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给水厂排泥水及污泥的处置

Disposal of Residual and Sludge in Water Supply Plant

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摘要 给水厂排泥水产生于水处理过程中的沉淀或澄清以及滤池反冲洗步骤,总量约占给水厂净水量的4%~7%。目前,国内外大多数的给水厂将排泥水直接排入附近水体、排入城市污水厂或将排泥水处理成污泥后作土地利用、填埋。本文对上述几种处置方式的特点及其对环境造成的影响进行了介绍,提出将排泥水单独处理后作土地利用较适合我国的实际情况。

关键词: 给水厂 排泥水 污泥 污泥处置 土地利用

1 前言

给水厂排出的含泥污水(排泥水)主要由滤池反冲洗排水和沉淀池或澄清池排泥水组成,约占水厂总净水量的4%~7%。其中,滤池反冲洗排水约占总净水量的1%~2.5%,它主要由悬浮盐类、粘土、有机物及化学药剂残余物组成;沉淀池排泥水(又称沉淀池污泥)可分为石灰软化污泥和化学絮凝沉淀污泥2种,软化污泥主要产生于原水的软化过程,主要成分为碳酸钙、氢氧化镁、淤泥、过剩软化药剂和有机物,化学絮凝沉淀污泥则由原水中的悬浮物、胶体物质、有机物、微生物和加入的净水药剂组成。沉淀池排泥水是给水厂排泥水处理的主要对象。

2 处置方法

2.1 排泥水处置:直接排入附近水体(外排)或排入到城市污水厂(下排)与污水共同处理处置。

2.2 将排泥水单独进行处理,如经过浓缩(浓缩后的污泥含固率可达10%左右,污泥仍具有液体特性)、脱水(污泥的含固率可达10%~30%,污泥呈现出半固体状)、干化(污泥的含固率可达30%~60%)等过程,形成污泥后处置。

3 排泥水处置

3.1 目前,国内外多数研究人员认为给水厂排泥水外排后,其中含有的大量铝盐会对藻类的生长产生影响;排泥水中污泥的沉积作用会造成水体中某些鱼类食物的短缺,影响鱼卵的成活率等[1]。但是,由于很难确定排泥水中的大量铝盐对受纳水体的实际危害程度,各国现在仍允许排泥水外排,同时对外排还作出了具体的规定:

(1)对受纳水体中的水生生物作毒性试验,以确定外排是否有毒害作用;(2)含有铝盐的排泥水不能排入pH<6的水体中;(3)尽量避免将含有铝盐的排泥水排入$CaCO_3$硬度小于50mg/L的受纳水体;(4)对受纳水体作风险评价。

近年来,美国某些州已开始禁止排泥水外排,他们利用水力学模型(如美国Army Crop公司的HEC-2或HEC-6模型)估计其在受纳水体中可能的沉积形式,从而通过试验来评价其对受纳水体的影响。

3.2 给水厂排泥水通过下水管道排入污水处理厂与污水共同处理,其费用比单独处理少,同时也会给污水处理过程带来好处:增加了悬浮固体的去除,提高了BOD或COD的去除率等。但是,下排需满足污水处理厂提出的预处理要求,如限制排泥水的排放时间、排放量、最大TSS等。此外,排泥水下排时可能会明显提高污水厂污泥中砷的浓度,如美国费城的污水厂污泥中砷的浓度为11~12mg/kg(美国新泽西州规定:如果污泥作土地作用,砷的浓度不许超过10mg/kg[1];其中约30%由给水厂排泥水带入(费城共有3个城市给水厂,其中有2个给水厂排泥水下排),因此排泥水下排时需检测砷的浓度[1]。另外,需考虑给水厂排泥水的潜在腐蚀性和H_2S的产生问题,若排泥水中硫酸盐浓度过高,则下排过程中可能产生H_2S会对混凝土

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结构的污水管道产生腐蚀，但若排泥水中同时含有铁盐，它能与 H_2S 结合，可有效地缓解产生 H_2S 的问题。

在污水厂污泥处理设施的容量能满足增加的固体负荷的基础上，给水厂排泥水下排后基本上不会对污水厂污泥处理系统造成太大影响，但却会对污泥的最终处置产生一定影响；排泥水中带来的铝盐会吸附土壤中的磷，减少土壤中作物可利用的磷量，并且铝盐的毒害作用会限制污泥的土地利用。另外，给水厂排泥水下排给污水厂污泥的焚烧也会带来诸多困难：给水厂排泥水中的有机物含量低，导致污水污泥热值下降；铁离子或铝离子的存在对焚烧操作和排出的废渣及废气都有较大的影响；此外，给水厂排泥水下排会降低污水厂污泥的 VS，减缓其堆肥的降解过程[2]。

4　污泥处置

4.1 给水厂污泥中含有粘土、腐殖质以及其它悬浮的或不溶于水的物质，其肥效很低(见表 1)。

表 1　给水污泥中的营养成分[1]
Table 1　Nutrient contents of sludge in water supply plant

营养成分(%)	范围1)
总固体含量	8.1 ~ 81.0
挥发性固体	9.3 ~ 29.1
电导率(μs/cm)	563.8(530.2)
pH	7.0 ~ 8.8
凯氏氮	0.495(0.256)
有机氮	0.752(0.399)
氨氮	0.016(0.016)
硝态氮	0.003(0.003)
总磷	0.228(0.248)
总钾	0.225(0.317)

