好氧及厌氧固定化微生物处理能力的比较研究

吴晓磊 俞毓馨 钱 易

(清华大学环境工程系,北京 100084)

摘要 以聚乙烯醇(PVA)为包埋剂,分别包埋固定活性污泥及厌氧污泥进行了对废水中有机物的好氧及厌氧降解试验,比较了固定化及未固定的污泥、固定化活性及厌氧污泥对废水的处理能力。结果表明,固定化污泥的容积负荷是未固定污泥的1.3—2.1倍,在试验条件下,固定化厌氧污泥与自由厌氧污泥的容积负荷之比(2.13)明显高于固定化活性污泥与自由活性污泥的比值(1.30—1.54)。综合污泥负荷及单位污泥产气量,说明固定化厌氧污泥比固定化活性污泥更能发挥微生物的处理能力。

关键词 固定化微生物,固定化活性污泥,固定化厌氧污泥。

应用包埋法固定化微生物处理废水是本世纪70年代末、80年代初发展起来的一种废水处理新技术。大量研究表明,这种新技术与传统生物处理法相比,具有可人为地提高和保持某些高效菌种的优势,系统的生物量及处理效率高,产泥量少,处理装置占地小,易于运行管理等优点[1,2]。目前,人们的研究工作大量是针对好氧情况进行的,对厌氧情况的研究报道相对较少。但对有机物含量高及含难降解物质的废水,厌氧生物处理有着其独特的优越性[3]。为了说明包埋法固定化微生物是否也具有这种优势,本研究利用聚乙烯醇(PVA)为包埋剂,分别包埋固定了活性污泥和厌氧污泥,在好氧和厌氧条件下,比较了它们对不同浓度的有机物的处理能力。

1 试验材料和方法

1.1 试验材料

包埋剂:PVA,工业用,1799F型,北京有机化工厂;交联剂:硼酸,分析纯,北京红星化工厂。

活性污泥,由北京市环保所生物接触氧化池中取出后用葡萄糖人工废水培养而得;厌氧污泥由天津纪庄子污水处理厂污泥消化罐中取得。

1.2 试验方法

1.2.1 固定化污泥小球的制备

固定化污泥小球的制备流程如图1所示。

图1中,A为PVA溶液的浓度(%),B为浓缩污泥与PVA溶液的重量比(简称包泥量),C为浓缩污泥与PVA溶液的混合物在交联剂硼酸溶液中的凝胶化反应时间(简称交联时间,h)。

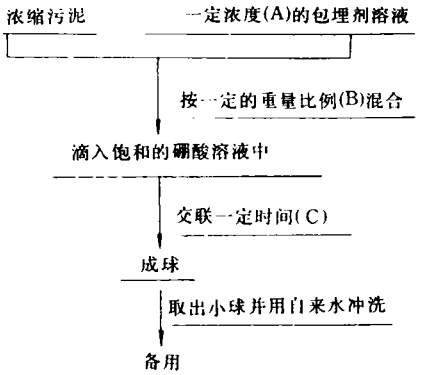

图1 固定化污泥小球制备流程

试验中所用浓缩污泥为活性污泥和厌氧污泥经4000r/min,离心15min而得,浓度分别为43.31g/L及70.7g/L。

1.2.2 固定化活性污泥的活性试验

将按图1所示工艺制得的固定化活性污泥(IAS)小球,依其与废水体积比为1∶20加入200mlTOC分别为160mg/L及290mg/L(COD为400mg/L及1000mg/L)的人工合成葡萄糖废水中,同时在另外相同的200ml废水中,保持未包埋的活性污泥(AS)浓度为3g/L,作对照试验,维持25℃恒温,鼓风曝气,在不同时刻取出少量溶液(约1ml),测定其中TOC含量。

1.2.3 固定化厌氧污泥的活性试验

将按图1所示工艺制得的固定化厌氧污泥(IANS)小球,依其与废水体积比为1∶20加入

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到95mlTOC为1600mg/L(COD为4887.2mg/L)的人工合成葡萄糖废水中,以含10g/L的厌氧污泥的相同废水作对照,恒温37℃,史氏发酵法测定产气量,并测定发酵结束后溶液中的最终TOC含量。

