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# Heavy Metal Removal from Electroplating Wastewater by Modified Whey Protein (diary waste) and Other Agricultural Waste

Arun Singh[1] and Varsha Parmar[2]

[1]Government Maharani Laxmi Bai Girls' Autonomous P.G. College Bhopal M.P. India

[2]Laxmi Narayan College of Technology & Science, Bhopal, M.P.

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**ABSTRACT**

The dairy waste, whey protein was modified by reaction with phthalic anhydride. The phthalated whey protein (PWP) and its mixture with bagasse, and corn cob were prepared. Such mixtures were used for removal of heavy metals (Pb, Cr, Cd, Ni, Cu, Fe and Zn) by batch adsorption method from electroplating industrial wastewater. In such a batch adsorption process the above adsorbent materials were used as bed and the parameters; effect of contact time, dosage, a temperature and pH were evaluated. The finding of this investigation reveals that the product natural adsorbents have excellent capacity to remove heavy metals from industrial effluents.



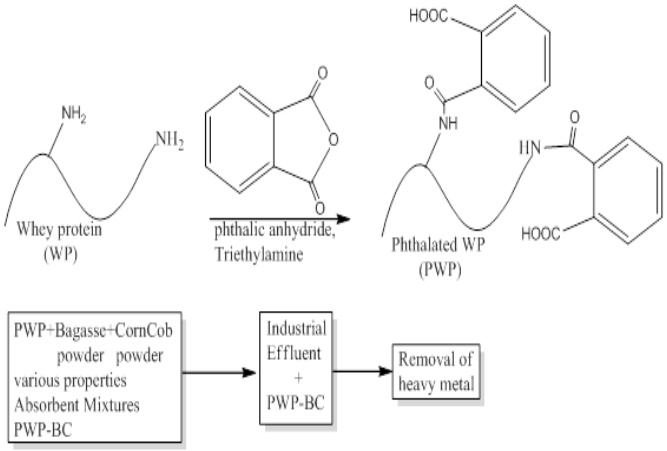
## Introduction

Water is basic need for life and it need to preserved and protected. [(1)] Whole world today faced the water pollution problem originated by human activities like chemical, metallurgical, electroplating, pharmaceutical and petroleum industries [(2,3)] activities. Electroplating is the process in which metal plating for corrosion inhibitions. The most elements used for plating are Zinc, Silver, Gold, Nickel, Copper, Iron, Chromium etc. [(4)]. In such plating process, the industries produce wastewater containing high level of heavy metal ions [(5-7)]. Such effluents are colored, turbid, and acidic in nature which cause toxic soil, crops and ultimately create negative effect on ecosystem.

Various these effluent treatment technologies developed like flocculation, co-precipitation, solvent extractions, ion – exchange etc. [8-10]. However, adsorption technology is proved pivotal method [11,12]. There are number of reports are documented regarding the adsorption techniques by using natural agricultural waste.

Looking to these investigations the present author thought to explain such type of work. He progressed the work in the direction of dairy waste product i.e. whey protein.

The whey protein (WP) is complex structure, having functional group -$NH_2$ group as pendent. Thus, in the present work the WP was phthalated by phthalic anhydride. The Phthalated WP designated as PWP was mixed with other agricultural waste like bagasse and corn cob. All the mixtures were used as heavy metal adsorbents for electroplating industrial effluents of Madhya Pradesh state. The study is scanned as follows :




## Experimental

### Materials

The natural materials say whey protein corn cob and bagasse were used for present study. Whey protein obtained from nearest milk dairy clean corn cob (from agricultural farm) and bagasse (from sugar industry) were powdered with pulverizer to pass through 50 mesh shieve. Both powders treated with aqueous alkali, filtered and washed repeatedly with water, then acetone and finally by petroleum ether. Then both powder filtered and vacuum dried for several hours. The resulting solids were packed in plastic bottle and stored in refrigerator. All other chemicals used were of pure grade.

Electroplating industrial waste water (EWW) samples were collected from various industrial zones of Madhya Pradesh (Indore, Bhopal). The samples were taken and filled into PET bottle. Prior to fill sample PET bottle were washed with dilute nitric acid and then deionized water. The samples were kept in refrigerator.

Tele:

E-mail address: dr.arunsingh68@gmail.com

**Heavy metal determination**

The metals present in wastewater samples were determined by Atomic absorption spectrophotometer (AAS). The metal ion concentrations obtained directly from a Calibration graph (in mg/lit)

**Modification of whey protein (WP)**

The WP was modified by the reaction of WP with phthalic anhydride followed by method reported for acylation of WP.[13] The resultant WP protein is known as phthalated WP and designated as PWP.

**Preparation of adsorption mixture**

The following adsorption mixtures were prepared from PWP, bagasse (B) and Corn Cop (CC).

| NO | PWP% | B% | CC% |
|---|---|---|---|
| M1 | 70 | 20 | 10 |
| M2 | 60 | 20 | 20 |
| M3 | 70 | 10 | 20 |

**Procedure for adsorption study of EWW samples by above adsorption**

Two gram of each of above mixture was weighed and put into 250ml B-24 Erlenmeyer flask. This was agitated for 2 hr with 100ml of EWW. After agitztions for 12 hrs the mixtures were filtered and the final concentrate of heavy metals in filtrate was determined by ASS.

