聚苯乙烯滤料过滤研究

何少华　秦成生　严煦世

提要　通过试验探讨了聚苯乙烯滤料在直接过滤、再絮凝过滤和载粉末活性炭(PAC)过滤中的应用。结果表明:粒径为 1.25～2.5 mm,厚度为 1 000 mm 的聚苯乙烯滤料在投加硫酸铝及阳离子型聚合物 T_{3010}时,既可用于直接过滤,又可用于再絮凝过滤及载 PAC 过滤。

关键词　聚苯乙烯　直接过滤　再絮凝过滤　载 PAC 过滤

0　概述

传统的采用石英砂作为滤料的上向流过滤属于反粒度过滤,比下向流石英砂滤料截污容量大,但这种滤料过滤时滤层容易松动,影响过滤出水水质,且不容易冲洗干净。采用聚苯乙烯作为滤料,上向流过滤时上浮而不会引起滤层松动,由于下向反冲洗时下向的水流使滤料分散,因而能够彻底地将滤池冲洗干净。

上向流聚苯乙烯滤料直接过滤(见图 1)具有如下特点:①可截留大量的絮体颗粒;②在滤层上部设置压滤层后可不设承托层;③因冲洗水头小,冲洗水可贮存于滤池之上;④不需要采用空气冲洗,适用于处理低浊度、低色度的原水。

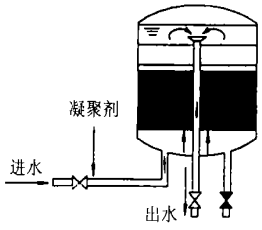

图 1　上向流聚苯乙烯滤料直接过滤

由于上向流聚苯乙烯滤料可截留大量絮体,因而可回流部分过滤出水进行再过滤,称为再絮凝过滤(见图 2)。与传统的过滤相比,再絮凝过滤可充分发挥截留于滤料层内的絮体的吸附特性,适用于处理污染程度较高的原水。

以上向流聚苯乙烯滤料直接过滤为基础,还可建立另一种新型过滤技术[1],即载粉末活性炭(PAC)过滤。该工艺由 PAC 预载、过滤和反冲洗三部分组成。该工艺为 PAC 应用提供了一条新途径,适用于去除原水中的有机物。

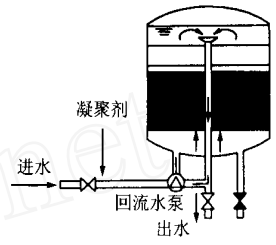

图 2　再絮凝过滤

1　试验系统与方法

试验系统由浓水箱、配水箱、平衡水箱、过滤柱、凝聚剂投加装置、PAC 投加装置等组成,见图 3。直接过滤时,原水加凝聚剂跌水混合后经阀门 8 进入过滤柱,出水从阀门 1 流出。再絮凝过滤时,原水经阀门 8 进入过滤柱,出水经阀门 3、5 由回流水泵压入平衡水箱 B 后,一部分经阀门 7、阀门 9 回流,一部分由阀门 6 流出。预载 PAC 时,在湿法投加 PAC 的同时开启回流水泵,经阀门 3、4、9 循环进入过滤柱。反冲洗时,反冲洗水由阀门 2 进入过滤柱,由阀门 10 流出。

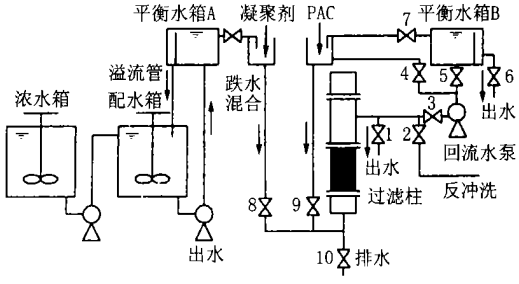

图 3　试验系统组成

原水用高岭土或池塘底泥配成。试验时,投加的凝聚剂为分析纯硫酸铝和阳离子型聚合物 T_{3010},同时投加在跌水混合之前,硫酸铝投加量以

$Al_2(SO_4)_3 \cdot 18H_2O$计。阳离子型聚合物 T_{3010}为弱阳电性有机高分子聚合物颗粒,外观呈白色,分子量高达 1 500 万,适用的 pH 范围为 3～13,其投加量以商品量计。

