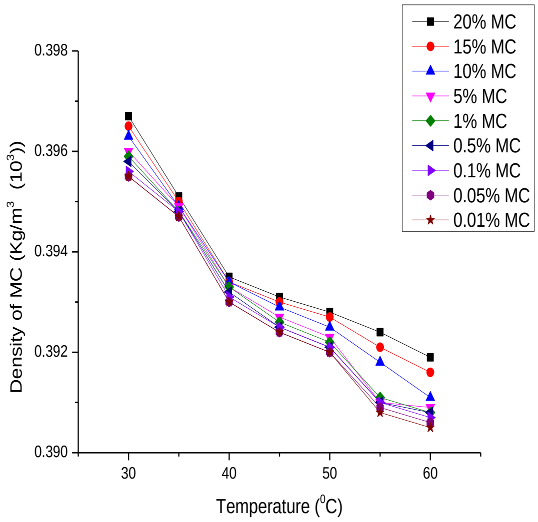

Fig.6. Effect of temperature on density of MC mixtures.

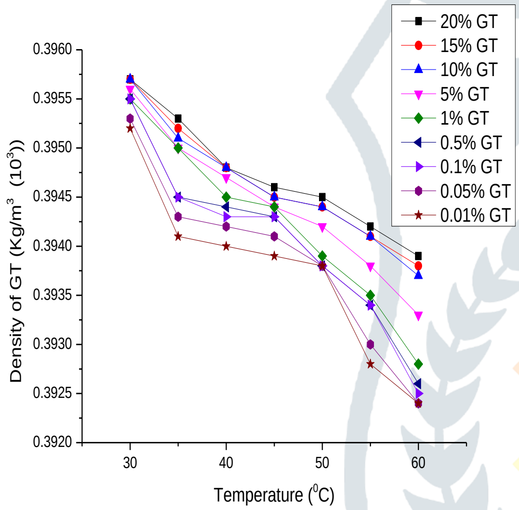

Fig.7. Effect of temperature on density of GT

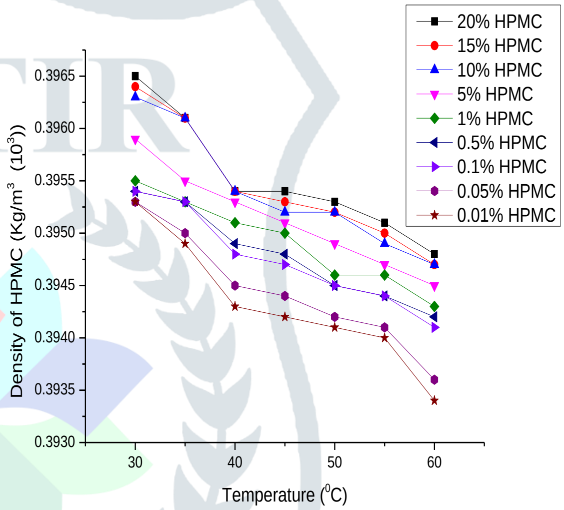

Fig.8 Effect of temperature on density of HPMC mixtures.

3.2.4 Effect of temperature on Viscosity values of bio-polymer mixtures

The viscosity of liquids decreases with increase in temperature. The cohesive force between molecules of liquids decreases. At high temperature the molecules of liquids have high energy and overcome strong cohesive forces and move freely. Hence viscosity of liquids decreases with increase in temperature. Change in viscosity values with increasing temperature for Cu blank is given below. (Fig.9). Gum tragacanth mixtures are quickly dissolves with Cu (II) metal ion solution so GT mixtures will not become too thick. Hence the temperature curve for viscosity of various concentrations of gum tragacanth mixtures from 20% to 0.01% seem to be closer in Fig.11. Thickness of 20% and 15% mixtures of both MC and HPMC were too high as a result, respective temperature curve lies at the top (Fig.10, 12). Temperature curve for 1% to 0.01% mixtures of both MC and HPMC lies almost in the same line since the thickness of these mixtures are very close to each other even though it becomes lesser from 1% to 0.01%. Fig.10, 11 and 12 represents the temperature effect on viscosity of different methyl cellulose mixtures, gum tragacanth mixtures and HPMC mixtures respectively.

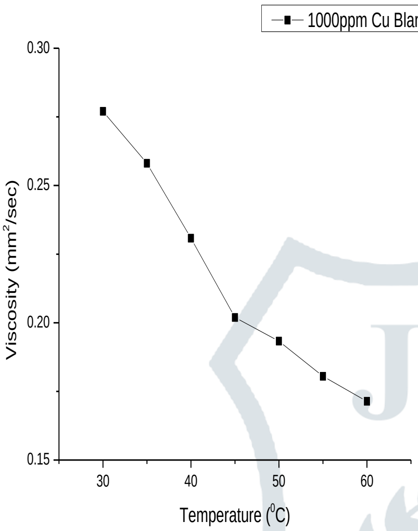

Fig.9. Effect of temperature on viscosity of Cu blank.