2 试验结果与讨论

2.1 试验条件的确定

直接影响固定化污泥性能的因素主要是A,B,C(符号意义如前所述)。在正式试验前,进行了预备试验,利用正交试验法,确定了对活性污泥及厌氧污泥包埋固定的适宜条件,如表1。

表1 适宜的污泥包埋固定化条件

污泥种类	A(PVA浓度)(%)	B(包泥量)	C(交联时间)(h)
活性污泥	10	1∶1	24
厌氧污泥	10	1∶1	24

2.2 IAS的TOC降解特性

将按上述适宜包埋条件制备的IAS及AS进行TOC降解试验,在进水TOC分别为160mg/L和290mg/L的情况下,TOC去除率随时间变化规律如图2所示。

从图2可以看出,在2种TOC浓度下,IAS对水中TOC去除率均高于AS,进水中有机物含量高时,这种优势更为明显。

以TOC为指标,计算IAS和AS对有机物处理的容积负荷、污泥负荷及二者相应的比值,在2种进水情况下,分别进行比较如表2。

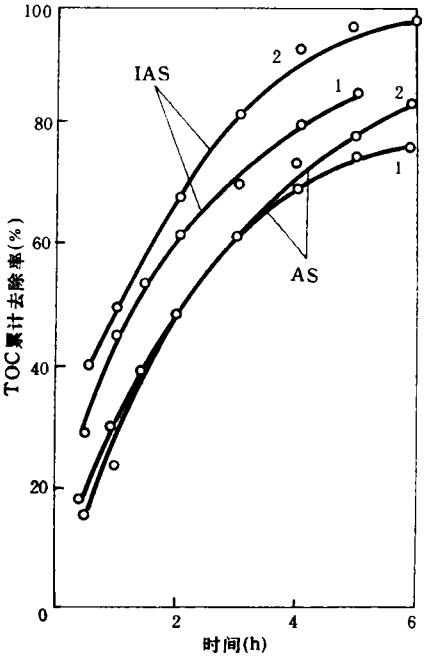

图2 TOC去除率历时曲线

1. 进水TOC=160mg/L　2. 进水TOC=290mg/L

对典型城市污水,其有机物含量的中常水平及高水平分别为160mg/L和290mg/L TOC[4]。由理论分析可知,常规活性污泥法处理城市污水的污泥负荷为0.16—0.40kgTOC/(kg MLVSS·d)。在本试验条件下,AS的污泥负荷分别达到了0.25kgTOC/(kg MLVSS·d)和0.44kgTOC/(kg MLVSS·d),反映出AS的处理能力得到了正常发挥。从表2可以看出,进水TOC浓度从160mg/L上升到290mg/L时,有机物含量上升了1.81倍,此时IAS的污泥负荷上升了2.06倍,而AS的污泥负荷上升了1.76倍,IAS的污泥负荷增加幅度大于TOC的增长幅度,说明在进水有机物浓度较低的情况下,IAS的处理能力没有得到充分的发挥。

表2 IAS和AS的活性比较

污泥状态	污泥浓度(g/L)	容积负荷(kgTOC/m³·d)	污泥负荷(kgTOC/(kg MLVSS·d))	容积负荷之比	污泥负荷之比
TOC=160mg/L IAS	7.0	0.99	0.14	1.30	0.56
AS	3.0	0.76	0.25		
TOC=290mg/L IAS	7.0	2.04	0.29	1.54	0.66
AS	3.0	1.32	0.44		

表2结果还表明,IAS的容积负荷高于AS,(TOC投配负荷越高,这种差别越明显),但污泥负荷却是IAS小于AS。维持较高的容积负荷及较低的污泥负荷是绝大多数废水处理工艺所力求达到的。因此无论从对有机物的处理效率,还是从负荷情况来考察,固定化活性污泥法优于普

通的活性污泥法。

2.3 IANS的厌氧活性

将按表1所示的适宜条件制备的IANS和厌氧污泥(Anaerobic Sludge以下缩写为ANS)进行史氏发酵,测定产气量,作产气曲线如图3。

从图3可以看出,IANS的产气量及产气增长速率均明显高于ANS。

同样,以TOC为指标计算容积负荷、污泥负荷以及单位污泥产气量,作如表3所示的比较。

由表3可看出,IANS与ANS的容积负荷之比,污泥负荷之比及单位污泥产气量之比3者相差不大,均为2左右。这既说明IANS优于ANS,也表明,在试验条件下,IANS的处理能力得到了正常发挥。

