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A Review of Groundwater Remediation Technologies in Contaminated Sites

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Abstract

Heavy metal pollution in soil is a very serious "chronic disease" left over from the modernization process, causing serious environmental and health risks. How to effectively manage and obtain economic benefits is the focus of many environmental protection companies. This article mainly introduces the characteristics of groundwater pollution treatment technology in contaminated sites, and looks forward to the prospects of heavy metal pollution control, with a view to providing reference and suggestions for enterprises developing the heavy metal pollution control market.

Keywords

Heavy Metal, Contaminated Sites, Groundwater.

1. Introduction

Entering the 21st century, my country's economic level continues to improve. With the increase in various production and living activities, the degree of soil pollution has become more and more serious. According to statistics, the area of heavy metal-contaminated soil in my country is as high as 20 million hectares. The ecological environment and ecosystems in some areas of our country have been severely damaged, and the market for heavy metal pollution control is huge. Heavy metal soil pollution in my country is in its infancy and is constantly being improved and explored. At present, my country's relatively mature heavy metal groundwater pollution remediation technology is mainly based on in-situ remediation technology. With the adjustment of the domestic economic structure, the traditional construction industry has been impacted, emerging business markets have developed, and many companies are targeting the heavy metal pollution control industry. How to achieve breakthroughs in technology or market share in this industry is a hot topic for many companies. This study mainly introduces groundwater heavy metal pollution control technology, with a view to providing reference and suggestions for enterprises to develop the heavy metal pollution control market.

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2. In-situ remediation technology for heavy metal contaminated groundwater

2.1. In-situ chemical reduction technology

In Situ Chemical Reduction (ISCR) technology uses the strong reducing properties of some chemical remediation agents to reduce heavy metals in groundwater into low-priced, stable substances through reduction, adsorption, precipitation or isolation. state or elemental form to achieve the purpose of reducing its toxicity and stabilizing activity. The use of chemical reduction technology to remediate chromium (VI), arsenic (V), etc. in groundwater environments has been widely used in practical engineering [1-3]. In-situ chemical reduction technology has the advantages of high heavy metal removal efficiency, relatively low investment cost, and less disturbance to the aquifer. This technology emphasizes the investigation of site hydrogeological conditions, tracking of pollution sources and the selection of reducing agents. Elemental metals Fe0, Zn0 and other reducing agents, such as dithionite, are currently common reducing agents [4].

Fe0 is a classic reducing agent. As an electron donor, its standard redox potential (Eh) is -0.44 V, and it can reduce a variety of heavy metals (such as lead, cadmium, nickel and chromium). Micron and nanoscale Fe0 not only has strong reducing properties, selectivity, conductivity, photocatalysis and magnetism, but also has a small particle size that makes it highly active, has a large specific surface, and has certain pores, which is very conducive to adsorption and reduction of high concentrations. , highly toxic heavy metal pollutants [5]. When 0.24 g of nano-Fe0 was added to the groundwater of a chromium slag site, the concentration of Cr6+ decreased from 50 mg/L to about 10μg/L after 10 days of reaction [6]. In order to overcome the "blocking" problem of Fe0 in groundwater transmission, its particle size is generally 100-150nm. With the rapid development of materials chemistry, commercial mass production of iron slag, iron powder, and nano-zero-valent iron has gradually been realized. The application prospects of nano-zero-valent iron to remove heavy metals from sewage are becoming more and more broad.

2.2. In Situ Chemical Oxidation

In Situ Chemical Oxidation (ISCO) technology refers to a remediation technology that injects chemical oxidants into groundwater to react with heavy metals and convert them into low-toxicity and low-mobility products. For example, when remediating As3+ contaminated groundwater, adding oxidant H2O2 or potassium permanganate can convert As3+ into less toxic As5+. In addition, because the solubility of As3+ is greater than As5+, using chemical oxidation technology to convert As3+ into As5+ can significantly reduce the mobility of As in groundwater. The in-situ chemical oxidation method has a shorter repair cycle and lower cost. It can be used alone or in combination with other repair technologies. The four commonly used oxidants at present are permanganate, hydrogen peroxide, persulfate and ozone. However, there are many limitations in the application of ISCO: If As3+ pollution in groundwater is accompanied by Cr3+ pollution, the use of ISCO will generate more toxic Cr6+. In addition, the short effective action time of oxidants in the groundwater environment, the health and safety issues of the oxidants themselves, and the possible migration of heavy metals caused by the oxidants also limit the application of ISCO. Therefore, there are few engineering application examples of this technology reported.

2.3. In situ bioremediation technology

Bioremediation of heavy metal pollution in groundwater usually refers to the use of wild or artificially cultivated microorganisms with specific functions. Under suitable environmental conditions, through the metabolic activities of microorganisms, the migration ability of heavy metal elements in groundwater is reduced or its form is changed, thereby reducing groundwater pollution. There are some practical engineering cases abroad for remediation technology that can reduce the concentration of heavy metal elements or reduce their toxicity. A variety of microorganisms that can reduce chromate and dichromate are often distributed in the soil and groundwater of contaminated sites, such as Alcaligenes, Bacillus, Coryne-bacterium, and Enterobacter, Pseudomonas and Microspheres (Mi-crococus), etc. These bacteria can reduce highly toxic Cr6+ to low-toxic Cr3+ [24]. Therefore, as long as conditions suitable for the growth of microorganisms are created in the soil and groundwater, the activity of these indigenous microorganisms can be used to remediate heavy metal pollution in groundwater. Generally, carbon sources can be added to heavy metal-contaminated groundwater, such as injection of syrup, acetate, lactic acid, etc., which can significantly enhance the activity of site microorganisms, thereby changing the redox conditions of groundwater and allowing heavy metal elements to be fixed. The U.S. EPA has announced the use of sulfate-reducing bacteria to remediate groundwater contaminated by heavy metals such as chromium, cadmium, arsenic, and zinc. The principle is to use HS- produced during the metabolic process of sulfate-reducing bacteria to react with heavy metal elements to form insoluble metals. sulfide, reducing the mobility and availability of heavy metals in groundwater [7].

3. Conclusion

Although the remediation of heavy metal soil and groundwater in contaminated sites has attracted attention from all walks of life, and there are many studies on the technical mechanisms of heavy metal pollution remediation, there are only a handful of actual engineering cases. It is undeniable that solidification and stabilized soil remediation technologies have become increasingly mature, but the research and development of heavy metal in-situ chemical reduction, biological and combined remediation technologies still need to be strengthened.

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