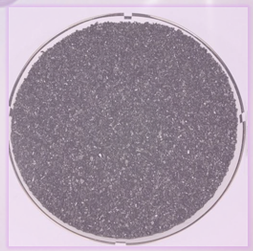
工程化大肠杆菌使其在耐盐的基础上吸附 Cd2+

背景知识 Background

含Cd(II)废水具有剧毒，而Cd(II)的化合物毒性更大。Cd(II)易在生物体内富集，如含Cd(II)废水未经严格处理，易引起生物体的慢性中毒，危害较大。其中毒性最大的为CdCl2，当质量浓度为 0.001 mg／L 时，对鱼类和水生物就能产生致死作用。Cd(II)能严重抑制微生物的生长，浓度0.1—1.0 mg／L 时，微生物死亡率可达50 %左右。水中Cd(II)质量浓度为 0.1 mg／L时，就可抑制水体自净作用。含 Cd(II)废水流入到水生环境，对水生生物有剧毒。

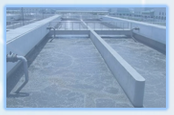
Wastewater containing Cd (II) is highly toxic, while compounds containing Cd (II) are more toxic. Cd (II) is easy to accumulate in organisms. If the wastewater containing Cd (II) is not strictly treated, it is easy to cause chronic poisoning of organisms and great harm. Among them, the most toxic is CdCl2. When the mass concentration is 0.001 mg / L, it can have a lethal effect on fish and aquatic organisms. Cd (II) can seriously inhibit the growth of microorganisms.When the concentration is 0.1—1.0 mg / L, the microbial mortality can reach about 50%. When the mass concentration of Cd (II) in water is 0.1 mg / L, the self purification of water can be inhibited. Cd (II) containing wastewater flows into the aquatic environment and is highly toxic to aquatic organisms.



其他可行的方法及其缺陷 Other manner with their drawback

化学中的化学沉淀法会产生大量残渣，很容易对水体产生二次污染；而且沉淀法产水水质不好，难以深度去除重金属离子，往往需要进一步处理。电化学法存在处理废水量小，电流效率低，对低浓度重金属离子废水处理能力差，不能深度去除水体中重金属离子的问题。氧化还原法污泥产生量大、占地面积大且一般需要二次处理，该法多用于重金属废水预处理。

The chemical precipitation method in chemistry will produce a large number of residues, which is easy to cause secondary pollution to the water body; Moreover, the quality of precipitation produced water is not good, so it is difficult to remove heavy metal ions in depth, and it often needs further treatment. Electrochemical method has the problems of small amount of wastewater treatment, low current efficiency, poor treatment capacity for low concentration heavy metal ions wastewater, and can not deeply remove heavy metal ions in water. The oxidation—reduction method has a large amount of sludge, covers a large area, and generally requires secondary treatment. This method is mostly used for the pretreatment of heavy metal wastewater.



生物方法 Biology manner

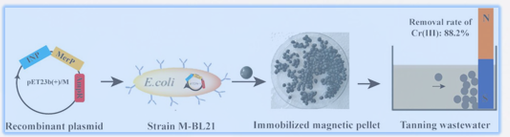
生物法主要是借助动植物、微生物等生物通过絮凝、富集等作用处理废水中的重金属离子。活性污泥法是微生物的胞外多聚物含有配位基团—OH、—COOH、 —NH、PO43—、—HS等，它们与重金属离子进行络合、吸附和离子交换等，去除水体中重金属离子。

Biological method mainly uses animals, plants, microorganisms and other organisms to treat heavy metal ions in wastewater through flocculation, enrichment and other functions. Activated sludge process refers to the extracellular polymers of microorganisms containing coordination groups —oh, —cooh, —nh, po43—, —hs, etc., which are complexed, adsorbed and exchanged with heavy metal ions to remove heavy metal ions from water.

生物法首先要对生物进行驯化，有选择性的对生物进行筛选，然后再应用于废水处理。该法具有成本低，操作简单等优点；但是活性污泥法处理后，存在污泥二次处理，且生物生存条件的约束和生物寿命的限制，导致其应用范围受到局限。

Biological method should first domesticate organisms, selectively screen them, and then apply them to wastewater treatment. This method has the advantages of low cost and simple operation; However, after activated sludge treatment, there is secondary treatment of sludge, and the constraints of biological living conditions and biological life limit, resulting in the limitation of its application scope.

重金属吸附 Heavy metal adsorption



微生物对重金属的作用包括细胞内的积累和细胞表面的吸附。

The effects of microorganisms on heavy metals include intracellular accumulation and cell surface adsorption.

细胞表面吸附，微生物细胞的细胞壁在从水溶液中去除金属离子中起着关键作用，因为存在大量具有不同电荷和几何形状的官能团（羧基、氢氧化物、氨基、咪唑、硫酸盐和巯基等），可以和重金属离子作用（螯合或络合），使重金属离子被微生物所吸附。

Cell surface adsorption, the cell wall of microbial cells plays a key role in the removal of metal ions from aqueous solutions, because there are a large number of functional groups with different charges and geometric shapes (carboxyl, hydroxide, amino, imidazole, sulfate, mercapto, etc.), which can interact with heavy metal ions (chelate or complex), so that heavy metal ions can be adsorbed by microorganisms.

细胞内的积累主要是微生物将吸附在细胞表面的重金属离子通过主动运输转运到细胞内。金属通过细胞膜的转运机制类似于钠离子和钾离子的转运机制。

Intracellular accumulation is mainly due to the active transport of heavy metal ions adsorbed on the cell surface to the cell by microorganisms. The transport mechanism of metals through cell membrane is similar to that of sodium and potassium ions. 工程菌构建基本流程（方法）Basic process （method） of engineering bacteria construction

目的基因选择和获取：PCR/合成 Objective gene selection and acquisition: pcr/ synthesis	载体、菌株选择：真菌/细菌 Carrier and strain selection: fungi / bacteria	目的基因连接到载体：双酶切/TA克隆/BKL试剂盒等 The target gene is connected to the vector: double enzyme digestion /ta cloning /bkl kit, etc	转化至克隆菌株：感受态细胞制备 Transformation to clonal strains: preparation of competent cells	筛选验证 质粒提取：挑取单克隆 Screening validation Plasmid Extraction: pick monoclonal	转化至表达菌株：完成构建 Transformation to expression strain: completion of construction