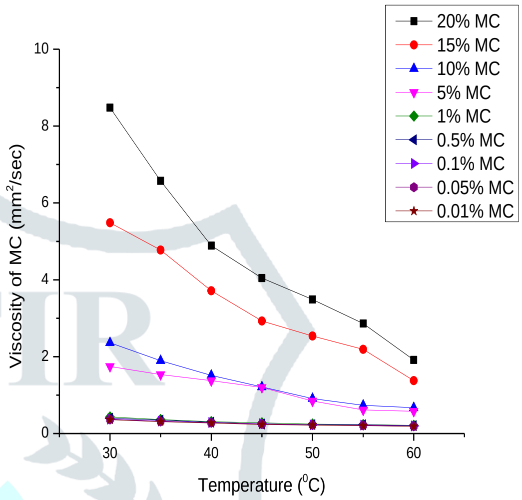

Fig.10. Temperature effect on Viscosity of MC mixtures

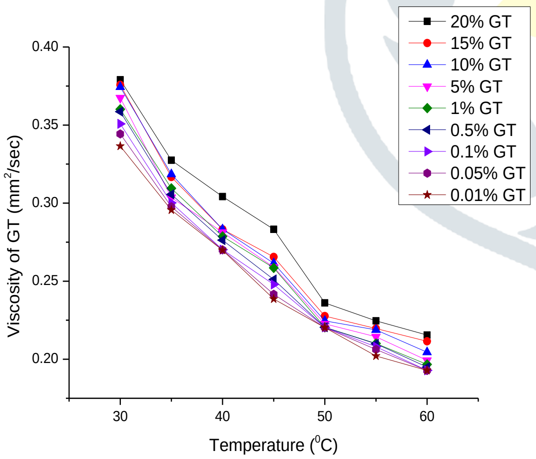

Fig.11 Effect of temperature on viscosity of gum tragacanth mixtures

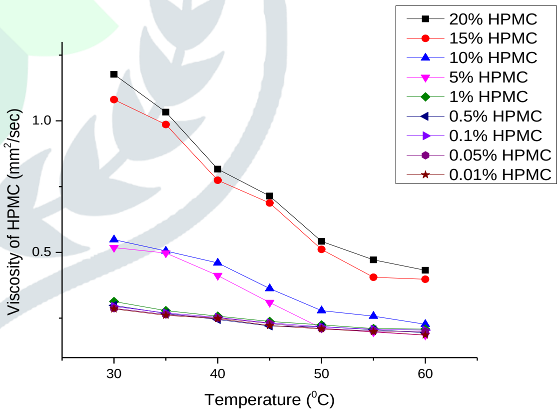

Fig.12. Effect of temperature on viscosity of HPMC mixtures

3.2.5 Effect of temperature on Ultrasonic sound velocity

Temperature is also a condition that affects speed of sound. Molecules at higher temperature have more energy thus they can vibrate faster. Since the molecules vibrate faster, sound waves can travel more quickly. The velocity of ultrasonic sound decreases as temperature rises. Ultrasonic sound velocity of blank Cu solution at different temperatures and effect of temperature on ultrasonic sound velocity of various methyl cellulose, gum tragacanth and HPMC mixtures are given below. (Table 6). All these values were decreased with increasing temperature but no characteristic changes observed between the values of ultrasonic sound velocity for different concentrations of biopolymer mixtures.

Table 6. a.) Temperature study on ultrasonic sound velocity of Cu blank

Temperature (^{0}C)	Ultrasonic Velocity of Cu blank (m/s)
30	2144
35	2106
40	1956
45	1859
50	1858
55	1729
60	1643

Temperature (^{0}C)	**b.)** Ultrasonic Velocity of methyl cellulose mixtures (m/s)								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	1863	1985	1735	1879	1735	1808	1742	1898	1735
35	1862	1942	1727	1863	1618	1805	1620	1877	1606
40	1850	1907	1709	1854	1595	1799	1597	1854	1602
45	1822	1866	1660	1833	1594	1786	1593	1831	1599
50	1735	1840	1615	1788	1592	1754	1590	1793	1595
55	1704	1725	1602	1746	1560	1737	1585	1791	1580
60	1661	1713	1596	1704	1509	1711	1539	1772	1571

Temperature (^{0}C)	**c.)** Ultrasonic Velocity of GT mixtures (m/s)								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	1597	1806	2004	1707	1598	1681	1622	1707	1624
35	1596	1717	1979	1663	1594	1653	1605	1686	1607
40	1594	1702	1947	1636	1471	1645	1602	1643	1604
45	1512	1692	1919	1611	1469	1620	1535	1601	1601
50	1480	1687	1866	1595	1467	1601	1486	1599	1599
55	1461	1653	1696	1575	1440	1580	1478	1571	1551
60	1457	1610	1560	1560	1414	1577	1471	1510	1462

