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REMOVING 3,5-DICHLOROPHENOL FROM WASTEWATER BY ALTERNATIVE ADSORBENTS

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ABSTRACT

The main objective of this paper is to evaluate an efficiency of 3,5 – dichlorophenol removal from wastewater by using alternative adsorbents. Chlorophenols are organic compounds consisting of a benzene ring, OH groups and also atoms of chlorine. Chlorophenols may have a huge isomere variety that means there are differences in their chemical and physical properties. Due to their toxicity it is necessary to remove them from waste water and in this paper an alternative way of such process is described.

KEY WORDS

Red mud, Black nickel mud, Lemna minor

INTRODUCTION

As a result of increasing population and the concentration of the population especially in larger cities, industrial development and intensification of agriculture increases the amount of water consumed. Agriculture and industry take a leading position. These are also leaders in water polluting. The main source of chlorophenols from these human activities are pesticides. Chlorophenols are able to accumulate in organisms, they are persistent and able to transport in the environment.

LOW-COST ALTERNATIVE ADSORBENTS

In last years there was a huge research in area of alternative adsorbents preparation with a purpose to replace traditional active carbon. The main reason is its high price.

Attention is focused on natural solid materials, which are able to remove contaminants from the contaminated waste water at an affordable price, since price plays an important role in making comparison. The adsorbent can be considered low cost if it occurs in nature and its treatment process is challenging. It can also be defined as a by-product or waste from industry.

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Certain waste from industry and farms, natural materials and bioadsorbents are potential economical alternative (1).

Low-cost alternative adsorbents can be divided (2):

- Regarding to availability:
  - natural materials,
  - industrial, agricultural and domestic wastes,
  - synthesized materials.
- Regarding to chemical origin:
  - organic,
  - anorganic.

METHODS

Fig.1 shows the process used for 3,5 – dichlorophenol removal form wastewater by using alternative low-cost adsorbents. Adsorbents used for this removal are: red mud, black nickel mud and *Lemna minor*.

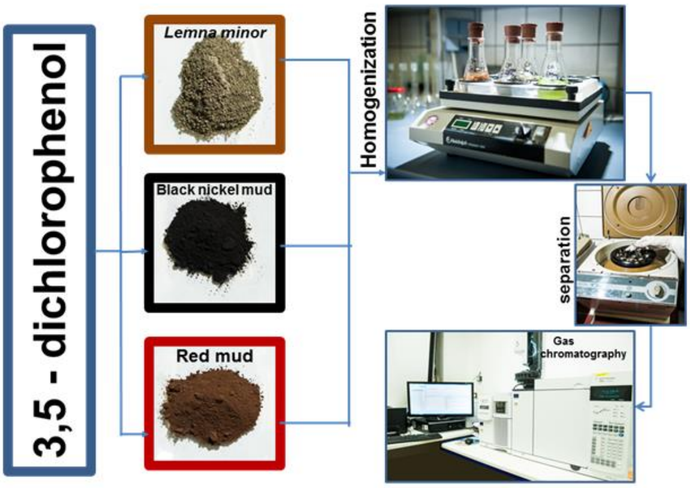

Fig. 1 *Scheme of 3,5 – dichlorophenol removal form wastewater*

DESCRIPTION OF LOW-COST ADSORBENTS USED FOR 3,5 – DICHLOROPHENOL REMOVAL

In Fig. 2 used alternative low-cost adsorbents are shown.

Fig. 2 *Lemna minor (natural), red mud, black nickel mud*

Black nickel mud

The result of nickel and cobalt production is huge amount of black nickel mud. For nickel production hydrometallurgical processes are used. black nickel mud contains Fe_2O_3 (38.50 wt. %), FeO (25.63 wt. %), SiO_2 (17.57 wt. %), Al_2O_3 (4.99 wt. %), Cr_2O_3 (3.31 wt. %), Mo (3.19 wt. %), CaO (3.20 wt. %), MnO (0.52 wt. %), C (0.50 wt. %), Ni (0.24 wt. %), Na_2O (0.23 wt. %), TiO_2 (0.17 wt. %) and others (< 0.01 wt. %). Danger point of view is polymetallic dust which spreads into the environment. Despite the high value of oxides of iron (95 %) Black nickel mud can not be used for iron production because of a great content of chromium (approx. 3 %). Neutralized black nickel mud has (as red mud) large specific surface area and is widely use as an adsorbent and coagulant in the remediation of waters in agriculture and also in the technology of wastewater cleaning and in chemical industry. The plant for this production was situated in Sereď (3).

Red mud

Red mud residues as unconventional adsorbents for water and wastewater treatment are motivated by the fact that red mud is a fine-grained mixture of oxides and hydroxides, capable of removing several contaminants, as well as being widely available. Red mud is a waste from production of Al_2O_3. The most common for Al_2O_3 is Bayer process. In Slovakia red mud was produced by aluminium plant in Žiar nad Hronom (4). Chemical constituents contained in red mud are in Table 1. Chemical structure depends on a location and the process used in metal production.

