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Original Research Article

The Divine Solution to the Fate of Metal Pollution from Industries

Zakiuddin Ahmed[*1], S. Arif Kazmi[2], Muhammad Shahid[3] and Nadir Buksh[1]

[1]Fuel Research Center PCSIR Karachi.

[2]Department of Chemistry University of Karachi, 75280

[3]Bahria University Karachi Campus

***Corresponding Author Email: Zakiuddinahmed734@yahoo.com: Tel: 03223508653**

Abstract

Humic acid is a naturally occurring polymeric, brown organic compound present mostly in lignitic coals. Nature granted hydrogen ion concentration to play an important role in chelation of this valued compound with inorganic metals and organic pollutants also. This chelation provides not only bio-availability of metal ions to plants which in result, gives soil conditioning but also conversion of active toxic metal ions to non-toxic complexes. Humic acids in the form of humate salts (Ammonium, Sodium, Potassium and Iron) can be used during treatment of wastewater, groundwater, leachates and soil. These abundant natural macromolecules can immobilize not only the metal ions but also toxic organic compounds by complexation or adsorption. These pollutants become incorporated into the humate chemical structure. This study is persuading with the objective to develop economical methods for the abatement of pollution through humic acids in the form of humate for the treatment of effluents from industries.

Keywords: Humic acid, Wastewater, Heavy metal pollution

INTRODUCTION

The city of Karachi is facing population flow from other remote areas of the country and due to this urbanization, industrial units are setting up quickly for production at low cost labors. Due to this haphazard industrialization, huge effluent is being created and further without any treatment, this seeps down to underground water table affecting population reservoirs. This situation insisted us on searching for an inexpensive solution for general public and also for industries. This hypothesis will deliver a divine solution environmental friendly.

As metallurgical wastewater producing industries in Pakistan, not equipped with effluent effective disposal / treatment facilities, causing a colossal damage to the environment and needing immediate remedial action. Humic acids have been produced from lignitic coals and widely utilized for metallurgical waste water treatments, in which these abundant natural macromolecules can substitute for activated carbon and other more expensive, organic and inorganic adsorbents (Janos, 2005). References have shown that humic acids due to its carboxylic grouping has great ion exchange properties (Zak, 1988; Sahu and Banerjee, 1996) and form complexes with heavy metal ions like mercury, lead, nickel, chromium etc (Khan et al., 1996). The resulting metal humic acids complex is comparably non toxic and can be utilized in agriculture (Badaische and Soda, 1963), and industry (Nasreen et al., 1995) for enhancing agriculture growth and as pigments, coloring agent, in cosmetics etc (Gelszier et al., 1981; Barron and Wilson, 1981).

Humic Acids are actually, highly biodegraded and compressed remains of ancient plant and animal macirals. Simply, they are decomposed organic materials that have fossilized over a period of millions of years. They are also referred to as Humic substances and are used as soil conditioners, soil supplements and fertilizer