Temperature (^{0}C)	**d.)** Ultrasonic Velocity of HPMC mixtures (m/s)								
	20% (200mg)	15% (150mg)	10% (100mg)	5% (50mg)	1% (10mg)	0.5% (5mg)	0.1% (1mg)	0.05% (0.5mg)	0.01% (0.1mg)
30	1611	1623	1594	1606	1599	1575	1563	1619	1602
35	1568	1618	1586	1603	1569	1563	1541	1602	1589
40	1533	1606	1571	1598	1555	1545	1523	1580	1580
45	1512	1595	1562	1595	1548	1530	1502	1574	1566
50	1490	1580	1550	1588	1520	1521	1456	1555	1545
55	1478	1566	1520	1574	1494	1514	1438	1538	1518
60	1462	1514	1492	1560	1473	1507	1421	1510	1500

3.3 Spectrophotometric study

The solution containing Cu (II) metal ion with different concentrations of bio-polymers were analyzed using Visible Double Beam spectrophotometer. 5ml ammonia is added to every biopolymer mixtures. The absorption value for different concentrations of methyl cellulose, gum tragacanth, HPMC mixtures were obtained. Maximum absorption was obtained at 341nm (λ_{max} 341nm) for all the biopolymer mixtures including blank solution of Cu. Absorption value for Cu blank is 0.098. For each biopolymer mixture, blank reading was taken. Spectroscopic readings for various concentrations of methyl cellulose, gum tragacanth and HPMC mixtures are shown in Fig 13,14 and 15 respectively.

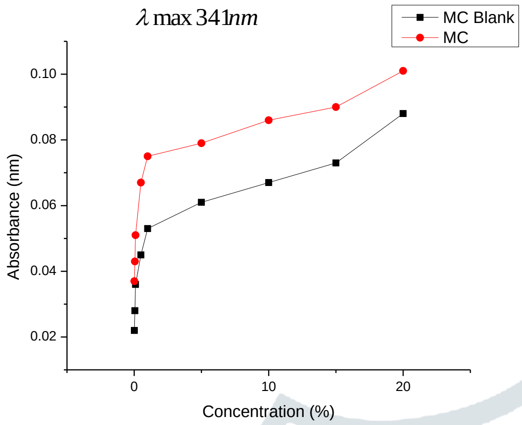

Fig 13. Spectral readings for various MC mixtures.

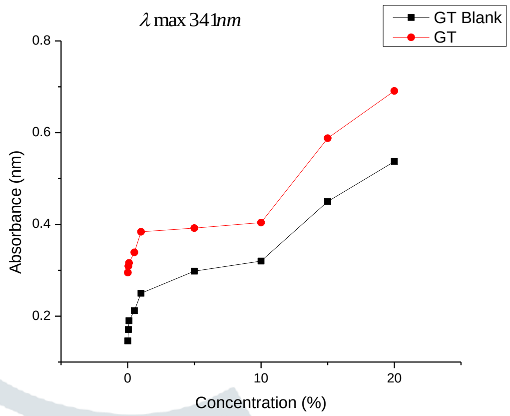

Fig 14. Spectral readings for various GT mixtures.

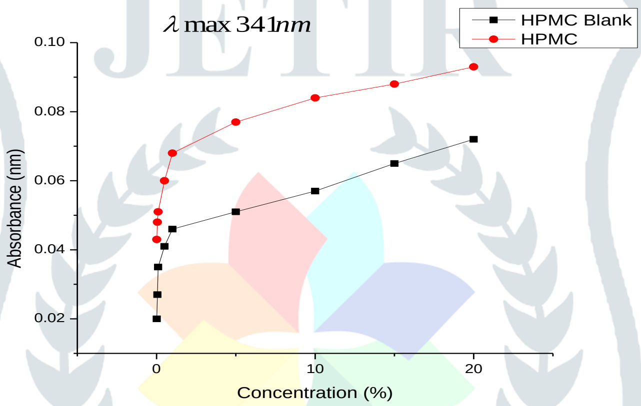

Fig 15. Spectral readings for various HPMC mixtures.

IV. CONCLUSION

This study has shown that biopolymers such as methyl cellulose, gum tragacanth and hydroxypropyl methyl cellulose mixtures can absorb a significant amount of heavy metal ions like Cu from waste water. Minimal quantity of biopolymer mixture that is 0.01% or 0.1mg of biopolymer can effectively absorb Cu (II) metal ion from waste water instead of using large quantity of biopolymers. Sorption properties of biopolymers were studied at different concentrations at different temperatures. Study revealed that, solution property studies of biopolymers like change pH, viscosity, density, absorption capacity and ultrasonic sound velocity with and without the sorbed metal ions, were decreased with increase in temperature. Neutral pH range (6-7pH) was noticed in every mixture even though the pH values decreased due to increase in temperature. During temperature study it has seen, there was no much difference in density values even though different concentrations of biopolymers were used. Maximum absorption has seen at 341nm for all the biopolymer mixtures containing Cu (II) metal ion, such as MC, GT and HPMC mixtures and also for Cu blank solution.

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