2 试验结果与分析

2.1 直接过滤试验

直接过滤时,原水用高岭土配制,各周期的试验条件和试验结果见表 1 和表 2,以出水浊度大于3 NTU 或水头损失大于 1.8 m 确定过滤周期。

表 1 直接过滤试验条件

周期编号	原水浊度 / NTU	硫酸铝投加量 / mg/L	T_{3010} 投加量 / mg/L	滤料粒径 / mm	滤料厚度 / mm	滤速 / m/h
1	100	5	0.15	1.0～1.25	700	10
2	100	5	0.12	1.0～1.25	700	10
3	100	5	0.09	1.0～1.25	700	10
4	100	5	0.15	1.25～2.5	700	10
5	100	5	0.12	1.25～2.5	700	10
6	100	5	0.09	1.25～2.5	700	10
7	100	5	0.15	1.25～2.5	1 000	10
8	100	5	0.12	1.25～2.5	1 000	10

从表 1 及表 2 可以看出:①在原水浊度和硫酸铝投加量相同时,影响出水水质和过滤周期的主要因素为絮凝剂 T_{3010}投加量、滤料粒径及滤层厚度。②当 T_{3010}投加量小于 0.12 mg/L 时,过滤周期将因浊度泄漏而终止,为保证良好的出水水质,T_{3010}投加量宜在 0.12 mg/L 以上。③减小滤料粒径或增加滤层厚度有利于改善出水水质。④直接过滤时,采用的滤料粒径为 1～1.25 mm 或 1.25～2.5 mm,前者的出水水质较好,后者的过滤周期稍长。根据研究[1],要使直接过滤、再絮凝过滤和载 PAC 过滤在一个滤池内完成。宜采用粒径为 1.25～2.5 mm,厚度为 1 000 mm 的滤层。

2.2 再絮凝过滤试验

再絮凝过滤时,各周期的试验条件的结果见表 3,表 3 中回流比为产水量与回流水量之和除以产水量,直接过滤时没有水回流,其回流比为 1。原水由高岭土与池塘底泥混合配制。

从表 3 可以看出,将过滤出水进行回流后,可以提高高锰酸盐指数的去除率,改善出水水质,适用于污染程度较高时的原水处理。

表 2 直接过滤试验结果

周期编号	下列过滤时间(h)的出水浊度/ NTU														过滤周期/ h	终点水头损失/ m
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1						9.5	1.810
2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	0.8	1.0	1.2					10.0	1.825
3	0.25	0.2	0.4	0.8	2.0	2.2									6.5	0.825
4	1.5	1.8	1.2	1.0	0.9	0.8	0.8	0.6	0.5	0.4	0.2				11.1	1.803
5	1.4	1.5	1.2	1.0	0.9	0.9	0.9	0.8	0.6	0.5	0.4	0.25	<0.1	<0.1	14.0	1.825
6	4.0	2.7	1.8	1.5	2.0	2.2	2.5	2.9							8.0	0.630
7	1.4	1.2	1.0	0.9	0.7	0.5	0.3	0.3	0.2	<0.1					10.0	1.830
8	1.6	1.3	1.1	1.0	0.8	0.45	0.4	0.4	0.2	0.2	0.2	0.1	<0.1		13.0	1.860

