

废水中起始惰性溶解有机物的测定^{*}

于静洁 顾国维 张志峰

(同济大学污染控制与资源化研究国家重点实验室,上海 200092)

摘要 介绍了4种测定起始惰性溶解有机物的方法,即 Ekama 和国际水质协会提出的两种直接测定法和排除溶解性残留物干扰的两种间接测定法。通过分析比较,指出了4种方法的优缺点及适用情况。其中直接测定法适用于有机物浓度较低的生活污水,间接测定法适用于有机物浓度较高的工业废水。

关键词 废水 起始惰性溶解有机物 排放标准

为了确定有机物含量,使用最为广泛的集合参数之一是 COD。尽管与其他参数相比,COD 可以提供基质、生物量和耗氧量之间的电子和能量平衡,但是它不能区分可生物降解有机物和惰性有机物。

废水包含的有机物种类很多,以生物降解性为基础可分为^[1]: 惰性溶解有机物(S_I),指小分子不易降解的有机物,可以无变化地流经生物处理系统;

惰性悬浮有机物(X_I),指高分子量、胶体状和颗粒状有机物,不易在系统内降解,可以被活性污泥捕捉,并随剩余污泥排出系统; 易生物降解有机物(S_S),指由简单的有机分子和小分子量的碳水化合物组成,能通过细胞膜,可被微生物快速代谢掉; 慢速生物降解有机物(X_S),指高分子量、胶体状和颗粒状有机物,需先水解成易生物降解物质,而后才能被微生物利用。由此可见,污水处理系统进水中的惰性溶解有机物(即起始惰性溶解有机物 S_0)的含量对出水水质的影响很大,对于高浓度工业废水尤其如此。因此,本文重点介绍了几种测定废水中起始惰性溶解有机物的方法。

1 S_0 的测定方法

1.1 直接测定

根据定义,惰性溶解有机物不参与生化过程,且不被活性污泥吸附,由此认为活性污泥系统长时间处理后,出水中所包含的惰性溶解有机物即等于起始惰性溶解性组分 S_0 。

方法一 Ekama 等^[2]于 1984 年提出假设,认为 S_0 等于一个细胞平均停留时间(MCRT)大于 3 d 的活性污泥系统出水真溶 COD 值。并于 1986 年提出使用泥龄大于 5 d 的连续流完全混合反应器确定起始惰性溶解有机物浓度。即:维持反应器污泥龄、

MLVSS 恒定,使反应器进水 COD 浓度维持在较低水平,且要保证每日进水流速、进水 COD 浓度恒定不变,则认为该反应器出水经 0.45 μm 滤膜过滤后的 COD 值等于起始惰性溶解有机物 S_0 ^[3]。

方法二 国际水质协会(IAWQ)提出了另一种测定方法:从泥龄超过 10 d、连续进水的完全混合反应器中提取混合液,对其进行间歇曝气,对间歇处理的水样进行周期性的取样分析,当 COD 值恒定不变时,就认为该 COD 值为起始惰性溶解有机物浓度 S_0 。

1.2 间接测定

方法三 前面两种方法都是基于起始惰性溶解有机物等于出水惰性溶解有机物这样一个假设。某些文献^[4,5]中已提出了确实的证据,表明生物反应器出水溶解有机物的主要成分不是起始惰性溶解有机物,而是溶解性残留物(即溶解性微生物代谢产物)。溶解性残留物的性质也已确定,实验表明它们是可以生物降解的,但是比进水有机物降解的速率要低,这类物质是活性污泥实际操作过程中正常水力停留时间或污泥停留时间范围内的残留物^[6]。某些研究者提出的模型认为^[7],慢速生物降解有机物大部分水解,产生易生物降解物质 S_S ,而剩余部分则是溶解性残留物 S_R 。综上可知,在间歇系统中,当易生物降解物质 S_S 耗尽时,COD 值达到最小,这时剩余的基质是由 S_R 和 S_0 组成。溶解性残留物以下面的速率公式表达:

