ISSN: 2688-8645

Research Progress on Remediation of Heavy Metal Contaminated Soil in Mines

Qi Yao[1,*], Yufen Wang[2], Yuting Gao[1], Yuanchao Ma[1], Tianheng Zheng[1]

[1]Yunnan college of business management, Kunming, China

[2]Yunnan Province Qujing Fuyuan County Shiba Lianshan Town Guotuhe Village Planning Construction Service Center, Qujing, China

*1121381748@qq.com

Abstract

The environmental problems caused by heavy metal pollution in mines are becoming more and more serious, especially the large-scale heavy metal pollution will cause the waste of land resources. At present, there are many remediation methods for heavy metal contaminated soil in mines, and the results of research and practice are scattered, without big data analysis. This paper summarizes the current remediation methods of heavy metal contaminated soil in mines, and puts forward some suggestions for remediation of heavy metal contaminated soil in mines in the future. China is one of the countries rich in mineral resources. With the rapid growth of national economy, the development speed of mineral resources is accelerating, forming a large area of mined-out areas and abandoned land of metal mines, and the land area polluted by mineral resources development is expanding accordingly. The development of metal mines not only promotes the development of national economy, but also brings severe environmental problems. Chemical agents are usually used in the mining and dressing process of metal mines, and the harmful substances produced are fixed in the soil after circulation, which causes soil pollution and damages to the soil in different degrees. Soil pollution in metal mines is hidden, irreversible and lasting for a long time. Heavy metals are ingested by human body through food chain flow and atmospheric circulation, threatening human health and ecological security. During the "14th Five-Year Plan" period, the state attaches great importance to the construction of ecological civilization. Mine ecological restoration is one of the quantitative indicators assessed by local governments, and the restoration of heavy metal contaminated soil is an unavoidable problem. Therefore, it is necessary to conduct in-depth research and try to find the best solution.

Keywords

Heavy Metal Contaminated Soil in Mines; Soil Remediation.

1. Remediation of Contaminated Soil in Mining Area

1.1. Physical Repair

Physical remediation refers to the removal of pollutants from the soil by physical methods, including heat treatment, engineering measures and electric remediation. Usually, heat treatment is mostly used to control mercury pollution. The engineering measures take advantage of the characteristics of heavy metal enrichment in the surface soil to replace polluted soil, and replace the surface soil by guest soil or soil replacement. Guest soil covers the contaminated soil surface with unpolluted new soil, provided that the natural conditions of the contaminated site and the physical and chemical properties of the contaminated soil are

ISSN: 2688-8645

comprehensively analyzed. The physical and chemical properties of the unpolluted new soil should be close to those of the contaminated soil before it is contaminated, so as to avoid the heavy metal activity in the contaminated soil becoming larger due to the change of environmental factors. Soil replacement is to move the contaminated soil and replace it with new soil. No matter whether the guest soil method or the soil replacement method is adopted, the secondary pollution should be avoided, so its application in practice is not much. Electroremediation refers to the separation of heavy metal ions by artificially controlling different forms of electricity in polluted soil. Electric remediation can separate heavy metals in areas with active magnetic fields, but the remediation effect is affected by the pH value of soil, and the application cost is high. This method can improve the separation effect by adding reinforcement, but it is not suitable for large-area sites with low heavy metal concentration and single pollution. It is mostly used in sites with high heavy metal ion concentration, and should be combined with other remediation technologies in practice.

1.2. Chemical Repair

The main mechanism of heavy metal pollution in mining area soil is that the forms of metal ions are easy to change, and the physical and chemical properties of soil can affect the existing forms of heavy metals in different external environments. Remediation refers to the remediation of polluted soil by regulating the mobility of heavy metals in soil through chemical reactions. Most of them use chemical reagents to adjust or reduce the concentration, solubility and dissolubility of heavy metals, increase the content of soil organic matter, and then change the electrolytic property of soil. It reduces the bioavailability of heavy metals and reduces the harm through oxidation-reduction reaction. Chemical remediation belongs to passive remediation, which has the advantages of quick response and thorough treatment. However, it is easy to cause soil environment deterioration due to the large amount of reagents and investment, and the possibility of secondary pollution is high, so it is difficult to popularize site remediation in large areas. For example, vitrification repair is expensive, consumes a lot of energy, and is inconvenient to operate, so it is not suitable for large-scale popularization.

1.3. Bioremediation

Bioremediation uses microorganisms, fungi, green plants, enzymes and other organisms to absorb, enrich, extract, transform and solidify heavy metal elements in soil, so that the content of heavy metal elements in soil is reduced, toxicity is reduced or disappeared. There are many such methods.

1.3.1. Phytoremediation

Phytoremediation refers to the use of plants cultivated by natural growth or genetic engineering to reduce the content of heavy metals in soil, simultaneously improve soil nutrient conditions and restore its functions, and promote micro-environment optimization. Remediation of soil pollution is usually achieved by the fixation, volatilization and extraction of specific plants. There is a certain potential risk when plants volatilize and transfer pollutants into the atmosphere. Pollutants may return to the soil surface layer through dry and wet deposition in the atmosphere, so the removal of heavy metals is incomplete. At present, mine restoration involves not only vegetation cultivation, but also the establishment of an ecological system that can be self-renewed. Therefore, vegetation restoration should comprehensively utilize various ways, and finally thoroughly remove pollutants.

1.3.2. Microbial Remediation

Microbial remediation utilizes microorganisms or strains in the soil to quickly degrade and transform pollutants stranded in the soil into non-toxic or low-toxic substances through absorption, precipitation, oxidation and reduction, etc., so as to partially or completely restore the functions of the polluted soil to the initial state. Microorganisms have the characteristics of

ISSN: 2688-8645

small size, rapid reproduction, strong adaptability and easy variation. At present, there are many research achievements in natural attenuation, and their applications are relatively extensive.