表3还表明,在试验条件下,与好氧情况相比,厌氧条件下的固定化污泥容积负荷更高,反映出厌氧处理的优越性。

好氧及厌氧条件下的活性对比试验结果表明,2种固定化污泥的处理效率均明显高于未包埋的污泥,这种优势随水中有机物浓度的增加而更加明显。其原因为:①固定化污泥的生物量可以人为地提高到较高水平(而且不会发生活性污泥法中的污泥膨胀问题);②固定化污泥小球对有机物的吸附使有机物在微生物周围的局部浓度得以提高,使传质效率得到提高。

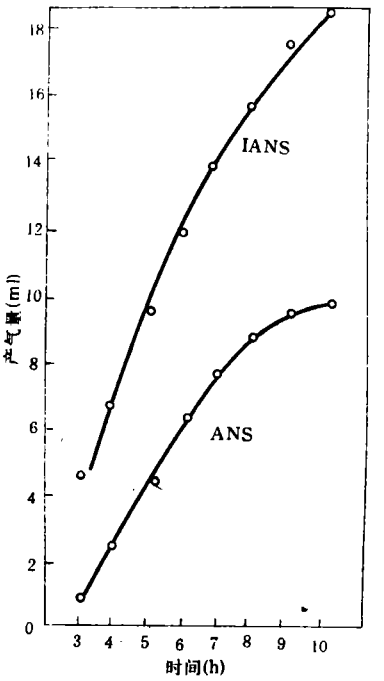

图3 产气量历时曲线

表3 IANS与ANS活性比较

污泥状态	污泥浓度 (g/L)	容积负荷 (kgTOC/m³·d)	污泥负荷 (kgTOC/(kg MLVSS·d))	单位污泥产气量 (L/(kg MLVSS·d))	容积负荷之比	污泥负荷之比	单位污泥产气量之比
IANS	11.4	4.5	0.4	16.5	2.12	1.86	1.79
ANS	10.0	2.1	0.2	9.2			

在好氧条件下,由于氧传质的限制,因而IAS处理的废水,其有机物浓度不能很大,这将限制高污泥浓度的IAS的活性的充分发挥;在厌氧情况下,不存在氧的传质供应问题,废水中有机物浓度可以大大高于好氧情况,所以IANS中微生物的处理能力可以得到更充分的体现,而且可以长时间地保持较高的生物量和活性,充分体现固定化微生物的优越性。

从充分利用微生物处理的能力,发挥固定化微生物的优势来说,包埋法固定化微生物技术更适用于废水的厌氧处理。

3 结论

(1)固定化污泥对有机物的处理效率高于未固定的污泥,而且随废水中有机物浓度的增加,这种优势更加明显。

(2)厌氧污泥包埋固定后应用于废水厌氧处理比对活性污泥包埋固定后应用于废水好氧处理更能发挥固定化微生物的处理潜力,体现固定化微生物处理废水的优势,因而固定化技术更适用于废水的厌氧处理。

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than 0.5 mg/L, i.e., the national standard for its discharge.

Key words: acidic wastewater, pollution control, arsenic (As), iron salts neutralization.

Study on the Manufacture of Activated Carbon from the Carbon in Coal Ash from a Power Station. Wu Xinhua and Yu Wei (Fujian College of Forestry, Nanping 353001): *Chin. J. Environ. Sci.*, **15**(1), 1994, pp. 47—49

A production process of activated carbon in which the carbon in a coal ash from a power station was used as a starting material has been developed. The optimized conditions for this process to produce a granular activated carbon were using charcoal, white charcoal or coal as an auxiliary raw material, together with which the starting material was undergoing a treatment in a preactivation process, then was washed with acid and water, and finally was activated or even further reactivated if required. The activated carbon product thus produced had an iodine value of 600—700 mg/g. The activated carbon from a pilot industrial production had an iodine value of 630—800 mg/g with a wearability of over 95%. This process provides a new way for coal ash to be utilized comprehensively.