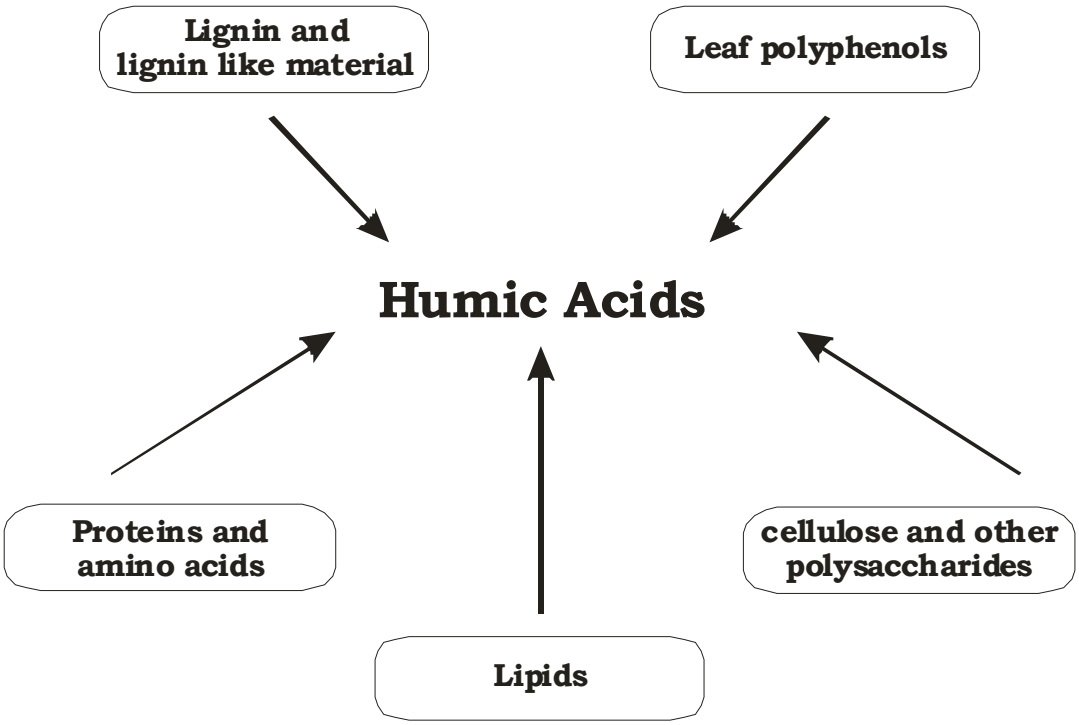

Figure 1. Typical soil inputs

Table 1. Proximate and Ultimate analysis of coal

Moisture %	Volatile Matter %	Ash %	Fixed Carbon %	C %	H %	N %	S %
28.05	29.96	12.06	29.93	63.30	5.09	1.87	6.21

Table 2. Ultimate Analysis of Humic Acids

Carbon %	Hydrogen %	Nitrogen %	Oxygen %
57.30	4.43	6.86	31.41

amendments (Davies and Ghabbour, 2001). Humic Acids, designated by nature to perform a wide variety of functions, produced through the decay or oxidation of vegetable matter in result of microbial action, are naturally found in soils, rivers, oceans and in lignite coals (Lawson and Stewart, 1989; Barna, 1983). This wonderful naturally occurring product is found in abundance in low rank lignite coals. Pakistan has large deposits of these coals at Lakhra and Thar (Couch, 2004).

METHODOLOGY

As humic acid is a natural product (Davies and Ghabbour, 2001) found in fertile soils and fertility of these soils depends on its quantity present there. In the nature, it formed in result of complex actions of different compounds (Figure 1) over a long period like lignin, polyphenols, cellulose, proteins, aminoacids and lipids etc. However, we have produced in the laboratory according to the given method.

Humic acids was prepared from Lakhra Coal and analyzed for its proximate and ultimate analysis. (Table 1 and 2) Lakhra coal (200 mesh) was extracted with 2:1 (v/v) benzene methanol. After extraction, the residue washed with 0.1 M hydrochloric acid and then with distilled water. Now, dissolved residue coal in 0.1 M sodium hydroxide solution for 48 hours and acidified to pH = 1 with HCl (10%). A gel like substance precipitated out, which was then dialyzed with HCl /HF, and H_2O (25 % yield) and dried to crystals of humic acids on water bath (Figure 2).

To study metal complexes, humic acids- metal complexes formed using imported reagents of analytical grade. Different concentration solutions of heavy metals

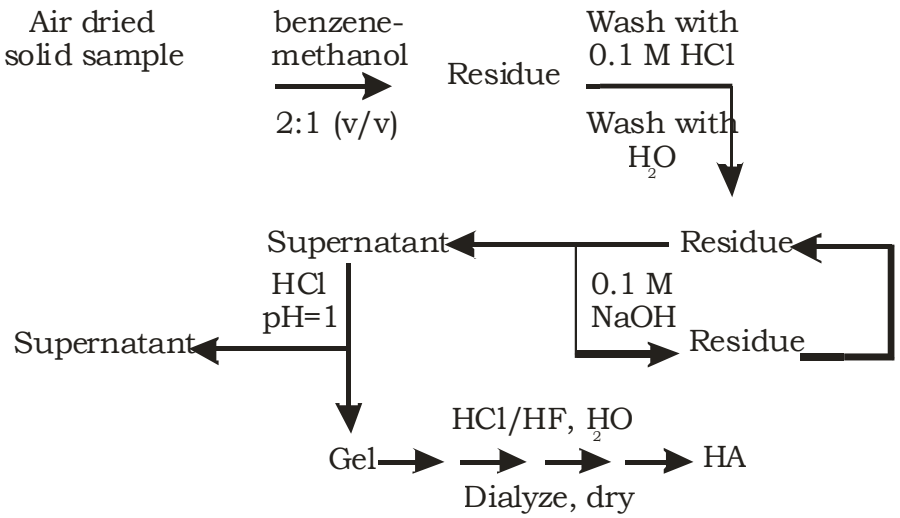

Figure 2. Flow diagram of HA Extraction scheme

Table 3. Effect of Gradual Change of pH on Relative % of Complexed Species

	Relative % of Complex Species of Metals under Study						
pH	4.5	5.0	5.5	6.5	7.5	8.5	9.0
Nickel (Ni^{2+})	32	40	62	74	70	67	52
Lead (Pb^{2+})	69	89	97	76	68	74	70
Zinc (Zn^{2+})	11	20	25	23	31	27	24
Copper (Cu^{2+})	68	83	95	77	72	74	70
Iron (Fe^{2+})	83	79	76	77	75	72	68
Chromium (Cr^{3+})	9	17	23	50	80	99	82