**Result and Discussion**

As the modified whey protein (PWP) contains chelating phthalate group and also hydroxy groups present in B and CC, It is expected that the metal could be gripped on such adsorption. So present study given excellent results.

The results of EWW by mixtures shown in Table 1 to 3.

**Table 1. Removal Of Metals From EWW (Zone-1)**

| Metal Parameter mg/l | Metal content in EWW Sample | Metal after by M-1 adsorption | Metal after by M-2 adsorption | Metal after by M-3 adsorption |
|---|---|---|---|---|
| $Fe^{3+}$ | 130.2 | 15.1 | 15.0 | 14.3 |
| $Ni^{2+}$ | 116.1 | 7.4 | 7.3 | 7.1 |
| $Cd^{2+}$ | 2.88 | 0.003 | 0.003 | 0.003 |
| $Pb^{2+}$ | 4.73 | 0.012 | 0.0011 | 0.012 |
| $Cu^{2+}$ | 101.2 | 5.2 | 5.0 | 5.0 |
| $Zn^{2+}$ | 211.3 | 5.9 | 6.1 | 6.2 |
| Cr3+ | 87.2 | 0.12 | 0.11 | 0.11 |

**Table -2 Removal Of Metals From EWW (Zone-2)**

| Metal Parameter mg/l | Metal content in EWW Sample | Metal after by M-1 adsorption | Metal after by M-2 adsorption | Metal after by M-3 adsorption |
|---|---|---|---|---|
| $Fe^{3+}$ | 140.3 | 16.3 | 16.1 | 14.3 |
| $Ni^{2+}$ | 108.4 | 7.1 | 7.3 | 7.1 |
| $Cd^{2+}$ | 3.1 | 0.004 | 0.004 | 0.004 |
| $Pb^{2+}$ | 4.53 | 0.012 | 0.013 | 0.013 |
| $Cu^{2+}$ | 112.3 | 4.9 | 4.8 | 4.3 |
| $Zn^{2+}$ | 204.3 | 5.4 | 5.3 | 5.3 |
| $Cr^{3+}$ | 83.3 | | | |

**Table -3 Removal Of Metals From EWW (Zone-3)**

| Metal Parameter mg/l | Metal content in EWW Sample | Metal after by M-1 adsorption | Metal after by M-2 adsorption | Metal after by M-3 adsorption |
|---|---|---|---|---|
| $Fe^{3+}$ | 128.7 | 14.3 | 14.2 | 13.3 |
| $Ni^{2+}$ | 109.3 | 7.3 | 6.9 | 7.0 |
| $Cd^{2+}$ | 2.94 | 0.003 | 0.0029 | 0.0031 |
| $Pb^{2+}$ | 4.82 | 0.013 | 0.012 | 0.012 |
| $Cu^{2+}$ | 118.1 | 4.7 | 4.8 | 4.7 |
| $Zn^{2+}$ | 201.8 | 5.4 | 5.0 | 5.0 |
| $Cr^{3+}$ | 88.3 | 0.11 | 0.11 | 0.12 |

**Results and Discussion**

In the present study the modified whey pertain (PWP) containing legend. So it has good to capacity for metal gripping (13). Also bagasse and can cob have number of hydroxy groups. So both have good attachment of metal by replacement of H ions of OH graphs. Thus the produced adsorbent are good metal adsorbents.

The waste water samples EWW of three zones were treated with three adsorbent mixtures. In such study the pH is important for metal absorbance. Overall observation reported reveals that optimum pH for these metal adsorption is in the range of 4 to 6 (14). So the present adsorption were performed between pH & 4 to 6. The metal was $Fe^{3+}$, $Zn^{3+}$, $Cr^{3+}$, $Ni^{3+}$, $Zn^{3+}$, $Pb^{3+}$, $Cd^{3+}$ are highly adsorbed between 5 to 6 pH. From the results shown in Table 1 to 3 & show that proposed whey protein chelating ligand can be used for metal for removal from waste water.

From the result shown in Tables 1 to 3 it is shown that %age removal of metals mention above varies from 85 to 95% for all three mixtures on average the metals are almost in near range of all three zone wastewater samples. The result show that there is no particular order of metal update from the effluents overall the efficiency of removal of heavy metals in all three adsorbed is excellent.

**Conclusion**

The natural adsorbents say modified whey protein, bagasse, corn cob mixtures were prepared and their capacity for metal absorbance electroplating industrial water was performed. The adsorptions is parity to the action at ion-exchange resins, overall results suggest that ease of availability of and low cost of adsorbent this technique has excellent potential application for removal of effluents of metallurgical industries.

This sludge after adsorptions also may be applied as micronutrients is soil for agriculture crops.

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