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Natural Purification of Industrial Waste Water used as the Water Resources by using Hyper Accumulator Plants

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ABSTRACT

Nowadays with concern of water resources reduction, it is more common to use other resources such as filtered sewage using in irrigation and agriculture. Although this solution is the sub tree of a stable management of water resources, but with the researches that have been made by the scientists, it has a bad influence and would cause the poisoning of the soil with the heavy elements because of the wastewater. Due to the results of the long time research, phytoremediation usage would increase the stability of this solution. This way is much cheaper than filtering the additional wastes which are used.

The main problem for doing any activity due to filtering of metal pollution, is finding the kind of pollutant metals, so in regarded to that we could use hyper accumulator plants. In this research, we examine classified heavy metals with the producer factories. Among the whole three hundred thousand kinds of vascular plants, about 418 of them are metal hyper accumulator plants. Since most of the researches have been done some work on plants compatible with European or American climate so only a few of these known hyper accumulator plants are able to live in the climate of Iran. The experiments which have been done in Iran are like treatment experiments and there are no additional to the whole hyper accumulator plants so far. In this paper, we examine separately the hyper accumulator plants which are recognized in Iran and the whole experimented hyper accumulator plants in climates of some countries similar to Iran condition. All of the heavy metals have examined due to their majority.

Keywords: *Water filtering, Phytoremediation, Hyper Accumulator plants, Water resources.*

INTRODUCTION

Reduction of water resources and extensive need to increasing agricultural and industrial products enforce humans to use low quality waters. Not only the demand increased for water by increasing the population, but the rates of waste waters also increase. Most of these waters have lost their quality, but they can still be used as a source of water.

About 80% of the consumed water can be used for agricultural purposes by purification and filtering the sewage and urban as well as industrial waste waters to prevent extensive costs of water supply and transfer [1]. Moreover, irrigation by waste waters is the best way for purification and removal of sewage, since it is a reliable way to eliminate pollutions from the waste waters, and these waters can be used longer [2]. The preliminary results of G10/80/004 global project show the superiority of purified sewage and waste waters as compared to ordinary water, in agricultural applications, since urban waste waters possess nutritional elements, especially phosphorous and nitrogen, which lead in higher agricultural products [3].

However, using waste waters has various problems and limitations. One of the reasons that reduces the reusing of waste water is the existence of heavy metals, since most of the plants cannot grow in high densities of heavy metals. Various standards are defined for reusing the waste waters that should be compared with international standards, before being used [4]. The specifications of the area, soil and plants are also effective for proper management of reusing waste waters. Iran Environmental Organization reported the most recent standards for re-exploitation of sewage and waste water in agriculture in 1992 [5].Recent researches by scientists have shown that despite observing all the existing standards for reusing industrial waste water, long-term use of it leads to pollution of soil and ground water. Alnenah *et al*. have stated that using waste water for irrigation in 47 years increase phosphorous, nitrogen, cadmium, chromium, copper, and lead in soil [6].

Despite all the problems occurred by using waste water, purification and reusing it is one the most profitable ways for its pollution and exploiting water requirements in dry and semi-arid lands. One of the newest methods of using plants is for purifying surface and ground waters, sediments and polluted soil to heavy metals, organic materials and radioactive materials, which is called “phytoremediation” [7]. The plants that have high growing potentials in different densities of heavy metals that can also absorb high rates of heavy metals are used in this method. Since the depth of in advancing the pollutants is dependent on the development of roots, using the plants with longer roots reduces accumulation of heavy metals in long-term [8]. Using this method reduces the pollution of irrigated soils with waste water, increasing the possibility of reusing industrial waste waters. The advantages of this method include low cost, being remained in the polluted area to eliminate the surface and ground waters, not having lateral effects, and creating green spaces [9]. This technology is more economical as compared to the common chemical and mechanical methods for separating harmful pollutants from the soil. The costs of soil purification with some of the popular methods are compared in table 1 [10].

Table1: Cost of purification of polluted soils by different methods

Type of purification	Cost of purification for every ton of soil (in $)
Phytoremediation	10-35
Digging and burying	20-220
Extraction by solvents	360-440

MATERIALS AND METHODOLOGY

The pollution of soil by industrial waste water can be divided into two categories: contamination due to heavy metals and oil hydrocarbon materials. One of the most important sources of environmental pollution to heavy materials is industrial activities such as melting, plating, and also the sludge from sewage filtration [11]. A list of the industrial factories producing heavy metals is shown in table 2.In contrast to the weather, soil pollution cannot be measured easily with regards to the chemical compositions. However, this pollution can be observed from reducing the plant products, changing in the appearance (change in color), physical, chemical, and biological changes of soil and the soil composition of drainages in soil [12]. Since the popular methods for soil filtration and purification has harmful lateral effects for the environment in addition to having extensive costs, the purification of waste waters and soils by phytoremediation has been considered as a newly emerged and cheap technology [13].