1) 括号内数值为标准差值。

但是，当污泥适度施用于土壤中后，发生的类似于水处理过程中的絮凝反应可提高土壤的凝聚程度，改善土壤的结构，利于耕作。另外，给水厂污泥中含结晶水的金属氧化物可吸附痕量金属，减少土壤中游离的有害痕量金属量，这对作物也是有利的。据 Elliott 等报道[3]，给水厂污泥中未有大肠杆菌发现，这可能与水源较洁净、水处理过程中经过消毒过程和污泥在贮存池中长时间的堆置等因素有关。

在给水处理的絮凝过程中，来自于絮凝剂或水源中的重金属会吸附在氢氧化铝或氢氧化铁上，导致污泥施用后会对地下水或作物造成污染；给水污泥中大量的铝盐在施用后也会对环境产生负面影响。研究表明[1]，只要适度施用(20dt/hm²)及在土壤 pH>6.0 的情况下，污泥中金属迁移至地下水或作物中的量很少，可忽略不计。另外，污泥施用于土地后，由于大量的氢氧化铝或氢氧化铁吸附磷，使得土壤中的磷含量下降，将会导致作物出现缺磷现象。改进耕作技术可以改变此种状况，根据作物的不同生长阶段，将污泥施用于表层或深层，如发芽期的作物比成熟期的作物需磷多，因此污泥可施用于深层(>18cm)土壤。

给水厂污泥用于农业或园林中，施用量不大时(20dt/hm²)，不会对作物和环境产生负面影响，若在专用土地上或出地及建设地带上使用，施用量可相对大些(20 ~ 200dt/hm²)，但需要加强管理与监测，避免雨水径流及渗滤液可能造成的二次危害。

4.2 大多数情况下，给水厂污泥属于无毒害固体废弃物，可采用填埋作为其最终处置方式。污泥可单独填埋，也可与城市生活垃圾或污水厂污泥混合填埋。填埋方式的选择取决于污泥的含固率、稳定性、填埋场的水文地质条件(如地下水及岩石层的位置)、地表坡度及可使用的土地面积等因素。

给水厂污泥中的重金属可能会对地下水造成污染是填埋的主要限制因素。重金属浓度测试和迁移测试的结果均表明，在多数情况下，给水厂污泥的渗滤液不会使地下水中的重金属浓度超过饮用水标准。在美国给水协会填埋研究报告中，按照土壤的统一分类系统，给水污泥试样呈现出类似于 CH 类土壤(即高塑性无机粘土)的特性，这类土壤的渗水率小于 5×10^{-10}m/s，比普通粘土层的渗水率(1×10^{-9}m/s)要低得多[1]。

5　结语

当前我国给水厂所面临的主要问题是尽快采取经济可行的处置方法以避免排泥水继续对环境造成危害，在有条件的情况下，对排泥水单独进行处理并将污泥作土地利用是较为合理的一种排泥水处置策略。

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widely useful approach in such field. Then, four development trends of climate policy modeling were summarized, including strengthening the application of integrated assessment models, expanding the connotations of cost-benefit analysis, enhancing comparative research on different models, and emphasizing uncertainty analysis. Finally, the *status quo* and problems of China's climate policy modeling were briefly surveyed and discussed.

Key words: Climate change Climate policy study Integrated assessment model Uncertainty analysis Green house gas

Study Progress on Treatment of Refractory-degraded Organics by Electro-Fenton Method

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Review on application of Electro-Fenton method to wastewater treatment, including principles, advantages and disadvantages of the method and *status quo* of study around the world, and its development trend etc. have been presented

Key words: Fenton reagent Hydroxyl radical Electrolysis Hydrogen peroxide

Disposal of Residual and Sludge in Water Supply Plant

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During water treatment processes, residuals are produced from coagulation/filtration unit and filter operation which amount to 4-7 percent of the whole water flow. So far, residuals in water supply plant are disposed mainly by direct discharge to surface water or discharge to wastewater treatment plants(WWTP). Sludge, produced from residuals treatment, is disposed mainly by land application or landfill. Some water supply plants discharge their residuals into surface water, which do harm to environments. In this paper, characterstics and environmental impact of disposal methods were introduced. According to the situation of China, a reasonable disposal strategy, land application after treatment, was proposed in this paper.

Key words: Water supply plant Residual Residuals and sludge in water supply plant Disposal of sludge Land application

Approach on Cumulative Watershed Effect and Problems in Its Assessment

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Description on the concepts of cumulative effect, cumulative watershed effect and cumulative effect assessment were presented. In addition, the technical issues, philosophical issues and sociocultural issues in assessment of cumulation watershed were emphatically discussed. Through study and perspective of the cumulative watershed effects assessment to propose a more perfect and resonable thought of watershed ecological management.

Key words: Cumulative watershed effect Assessment Watershed ecological management

Approach on Development Relationship between Eco-economic Efficiency and Environmental Management

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Through analyses on the concept and development of eco-economic efficiency, relation between eco-economic efficiency and sustainabe development and the reason of why the eco-economic efficiency does not further development in China, to describe how to promote the strategies target and measures of eco-economic efficiency, and recommend the need for further study and analysis and application of eco-economic efficiency to local and regional levels, which can play a key role in sustainable developmeot in China.

Key words: Eco-economic efficiency Environmental management Sustainable development

Connotation of Environmental Awareness and Objective of Environmental Education

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It is urgent to improve public environmental awareness to resolve the exacerbating environmental issues, and education is the main measure to foster environmental awareness. Possessing a correct and comprehensive connotation of environmental awareness is the first step to be developed. At the same time, it is the important gist for this paper to bring forward four objectives according to the analysis of the connotation of the environmental awareness, those are: knowledge, value, moral and behavior objective. Finally, it offered some suggestions to help to achieve these objectives.

Key words: Environmental awareness Objective Connotation Environmental education

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