Key words: coal ash, activated carbon, comprehensive utilization.

Comparative Study on the Capacities of Aerobic and Anaerobic Immobilized Microbes to Treat Organics. Wu Xiaolei et al. (Dept. of Environ. Eng., Tsinghua University, Beijing 100084): *Chin. J. Environ. Sci.*, **15**(4), 1994, pp. 50—52

Activated and anaerobic sludges were respectively immobilized with polyvinyl alcohol (PVA) used as an entrapping agent, and then the immobilized sludges were separately used to degrade the organics in wastewater under the aerobic and anaerobic conditions, respectively. Comparisons in the capacity of treating organics were also made between the immobilized and free sludges and between the immobilized activated sludge and the immobilized anaerobic sludge. The results show that the volumetric loading was 1.3 to 2.1 times that of free sludge, meant by that the immobilized sludges had a higher capacity of treating organics than a free sludge. Under the conditions studied, the volumetric loading ratio of the immobilized anaerobic sludge to the free anaerobic sludge (2.13) was much higher than that of the immobilized activated sludge to the free activated sludge (1.30—1.54). Considering the sludge loading and gas yield per unit of sludge by weight, it was concluded that the capacity of microbe treating organics could be fullier developed in the immobilized anaerobic sludge so that the immobilized microbes entrapped in a gel would be more suitable for the anaerobic treatment of a high strength organic wastewater.

Key words: immobilized microbes, immobilized activated sludge, immobilized anaerobic sludge, treating capacity.

Study on the Indicators for Evaluating the Activity of Immobilized Microorganism in the Degradation of Isocarbophos. Zhang Xiaohe et al. (Institute of Environmental Medicine, Tongji Medical University, Wuhan 430030): *Chin. J. Environ. Sci.*, **15**(4), 1994, pp. 53—55

The indicators for evaluating the performance of immobilized microorganism before and after the biodegradation of isocarbophos in water samples have been studied. It has been found that the levels and degradation rates of the organophosphorus pesticide in water were in highly positive correlation to COD_{Cr} and COD_{Cr} removal, respectively, so that it would be proper to choose COD_{Cr} removal as a routine indicator for evaluating the activity of immobilized microorganism in the degradation of this pesticide. What was given in this article also included the regression equations established on the basis of experimental data, and the results from their significance tests, wherein the correlative coefficients of Eqs. 1—4, Eqs. 5 and 7, Eqs. 6 and 8, and Eqs. 9—12 were 0.992, 0.940, 0.951 and 0.978, respectively.

Key words: Isocarbophos, immobilized microorganism, biodegradation, indicators for evaluating activity.

Speciation of Selenium in Soils. Lan Yeqing et al. (Dept. of Basic Courses, Nanjing University of Agriculture, Nanjing 210014): *Chin. J. Environ. Sci.*, **15**(4), 1994, pp. 56—58

The distribution of natural and applied selenium (Se) species in three kinds of soil, i.e., tide-saline soil (C), gray tide-soil (G) and yellow brown soil (Y), in Jiangsu province was studied. The results show that the naturally occurred Se species were mainly distributed as residual species (F_5), and F_5 in each of the three kinds of soil accounted for about 80% of total Se species. After an incubation for 4 months, the applied Se species were relatively homogeneous to be distributed as soluble species (F_1) (except in Y), exchangeable species (F_2), aqueous ammonia extractable species (F_3) and residual species (F_5). With two different treatments, the distribution of Se species was found to be in some relation to soil pH value, glutinous grains and free iron oxide levels. The soil pH value was in such an order as $C \doteq G > Y$; the levels of glutinous grain and free iron oxides: $Y > C > G$; the percentage levels of F_1 and F_2: $C = G > Y$; and the percentage levels of F_3 and F_5: $Y > C > G$.

Key words: selenium (Se), soil, species.

Preliminary Analysis of Design Flow for Allowable Discharge Capacity of Rivers. Zheng Yingming (Institute of Environ. and Water Conservancy, Hehai University, Nanjing 210024): *Chin. J. Environ. Sci.*, **15**(4), 1994, pp. 59—61