表 3 再絮凝过滤试验结果

周期编号	原水平均高锰酸盐指数/ mg/L	硫酸铝投加量 / mg/L	回流比	过滤周期 / h	终点水头损失 / m	出水平均浊度 / NTU	出水高锰酸盐指数平均去除率/ %
9	8.30	5	1.0	10.0	1.845	1.4	49.7
10	8.22	5	2.0	9.5	1.839	1.2	69.9
11	8.28	10	2.0	9.0	1.826	0.9	76.0
12	8.41	15	2.0	7.0	1.614	1.1	76.1
13	3.28	10	2.0	9.0	1.870	0.8	58.5
14	2.56	10	2.0	9.0	1.818	0.8	35.1

注:试验条件为滤料粒径 1.25～2.5 mm;滤料厚度 1 000 mm;滤速 10 m/h;原水浊度 170 NTU;T_{3010}投加量 0.15 mg/L。

表4 载 PAC 过滤时的出水浊度

周期编号	下列过滤时间(h)的出水浊度/NTU															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
15	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7
16	0.8	0.7	0.7	0.5	0.4	0.3	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
17	0.4	0.4	0.3	0.3	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1						

上向流聚苯乙烯滤料过滤时能截留大量絮体颗粒,为了充分发挥絮体的活性,可将过滤出水的一部分回流,完成再絮凝过滤,以提高出水水质。但是出水回流会引起水流剪力增大,因而回流比不宜过大,以免滤料上的絮体被剪切下来,所以应根据原水水质和凝聚剂投加量等确定回流比,一般不宜大于2。

从表3还可以看出硫酸铝投加量对再絮凝过滤的影响,投加量高到15 mg/L时,可导致滤池过早泄漏,而缩短过滤周期。

2.3 载 PAC 过滤试验

载 PAC 过滤时,原水由高岭土与池塘底泥混合配制,各周期的试验结果见表4和表5,从中可以得出,在其他条件相同时,随着 PAC 载量的增加,滤层成熟期缩短,出水浊度降低。载 PAC 过滤时,正好与混凝时投加 PAC 可能引起的负作用相反[2],PAC 有着良好的助凝性能。

表5 载 PAC 过滤试验结果

周期编号	原水平均高锰酸盐指数/mg/L	PAC 载量/g/L 滤料	过滤周期/h	终点水头损失/m
15	5.41	0	16.5	1.835
16	5.34	1.132	14.5	1.860
17	5.24	2.264	12.0	1.845
18	5.48	3.396	10.0	1.830

注:原水浊度 50 NTU;硫酸铝投加量 5 mg/L;T_{3010}投加量 0.09 mg/L;滤料粒径 1.25～2.5 mm;滤层厚度 1 000 mm;滤速 10 m/h。

浊度大于 50 NTU 的原水,不宜采用载 PAC 过滤工艺,因原水浊度高时,过滤周期缩短,以致不能充分利用 PAC 的吸附容量,形成浪费。

载 PAC 过滤时,PAC 载量对出水高锰酸盐指数平均去除率的影响见图4,图4中各周期的原水平均高锰酸盐指数为 5.24～5.48 mg/L,硫酸铝投加量为 5 mg/L,T_{3010}投加量为 0.09 mg/L,原水平均浊度为 50 NTU。从图4中可以看出,随着 PAC 载量的增加,高锰酸盐指数的去除率增加。综合考虑水头损失和出水水质,PAC 载量一般可选用 2～3 g/L 滤料。

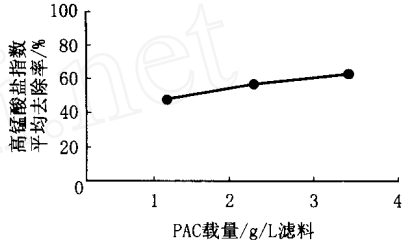

图4 PAC 载量对出水高锰酸盐指数平均去除率的影响

3 结论

通过试验研究,可得到如下结论:

(1) 同时投加硫酸铝和阳离子聚合物 T_{3010}时,粒径为 1.25～2.5 mm,厚度为 1 000 mm 的滤层既可用于直接过滤,又可用于再絮凝及载 PAC 过滤。