$$\frac{dS_R}{dt} = K_H \frac{X_S/X_A}{K_X + X_S/X_A} X_A \quad (1)$$

式中: S_R 为溶解性残留物; t 代表时间;为化学计量系数; X_S 为慢速生物降解有机物; X_A 为活性生物量; K_H 、 K_X 为速率常数。

第一作者:于静洁,女,1978 年生,博士研究生,主要从事水污染控制与资源化方面的研究。

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对式(1)进行简化,写成如下形式:

$$\frac{dS_R}{dt} = K X_A \quad (2)$$

式中: $K = K_H \frac{X_S/X_A}{K_X + X_S/X_A} X_A$, 则

$$S_R = K X_A t \quad (3)$$

式(3)中假定, t 期间 X_A 是常数。因此,为了精确计算,积分间隔 t 要取的很短, X_A 不是常数而带来的误差由 Y_{obs} 补偿。

$$X_A = X_{A0} + Y_{obs} (S_{S0} - S_S) \quad (4)$$

式中: X_{A0} 为实验初始时的活性生物量; Y_{obs} 为表观产率; S_{S0} 为反应初始时易生物降解有机物浓度; S_S 反应后易生物降解有机物浓度。

将式(4)代入式(3)得

$$S_R = K X_{A0} t + K t Y_{obs} (S_{S0} - S_S) \quad (5)$$

反应终点时 $S_S = 0$, COD 达到最小,则有

$$S_{RT} - m S_{S0} + n \quad (6)$$

式中: S_{RT} 为反应终点时的溶解性残留物浓度; $m = K t Y_{obs}$; $n = K t X_{A0}$ 。

式(6)表明, S_{RT} 和 S_{S0} 之间是线性关系。若在实验开始时接种很少量的活性污泥, n 可以近似认为是 0,在这种情况下反应终点时有:

$$S_{IT} = S_{RT} + S_{I0} = m S_{S0} + S_{I0} \quad (7)$$

式中 S_{IT} 为反应终点时总的惰性溶解有机物浓度。

在控制实验条件的情况下(接种很少量的活性污泥,维持活性生物量质量浓度为 10 mg/L),改变起始易生物降解有机物浓度 S_{S0} 进行一系列实验,可以得到 S_{IT} 和 S_{S0} 的线性关系式,公式中截距可以指示起始惰性溶解有机物浓度^[8]。需要指出的是,在进行的一系列实验中,改变 S_{S0} 的同时还要保证反应器进水 S_{I0} 不变,这可以通过引入起始惰性溶解有机物浓度为零的物质来实现,如可在待测废水中加入葡萄糖以获得几个不同的起始易生物降解有机物浓度。此外,该方法在反应开始时只能接种很少量的活性污泥,在实验过程中还要保持活性污泥浓度恒定,所以要定期排出一定数量的混合液。

方法四 平行运行两个起始溶解性有机物浓度相同的间歇反应器,一个处理废水,另一个处理葡萄糖溶液。反应终点时待测废水的最小溶解性有机物浓度等于 $S_{I0} + S_{RT}$,而处理葡萄糖溶液的反应器内最小溶解性有机物浓度等于 S_{RT} ,同时可认为 $(S_{RT})_{\text{废水}} = (S_{RT})_{\text{葡萄糖}}$,所以可以根据式(8)来确定起始惰性溶解有机物^[8]。

$$(S_{I0})_{\text{废水}} = (S_{I0} + S_{RT})_{\text{废水}} - (S_{RT})_{\text{葡萄糖}} \quad (8)$$

2 四种方法的比较

方法一、二忽略了溶解性残留物的影响,认为出水溶解性 COD 值等于起始惰性溶解有机物,从而导致 S_{I0} 测得值偏高。生活污水有机物浓度相对较低,溶解性残留物的干扰可以接受,但是对于成分复杂的工业废水,尤其是高浓度有机废水,溶解性残留物的干扰不可忽视。

方法三主要适用于起始惰性溶解有机物浓度较低的情况。但是由于该方法中至少包含 3~4 个不同的 S_{S0} 设定值,并且在实验过程中要阶段性地排出混合液以维持污泥浓度恒定,所以该方法难于实施。