THE MAIN CHEMICAL CONSTITUENTS OF RED MUD (%) (5) Table 1

Chemical constituent (%)	Fe_2O_3	Al_2O_3	SiO_2	CaO	Na_2O	TiO_2	K_2O	Sc_2O_3	V_2O_3	Nb_2O_5	Loss
Bayer process	26.41	18.94	8.52	21.84	4.75	7.40	0.068	0.76	0.34	0.008	9.71
Sintering process	7.95	10.36	17.29	40.22	3.53	7.14	0.053	0.16	0.024	0.020	12.95

Lemna minor

Lemna minor (duckweed) (Fig. 3) taxonomically belongs to department of flowering plants (*Angiospermuphyta*) flowering, monoecious class (monocotyledonopsida), the tribe *Lemnaceae*. From the point of view hydrobiology will become part of. soft vegetation, which includes plants floating on the water (supernatant) and submerged plants (submerged) (6).
Lemna minor has excellent storage capability, mainly observed in compounds of nitrogen, phosphorus and heavy metals (7). Biomaterials with low price, asexual reproduction, with fast rendering and an assumption on the biosorption of metals can be successfully used in the degradation of metals in aquatic ecosystems.

DETERMINATION OF 3,5 – DICHLOROPHENOL

For 3, 5 – dichlorophenol determination gas chromatography-mass spectrometry (GC-MS) is used (chromatograph GC-MS Agilent 5975C with capillary column (with internal average 30 m x 0,250 mm) and helium as a mobile gas). Parameters chosen were used according to EPA Methods 82 70.

In Fig. 4, 5, 6 graphical expression of 3,5 dichlorophenol sorption on black nickel mud, red mud and *Lemna minor* is showed. An efficiency calculated in time and depending on adsorbent is shown in Table 2, 3, 4. An experiment is done under the conditions of pH 7 and 25˚C.

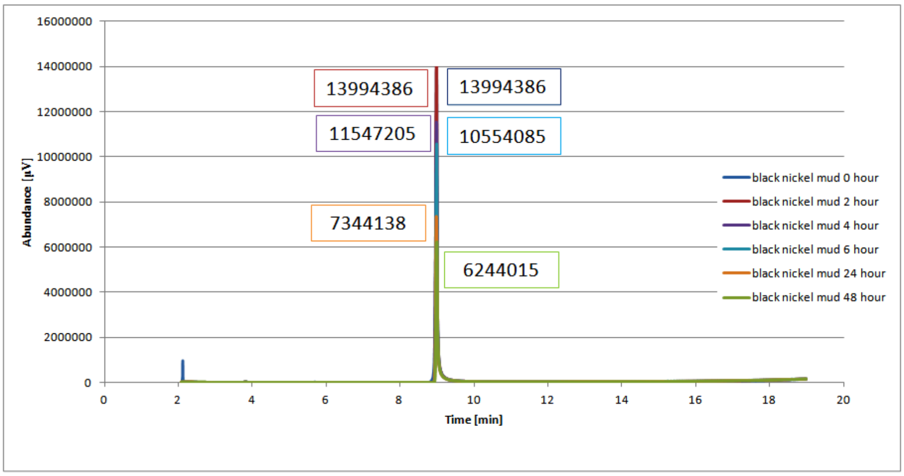

Fig. 4 *Sorption of 3,5 – dichlorophenol on black-nickel mud*

EFFICIENCY OF 3,5 – DICHLOROPHENOL SORPTION ON BACK-NICKEL MUD

Table 2

Black nickel mud		
	Abundance (µV)	**Efficiency (%)**
Sample t=0 h	13 994 386	
Sample t=2 h	13 994 386	0.000
Sample t=4 h	11 547 205	17.487
Sample t=6 h	10 554 085	24.583
Sample t=24 h	7 344 138	47.521
Sample t=48 h	6 244 015	55.382