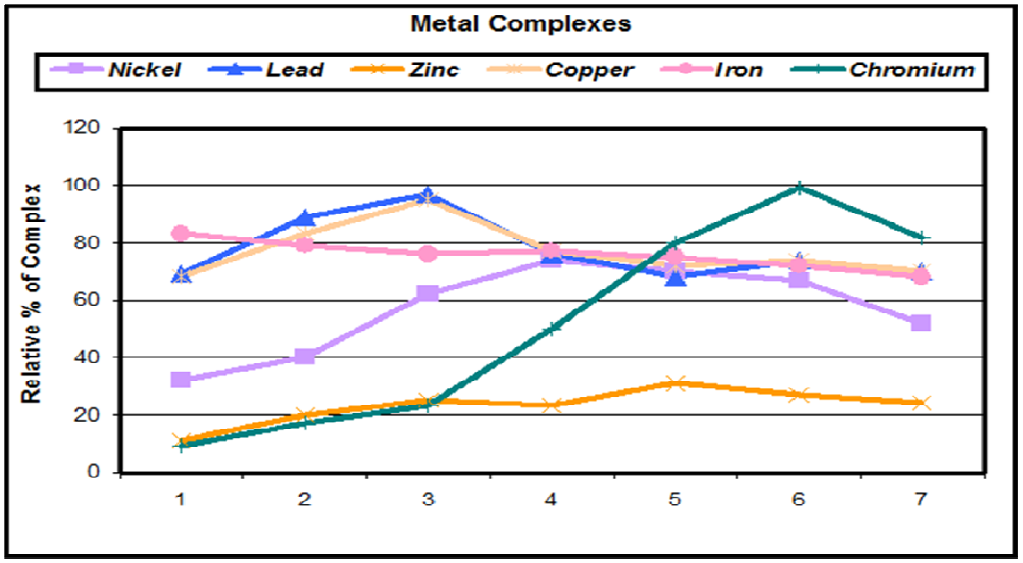

Figure 3. Graphical representation of complexation

(Cu^{2+}, Zn^{2+}, Ni^{2+}, Pb^{2+}, Cr^{3+}) were prepared from respective analytical grade salts. The supernatants were analyzed by Perkin Elmer 3030B Atomic Absorption Spectrometer. Each determination was carried out in triplicate (Table 3 and Figure 3).

Table 4. Maximum yield of Metal Humic Acids Complexes Formed during Treatment

S. No.	Metal Ion	pH	Log k	Relative % of Complex
1	Fe^{2+}	4.5	8.35	83.5
2	Cu^{2+}	5.5	9.50	95.0
3	Pb^{2+}	5.5	9.70	97.0
4	Ni^{2+}	6.5	7.45	74.5
5	Zn^{2+}	7.5	3.94	39.4
6	Cr^{3+}	8.5	9.90	99.0