(2) 再絮凝过滤可充分发挥附着于滤料之上的絮体颗粒的吸附特性,因而可用于处理污染程度较重的原水。

(3) 载 PAC 过滤时,PAC 有着良好的助凝性能,能够降低出水浊度,提高有机物的去除率。

(4) 再絮凝过滤时回流比的选择及载 PAC 过滤时 PAC 载量的选择均应根据原水水质条件及出水水质要求等综合考虑。

◇作者通讯处:421001 湖南省衡阳市南华大学建筑工程与资源环境学院
电话:(0734)8282394(O)
严煦世 200092 同济大学环境科学与工程学院
收稿日期:2002-12-30

Abstract: Since the biological fluidized reactor was adopted, the COD level of the effluent discharged from the advanced bio-membrane treatment facility treating both the trade and domestic wastewaters from a petro-chemical plant in Fushun City decreased obviously. Then the effluent was used to refilled into the circulated cooling water system. According to the operating data of this facility an appropriate process including the technological scheme and operating parameters suitable for chemical wastewater reuse for circulated cooling water system has been obtained. The effluent from this process is good enough to meet the requirement of industrial wastewater reuse with evidential social, environmental and economical profits.

Abstract: The photo-catalytic (PC) and biochemical (B) degradations of two brilliant red dyestuffs namely active X-3B and cationic 5GN were researched experimentally and it has been founded that X-3B can be easily decolored by PC but not by B, and the 5GN acts contrary. So the synthetic wastewater prepared by both dyestuffs will be treated by composite processes in sequence of PC and B. The biochemical treatability of the synthetic wastewater can be improved by PC process along with the removal of biologically non-degradable pollutants and then the enhanced B degradation will exert. The overall results of this composite process are much better than that of single PC or B process. Decolorizing and COD removal up to 94% and 94.09% respectively have been obtained.

Abstract: So called ecological sanitary water discharge (ESWD) system aims for a closed circulation of water resource and nutrients in the human social and economical activates. This circulation must be run in safety, economical and reliable conditions for the ultimate target of sustainable development. The concepts related to increase the water utilization and protect the restricted water resource are very noticeable. The feasibility of ESWD has been stated theoretically, technically and economically by practical ways. However, some problems come down to the conjunction of ESWD with the existing sewer system in urban area with high population density are still researchable. In this paper the recent developments of ESWD home and abroad are presented and compared, and our countermeasures are proposed.

Abstract: The distinguishing features of frequency controlled (FC) water supply system in the Hangyun international financial building in Shanghai are presented and the application of FC with combined series and parallel water supplying lines for super-high building are discussed. Also the control and monitoring measures of FC in building automation are presented briefly.

Abstract: The filtrating performances of four filtrating media, namely the fresh natural sand, blacken sand with Fe and Mn coat dyed at the pre-filtration of raw water, acid-washed sand and alkali-washed sand are compared. The results show that no evident difference was observed in output water quality and head loss of the filtration bed, and the performances of the treated three seem same as the fresh. So all of them could be reused to cut down the operating expenses. However, the authors suggest that using blacken media is preferable to reduce the backwashing intensity to prevent sand losses and to extend the preliminary filtration time for best output water quality.

Abstract: The performances of polystyrene filtration media in different operations such as the direct filtration, the re-flocculation filtration and the powdered activated carbon (PAC) filtration are researched experimentally. The results show that in case that cationic polymer T3010 was added, filtration layer with grain size of 1.25～2.5 mm and depth of 1 000 mm could be convenient for direct filtration, and it is also suitable for re-flocculation and PAC filtrations.

Abstract: The special characters of fire accident in dwelling houses were discussed, which indicating that the location to install the sprinkling fire control system would not be arbitrarily. The suitable water supplying schemes and nozzles for proper choice for dwelling house sprinkling system are presented. Also the calculation of the service area and sprinkling duration, the required water head of the nozzles and the installation attentions in design and construction of sprinkling system are indicated in this paper.