1.3.3. Animal Restoration

Animal remediation refers to the growth and breeding of soil animals in polluted soil under artificial control or natural conditions, and the decomposition, digestion and enrichment of pollutants through the food chain to reduce or eliminate pollutants. Animal restoration technology has unpredictable potential harm to animals, so its popularization is not high.

1.3.4. Combined Plant-Microbial Remediation

There are some limitations in a single plant or natural attenuation. The phytoremediation period is long, and a plant can only absorb one or several heavy metal pollutants, and there will be toxic reactions to high concentrations of heavy metals. It is difficult to screen plants that can accumulate a variety of heavy metals. Natural attenuation is still limited in the field of scientific research. Because of the strict requirements of remediation conditions and few practical applications, external interference factors and the unpredictability of remediation process have to be considered after microorganisms are put into the remediation site. Therefore, phytoremediation should be combined with microbial remediation. At present, the application of mycorrhiza inoculation to remediation of heavy metal contaminated soil is still in the initial stage, so it is necessary to conduct in-depth research and practice before it can be widely applied to remediation of heavy metal contaminated soil in mines.

2. Problems Existing in Remediation of Heavy Metal Contaminated Soil in Mines at Present

Metal mining is easy to cause soil pollution, and it is difficult to control it. Not only the site conditions, but also other factors should be considered. At present, some progress has been made in the research of remediation of heavy metal contaminated soil in mines, but there are still some problems in application practice. First of all, the evaluation and detection standards of soil pollution degree, scope and type in mining areas are not clear, and the remediation standards of heavy metal contaminated soil in mining wasteland have not been promulgated yet, which leads to the weak target of remediation process. The remediation effect is only evaluated from the growth of surface vegetation, and the evaluation content is too single, without considering whether the local ecosystem after remediation has the self-renewal ability. For microbial remediation, most of the technical research results are based on the ideal state, and there may be many problems in practical application. The specific remediation technology still has defects, which is the difficulty of transforming the current scientific research results into actual productivity. We should learn from similar successful cases. If the method of combining physics with chemistry is used to repair, it will be expensive and difficult to achieve a wide range of promotion. In the future, the competent department of mine remediation should formulate corresponding remediation standards and benefit evaluation system according to different utilization directions of abandoned land, so as to better guide the soil remediation of metal mine abandoned land.

3. Conclusion and Prospect

Through combing the present situation and progress of remediation technologies of heavy metal pollution in four categories of mines, physical chemistry, phytoremediation, microbial remediation and animal remediation, the preliminary conclusions are as follows:

ISSN: 2688-8645

Physical remediation technology is relatively simple and effective, but there is a risk of failure from the perspective of remediation timeliness, so it can't basically meet the needs of current environmental remediation.

Chemical remediation technology is one of the commonly used methods at present, including three mechanisms: chemical immobilization, chemical leaching and chemical transformation, among which chemical immobilization and chemical leaching have higher research degree and wider application range. However, chemical remediation needs to consume a lot of chemical reagents and new materials, so the cost of remediation is high. The key research directions of chemical remediation include: research and development of high-efficiency, green and reusable new remediation materials (such as nanomaterials) and optimized application of conventional cheap materials (such as fly ash, lime, humus and compost).

Phytoremediation technology, as a green, cheap and effective remediation approach, has great advantages and potential in the remediation of heavy metal contaminated soil in metal mines. However, phytoremediation faces some problems, such as long remediation period, incomplete remediation and treatment of contaminated biomass after remediation. The future research will focus on two aspects: genetic engineering, which can make the genes that can enhance the repair ability be transmitted to organisms and expressed accordingly, so as to enhance the heavy metal tolerance and repair ability (such as accumulation or transformation) of organisms, and finally shorten the repair cycle and improve the repair ability.

References

[1] Zhang Xi, Zhou Aiguo, Gan Yiqun, et al. Research progress on bioremediation of heavy metal contaminated soil in metal mines [J]. Environmental Science and Technology, 2010, 33 (3): 7.

[2] Chen Guirong, Zeng Xiangdong, Li Wei, et al. Current situation of heavy metal pollution in metal mine soil and prospect of remediation technology [J]. Mineral Conservation and Utilization, 2010 (2): 4.

[3] Wang Yinghui, Qi Shihua, Chen Xuejun.Phytoremediation technology of heavy metal pollution in metal mine wasteland [J]. China Mining Journal, 2006, 15 (10): 5.

[4] Li Qing, Zhou Lianbi, Zhu Yibin. Summary of remediation technology of heavy metal pollution in mine soil [J]. Nonferrous Metals Engineering, 2013, 3 (002): 56-59.

[5] Bi Yafan, Xu Junhu. Phytoremediation technology of heavy metal contaminated soil in mines [J]. Journal of Wuhan Institute of Technology, 2012, 34 (10): 4.

[6] Zhao Yonghong. Heavy metal pollution control and ecological restoration in nonferrous metal mines [M]. Metallurgical Industry Press, 2014.

[7] Wu Yuding. Preliminary study on social workers' intervention in pollution prevention and control in mining areas-comment on heavy metal pollution control and ecological restoration in non-ferrous metal mines [J]. Mining Research and Development, 2019.

[8] Qian Ting.Analysis of ecological treatment and environmental restoration of heavy metal mines [J]. North Environment, 2020, 032 (003): 189-190.

[9] Zhang Li, Wang Shu.Discussion on heavy metal pollution in metal mine soil and its remediation [J]. Nonferrous Metals: Mine Part, 2007 (04): 41-43.

[10] Cao Xiaoya, Cao Junya, Xie Qiang. Research progress of heavy metal remediation technology in mine soil [J]. 2012.