方法四仅需两个平行装置,易于操作,但是实验中需要培养、接种适应污水和葡萄糖两种不同基质的活性污泥。

3 结 论

废水中有机物种类繁多、成分复杂,按照其生物降解性可以分为惰性溶解有机物、惰性悬浮有机物、易生物降解有机物和慢速生物降解有机物,其中起始惰性溶解有机物的含量影响污水处理效果。本文介绍四种测定起始惰性溶解有机物的方法。方法一、方法二忽略了处理水中溶解性残留物的影响,从而导致测得的 S_{I0} 偏高。方法三操作复杂,主要适于测定起始惰性溶解有机物含量较低的废水。方法四操作简便,但要注意培养、接种适用于处理不同基质的活性污泥。

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by GC-MC. It was shown that the major composition of the wastewater have no change after ozonation, which are biorefractory organics. Most of the materials, vanished, reduced or generated during ozonation, were proved as biodegradable organics.

Key words :Leachate

Biodegradability

Ozonation

Property comparison between lime and limestone as two SO₂ absorbent

Chen Lianfang Xu Xiren

(School of Energy and Power Engineering, Shandong University, Jinan Shandong 250061)

Lime and limestone are the most common wet SO₂ absorbent. Their property comparison is made in several aspects, such as reaction mechanism, control standard, liquid/gas ratio, chemical excessive ratio and so on. They are different in desulfurization mechanism and control standards. Reaction temperature has incoordinately influence on both systems. The liquid/gas ratio and chemical excessive ratio of limestone system are 10 and 1.25 ~ 1.60. The liquid/gas ratio and chemical excessive ratio of limestone system are 5.6 and 1.05 ~ 1.15 otherwise. The desulfurization efficiency of lime is better than that of limestone.

Key words :Lime Limestone

Property comparison

Wet desulfurization absorbent

Comparison of two methods for determination of total nitrogen in aqua-plants

Jing Lijie^{1,2} Yuan Donghai¹ Wang Xiaodong¹
Wang Liansheng¹

(1. State Key Laboratory of Pollution Control and Resource Reuse, School of Environment, Nanjing University, Nanjing Jiangsu 210093; 2. Department of Environmental Science and Engineering, Jilin Institute of Chemical Technology, Changchun Jilin 132022)

The Aqua-plants play important roles in constructed wetland for sewage treatment. The review of total nitrogen and total phosphorus in the plants is a major index of sewage purification efficiency by constructed wetland. The total nitrogen (TN) in plant samples on constructed wetland was determined by the Kjeldahl with H₂SO₄-K₂SO₄+CuSO₄+Se and H₂SO₄-H₂O₂ digested method, respectively. The advantages and shortcomings of these methods were evaluated, and

SPSS was applied to analyze the testing data. The results showed that there was significant difference between the kjeldahl and H₂SO₄-H₂O₂ digested method. The suitable determination method should be selected to base demand of further research works.

Key words :Total nitrogen

Aqua-plants

Kjeldahl

H₂SO₄-H₂O₂

Digested method

Statistical package for the social science

Measurement of the initial soluble inert organic matter in wastewater

Yu Jingjie Gu Guowei Zhang Zhifeng

(State Key Laboratory of Pollution Control and Resource Reuse, Tongji University, Shanghai 200092)

Four methods are presented to measure the soluble inert organic matter in the influent wastewater. Some are direct measurements which are offered by Ekama and IAWQ, the others are indirect measurements which exclude the interference of soluble residua, meanwhile the advantages and disadvantages of each method are presented. Direct measurements can be used to municipal wastewater, however indirect measurements can be used to strong industrial wastewater.

Key words :Wastewater

Initial soluble

Inert organic matter

Effluent limitation criteria

Study on volatility and treatment strategy of 2,4-dichlorophenol solution

Pan Haidong Zhong Dengjie Wang Yalin Jia Jinping

(School of Environmental Science and Engineering, Shanghai Jiaotong University, Shanghai 200240)

Some factors such as temperature, pH value and aeration, which could affect the volatility of 2,4-dichlorophenol (2,4-DCP), were investigated. The volatility of 2,4-DCP could be enhanced with higher temperature, lower pH value and large amount of aeration. The low treatment efficiency by direct-electrolysis was unacceptable. So some important viewpoints and treatment countermeasures were mentioned and raised according to its character.

Key words :2,4-DCP

Volatility

Countermeasure