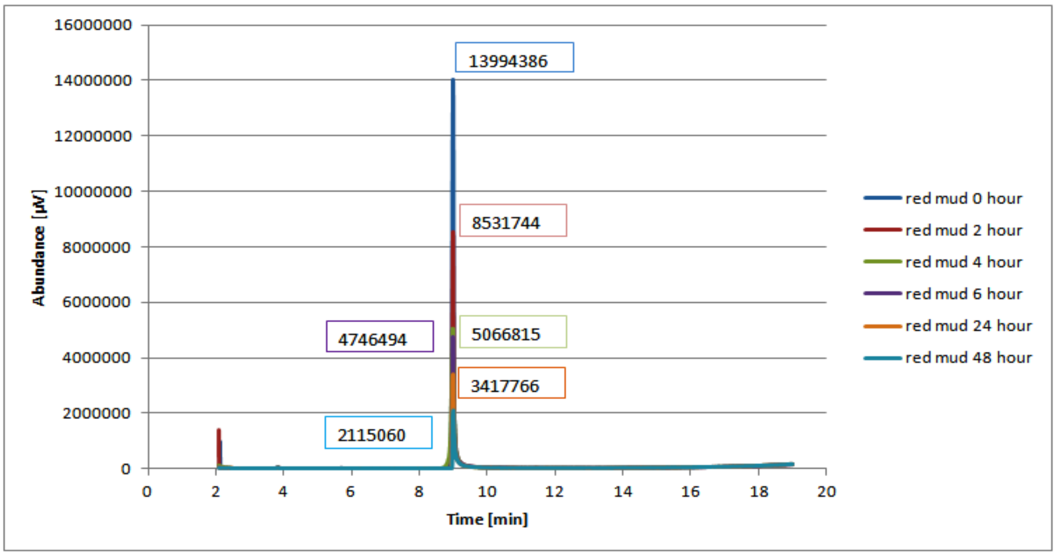

Fig. 5 *Sorption of 3,5 – dichlorophenol on red mud*

EFFICIENCY OF 3,5 – DICHLOROPHENOL SORPTION ON RED MUD

Table 3

Red mud		
	Abundance (μV)	**Efficiency (%)**
Sample t=0 h	13 994 386	
Sample t=2 h	8 531 744	39.04
Sample t=4 h	5 066 815	63.79
Sample t=6 h	4 746 494	66.08
Sample t=24 h	3 417 766	75.58
Sample t=48 h	2 115 060	84.89

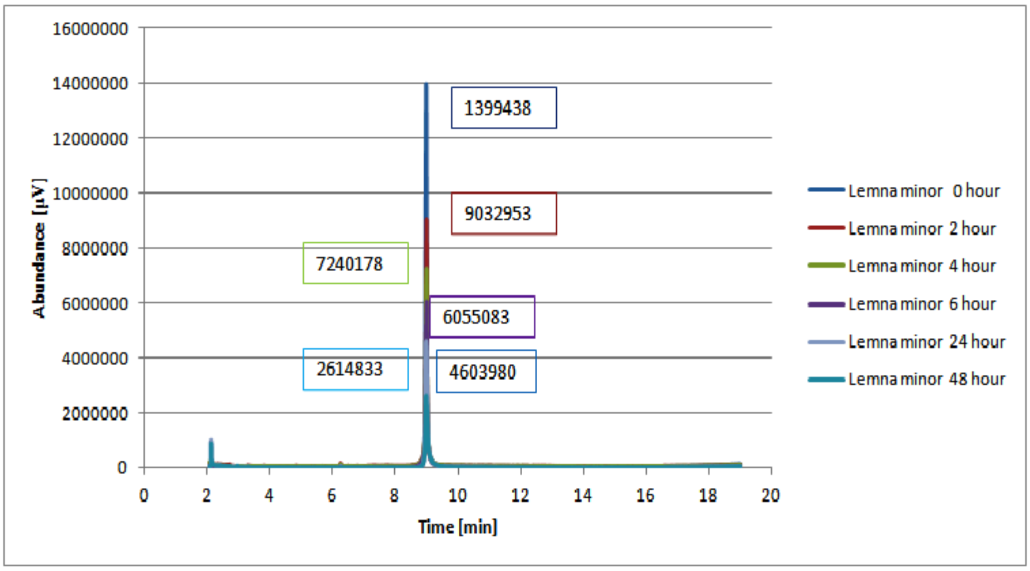

Fig. 6 *Sorption of 3,5 – dichlorophenol on Lemna minor*

EFFICIENCY OF 3,5 – DICHLOROPHENOL SORPTION BY ON *LEMNA MINOR*

Table 4

Lemna minor		
	Abundance (µV)	**Efficiency (%)**
Sample t=0 h	13 994 386	
Sample t=2 h	9 032 953	35.45
Sample t=4 h	7 240 178	48.27
Sample t=6 h	6 055 083	56.73
Sample t=24 h	4 603 980	67.10
Sample t=48 h	2 614 833	81.31

CONCLUSION

One of the basic criteria for remediation method application in practice is an economic factor. Nowadays there is still increasing research in area of new low-cost adsorbents, for replacing common, but expensive adsorbents. As a low-cost adsorbent can be considered proposed – red mud, black nickel mud and *Lemna minor*, which have a big pottential to be an efficient adsorbent for removing of 3,5 dichlorophenol from wastewater. Each of these adsorbents have an influence on 3,5 dichlorophenol removal process, especially in time t=48 h. The most significant influence was observed by using red mud as an adsorbent (84.89 %).

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