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山阴地区高砷饮用水处理技术

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Technology for Treating High Arsenic Drinking Water in Shanyin

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摘要 通过对山西省山阴县高砷地下水分布和污染程度的实地调查,对高砷水环境中砷的形态及富集转化规律进行了研究,并在此基础上形成一套以曝气氧化和加药(加入$FeCl_2$和$FeCl_3$的混合物作为混凝剂)过滤工艺为基础的联合水处理方法。结果表明,在山阴县砷污染严重的地段,地下水的氧化还原电位E_h为-50~142 mV,pH值为8.28~8.73,这种E_h下降、pH升高的地下环境给高砷地下水的形成创造了条件。当地下水中ρ(硫化氢)<140μg.L^{-1}时,用功率为5 W的松宝SB-648双头氧气泵连续曝气1.5 h即可达到基本去除的效果。以25 m深处地下水为例,其ρ(As)为275μg.L^{-1},待硫化氢去除后在水中加入摩尔比n($FeCl_2$)∶n($FeCl_3$)=1∶1的混合物,连续曝气5 h,水体中60%以上的As(Ⅲ)可转变为As(Ⅴ)。经投加药品和曝气氧化处理后的地下水若能及时通过简易过滤装置,过滤后的水体中ρ(As)仅为5~8μg.L^{-1},达到GB 5749—2006《生活饮用水卫生标准》,且过滤后的水体中ρ(Fe)为0.03 mg.L^{-1},远小于GB/T14848—93《地下水水质标准》规定的Ⅰ类标准。该水处理方法可快速有效地将As(Ⅲ)转化为As(Ⅴ),并使As(Ⅴ)与混凝剂发生吸附共沉淀反应,从而达到高效除砷的效果。过滤过程则可以防止氢氧化物胶体与砷酸盐形成的絮体二次进入环境,同时进一步降低水体中铁离子含量。该方法适用于我国广大高砷水地区家庭分散式供水的处理。

关键词: 砷 曝气氧化 混凝剂 过滤 饮用水 山阴县

Abstract: Through field investigations on distribution of high As underground water and degrees of As pollution of the underground water in Shanyin of Shanxi,a study was carried out on As forms in the high As water environment and laws of their enrichment and transformation.On such a basis,a set of water treatment technology was developed,consisting of aerated oxidation,drugs addition(adding a mixture of $FeCl_2$ and $FeCl_3$ as coagulant) and filtration.Results show that in the highly arsenic polluted areas in Shanyin County,the redox potential of groundwater was between-50-142 mV and pH between 8.28-8.73.Such an environment provided formation of high-arsenic groundwater with favorable conditions.When the concentration of hydrogen sulfide in the groundwater was less than 140 μg · L^{-1},continuous aeration for 1.5 h,using a 5 W double nozzled oxygen pump(Songbao SB-648) could basically remove all the hydrogen sulfide(H_2S) from the groundwater.Take groundwater from depth of 25 m for example.Its As content was 275 μg · L^{-1}.After hydrogen sulfide in the water was removed,the mixture of n($FeCl_2$)∶n($FeCl_3$)=1∶1 was added into the water,which was then aerated continuously for 5 h.As a result,over 60% of trivalent As was changed into pentavalent As in the water.Then the treated water was filtered in a timely manner to reduce As content in the water to 5-8 μg · L^{-1},which satisfies the National Hygienic Standard for Drinking Water(GB 5749—2006),and Fe content in the water to 0.03 mg · L^{-1},far less than the criteria in Grade Ⅰ of the National Groundwater Standard(GB/T 14848—93).The technology can quickly and effectively turn trivalent As into pentavalent As,which is adsorbed by coagulant and settled down together,thus making the As-removing effect high.Filtration may prevent flocs of hydroxide colloids and arsenates from entering into the water environment again,and reduce the concentration of ferric ions in the water.Results show that this water treatment system is simple in operation and low in cost,and can be widely extended for use in households in regions with high As groundwater.

Keywords: arsenic aerated oxidation coagulant filtration drinking water Shanyin County

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