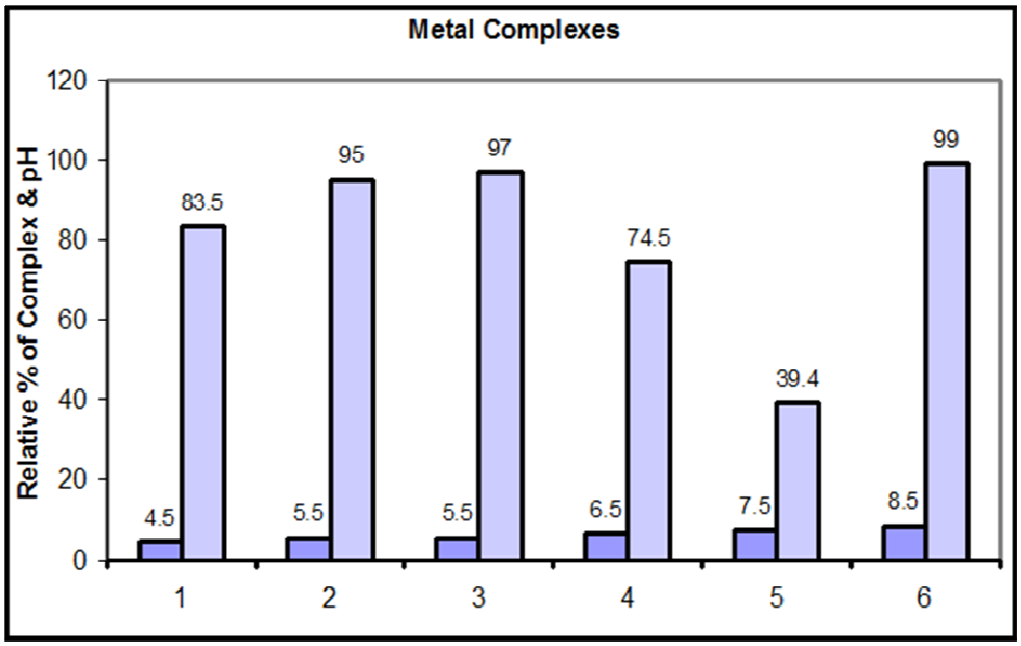

Figure 4. Graphical representation of complex species (in %) of each metal under study`at different pH

RESULTS AND DISCUSSION

As Humic acids are insoluble in neutral and acidic media, can be used as sorbents for removing metal ions from water. More advantageous, however, seems to be an application of the salts of Humic Acids with polyvalent metal cations (metal- humates) that are markedly less soluble over a wide pH range due to the 'Cross linking' and aggregation. Metal humates can be prepared relatively simply by precipitation of Humic Acids with suitable metal compounds.

The observations revealed that humic acids can complex with heavy metals effectively and have good potential to be used in wastewater treatment for heavy metal removal (Mir et al., 2006). It was found that humic acid-metal interaction is pH dependent, therefore, particular pH must be set for each metal. The (Table 4, Figure 4) shows that at pH on alkaline side, almost all major pollutants discussed here, going settled down and making effect relatively pollution free which is the main objective of the utilization of humic acids in this study and also it is practically proved.

Studies have shown that lignite coals are better source for the production of humic acids and the product can be utilized in minimizing pollution in the result of anthropogenic activities and disorders due to industrialization. Its utilization in agriculture, horticulture and forestry is well known in the world and several commercial products are available in USA, UK and other western countries for applications. Because, Pakistan has large deposits of low rank coal at Lakhra and now in Thar Desert of Sindh, the proper utilization of these deposits other than power generation is very important with reference to future policy for development.

Power generation from this coal is cumbersome without utilization of clean local technology which is very expensive in adoption while the option of other sources for the same is open whereas the lignite utilization in humic acids production for our green earth is proved to be beneficial and sustainable for the new generation.

CONCLUSION

This study leads to the conclusion that humic acids used in leaching out metal ions from their aqueous solutions, can be used as metal detoxification agent for industrial and domestic effluents containing high levels of such heavy metals. The humic acid technology is simple, economical involving indigenous raw materials and can be available at low cost.

REFERENCES

Badaische A, Soda FAG (1963). Mixtures of dyes with humates for dyeing leather, Ger. 1: 154, 068.

Barna J (1983). Humic substances clay complexes in Hungarian Coals, Fuel. 62: 380-388.

Barron PF, Wilson MA (1981). Humic acid and coal structure study with magic angle spinning ^{13}C C P-NMR, Nature. 289: 275-275.

Couch G (2004). The potential for coal use in Pakistan (report), IEA Coal Research, (London), U.K.

Davies G, Ghabbour EA (2001). Humic Acids: Marvelous Products of Soil Chemistry, Journal of Chemical Education. 78:12.

Gelszier A, Willad Jr, Greens R (1981). Post Treatment of humic acid dyed paper, US Patent US. 4238,283.

Janos P (2005). Iron Humate as a sorbent for inorganic and organic pollutants. Environ. Chem. 2: 31-34.

Khan S, Qureshi MA, Singh J (1996). Influence of heavy metal–humic acid complexes on the growth and nutrient concentration of wheat (Triticum. Aestivum) plant, Indian J. Environ. Health. 38(4): 269-273.

Lawson GJ, Stewart D (1989). Humic substances in soil, sediments and water, Mac Carthy Wiley Interscience New York. 2: 21-23.

Mir S, Ahmed Z, Kazmi A (2006). Control of Chrome Pollution in Tannery Wastewaters with Humic Acids, Pak. J. Sci. Ind. Res. 49(2): 145–146.

Nasreen S, Khawaja MA, Awan IA (1995). Pollution due to effluents from tanneries / leather, Pak. J. Sci. Ind. Res. 38:5–6.

Sahu S, Banerjee DK (1996). Complexation of copper (II), Cd (II) and lead (II) with humic and fulvic acids of Yamuna River sediments, Envion. Sci. Res. 51: 375-387.

Zak W (1988). Humic acid resin treatment of copper (II) and Ni (II), Huanjing Bashu. Beijing; (7): 21-2.