Since the ability of plants is different in accumulation of metals from polluted soils, only a limited number of plant species can accumulate and resist against high densities of toxic metals. These plants that are known as “hyper accumulator” can accumulate over 0.1% of lead, cobalt, chromium, or over 1 wt. % of nickel, zinc or manganese in natural growing conditions in their aboveground members [14]. The plant species and types have always been considered an effective factor in the phytoremediation efficiency [15]. The results obtained by the researches can be used for proper selection of hyper accumulator plants, but the point that should be considered is that the temperature, geographical latitude and rain are among the important factors in selecting hyper accumulator plants. Since most of the tested plant cannot be grown in Iranian climate, some of the analyzed species are rare in this country; thus, they cannot be utilized in phytoremediation projects. The climatic conditions for the identified hyper accumulator plants are compared with those in the Iranian climate, in this study. Among the hyper accumulator plants, any species and plant families than are able to live in the climatic conditions in Iran, which can be utilized in phytoremediation projects, are collected, and indicated in table 2.

Table2: Hyper accumulator plants

Heavy polluting element	Factories and industrial production plants (16)	Accumulator and hyper accumulator plants
Nickel (Ni)	Nickel is applied in ceramic production,	Campanula scheuchzeri [17]

	protective plating, electric molding covers, alkaline storage batteries, electrode fuel cells, catalysts, metalizing fuel gases, hydrogenating vegetable oils, steel, copper, and brass pipes, key making, shield production, desalination of plants, water transformation, liquid, Edison strong batteries, green glass and alloy glass production by iron and nickel that have magnetic properties	Leucanthemopsis alpine [17] Alyssum [18] Bornmuellera [19] Cardamineresedifolia [17] Peltariaemarginata [20] Streptanthuspolygaloides [21] Arenaria [22] Minuartialaricifolia [17] M. verna [17] Anthyllis sp. [17] Trifoliumpallescens [17] Luzulalutea [23] Trisetumdistichophyllum [17] Saxifraga [17] Linaria alpine [23]
Arsenic (As)	Additive alloy making material for metals, especially lead and copper in bullets, battery cells, cable shields, boiler pipes with high purity and semi-conductive, and in glass, wooden object, insecticide, pesticide products and electronic components	trichocarpapopulus [24] Egeria dens [25] demersumlagarosiphon major [25]
Selenium (Se)	Xerox plates, TV cameras, optical cells, computer magnetic cores, solar batteries, electric rectifiers, relays, ceramic industry, class dyes, enamels, photocopies, anti-scratch material in rubbers, colorification of pictures and photos	populustrichocarpa [26] Brassica napus cv [25] Fastucaarundinceaschreb [27] Lotus Corniculatusl.L [25] Brassica junceaCzern.L [25]
Zinc (Zn)	Applied in cement production, dentures, production of matches, floor covering, earthenware products, rubber products, car manufacturing, kitchenware, bronze and brass alloys, soldering, toothpaste tubes, metal adhesives, type writers, German silver, electric wires, nuts and bolts, steel galvanizing, roof plates, storage tanks, fences, ship bodies, digging platforms, and underground pipelines	T. rotundifolium [28] T. stenopterum [29] T. ochroleucum [30] T. caerulescens [30] Allyssumhedreichii [31] Viola culaminaria [32] halleriannus [33] T. ochroleucum [25]
Lead (Pb)	Ammunition factories, gas additive materials, internal coating of tanks, soldering alloys, battery production, eliminating vibrations in large buildings as foils, defensive devices, cable shields, plates, profiles, bearing production, sprays (galvanization) , soft soldering tubes, printing industry, tapes, wires, battery production, wood industry, oil and petrochemical industries, production of matches, glazing, paint manufacturing, producing hot and dense sulfuric acid tanks, chintz production, casting of components	Brassica juncea [25] Thlaspiavlanum [30] Thlaspicaerolescens [30] Thlaspiochroleucum [30] Cistus incanus [34] Brassica oleracea [35] Viola calaminaria [32] Polycarpaeasynandra [36] Acer pseudoplatnus [34]
Cadmium (Cd)	Floating and electrical covers on metals, alloys with low melting points, hard soldering alloys, nickel-cadmium batteries, electrical transmission systems, TV phosphorous materials, pigments used in ceramic plates, machinery glazes, lithography and photography, electrical rectifiers with selenium, cadmium vapor electrodes, and photoelectric cells	Salix viminalis [37] Populous tricharpa [26] Myropllum spicatum [25] Alyssum heldreichii [31] T.taerulescens [35]
Chromium (Cr)	Alloy element under metal and plastic layers for resistance against corrosion, stainless steel with chromium, protective coating for car components and other components, research in high temperatures, nuclear research regarding compound parts of non-organic materials	Festucarubra [27] Myriophyllum spicatum [25-299]

Conclusion and Suggestions

Since Iran is located in a dry and semi-arid region and is confronting shortage and limitation of water resources, reusing waste water can help a great deal to eliminate this problem. Waste waters can help water supply for agricultural purposes to a great extent, but long-term uses of waste waters may cause the contamination of ground waters and soil pollution, and purification of them requires extensive costs. In addition to having low costs, using hyper accumulator plants for filtering of water and soil has no lateral effects on the environment, giving us the possibility of using waste waters in long-run. Moreover, the hyper accumulator plants should be used in green areas that are supposed to be irrigated by industrial waste waters, for the pollutants that remain in the environment after the irrigation with the waste water to be minimized. Selection of the type of the plants is the first and most important step in phytoremediation. This selection should be done among the compatible hyper accumulator plantswith the climate and by considering the type of the waste water polluting elements that are used in that respect.

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