三种厌氧促进剂对亚铵废液厌氧发酵的影响

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摘要　根据亚铵法草浆蒸煮废液的间歇式厌氧发酵试验结果，分析了活性炭、硫酸亚铁和膨润土对亚胺废液厌氧发酵的影响。结果表明，当投量为 2.5 g/L 时，3 种厌氧促进剂都能显著地促进亚铵废液的厌氧发酵；与对照试组相比，可将厌氧系统的 30 d 累积产气量分别提高 16.1%、13.9%和 26.1%。本研究还初步探讨了这 3 种厌氧促进剂的作用机理。

关键词　厌氧促进剂，亚铵法草浆蒸煮废液，厌氧发酵，作用机理。

亚铵法草浆蒸煮废液（以下简称亚铵废液）是一种高浓度有机废水，含有木素磺酸盐等难降解物质和亚硫酸盐等厌氧抑制剂。为了了解厌氧促进剂对亚铵液厌氧发酵的影响，探索采用强化的厌氧生物法处理亚铵废液的潜力，本研究以活性炭、硫酸亚铁和膨润土为厌氧促进剂，进行了亚铵废液的间歇式氧发酵试验。

1　亚铵废液的水质

本研究试验用的亚铵废液取自咸阳市洋东造纸厂，该厂以麦草为纤维原料，以亚硫酸铵和氨水为蒸煮药剂，其蒸煮废液的水质状况见表 1。

表 1　亚铵废液的水质状况

pH	COD (mg/L)	BOD_5 (mg/L)	NH_3-N (mg/L)	SO_3^{2-} (mg/L)	SS (mg/L)
6.92	78400	15310	2027	1586	11700

2　试验概况

2.1　试验原理

某物质对厌氧发酵系统的影响，实质上就是它对微生物系统生化活性的影响。有机物在厌氧发酵过程中经历几个微生物种群的接替转化阶段，最终形成生物气。因此，以生物气产量（以下简称产气量）作为反映厌氧微生物活性的指标，最为直观和实用[1]。本研究选用产气量作为判定厌氧微生物活性的指标。这样，产气量的大小就指示着厌氧微生物活性的强弱和厌氧发酵过程效率的高低。

2.2　试验装置

本试验采用一次投料的间歇运行方式，速度快，费用低，便于实现多试组的同时运行[2]；此外，它可反映厌氧促进剂影响的历时变化规律。

试验装置由发酵瓶、量气系统和恒温系统 3 部分组成。发酵瓶容积为 500 ml，内装 400 ml 发酵液。量气系统由导气管、三通管、放空阀、量气管和平衡杯组成。试验装置示意图见图 1。

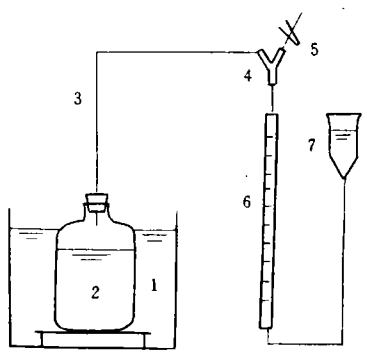

图 1　试验装置示意图

1. 恒温水浴槽　2. 发酵瓶　3. 导气管
4. 三通管　5. 放空阀　6. 量气管　7. 平衡杯

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2.3 试验系列安排

厌氧污泥取自西安污水厌氧消化池，去除粗大杂质后，测得SS为60.9 g/L，VSS为32.5 g/L。

厌氧促进剂选用活性炭、硫酸亚铁和膨润土。活性炭：太原新华化工厂生产的粉末状活性炭(200目筛下)；硫酸亚铁：分析纯$FeSO_4 \cdot 7H_2O$；膨润土：辽宁黑山产的粉末状膨润土(200目筛下)。

根据试验的目的、厌氧污泥的浓度和亚铵废液的水质安排试验系列，见表2。

表2 试验系列安排[1)]

试验组号	蔗糖溶液(ml)	亚铵废液(ml)	污泥(ml)	稀释水(ml)	促进剂(名称)
1	10	0	200	190	
2	10	90	200	100	
3	10	90	200	100	活性炭
4	10	90	200	100	硫酸亚铁
5	10	90	200	100	膨润土

1) 蔗糖溶液浓度为100 g/L；3种厌氧促进剂投量均为1 g/L

2.4 试验步骤

按照表2的试验系列安排填装各发酵瓶，摇匀后置于36±1℃的恒温水浴槽中，等瓶中混合物温度恒定后，连接量气系统开始测定产气量。产气量测定频率依发酵系统产气速率而定。试验初期，每日测量10—12次；试验末期，2—3 d测量1次即可。试验期间，每日摇动发酵瓶2次。试验持续30 d。

3 试验结果与分析

3.1 累积产气量的历时变化

整理试验数据，绘出累积产气量随时间的变化曲线(图2)。

3.2 亚铵废液的主要抑制因素

比较图2中的曲线1和曲线2，可以得到以下结论：(1) 亚铵废液在一定程度上可被厌氧微生物降解；(2) 亚铵废液在试组2的浓度水平下对厌氧微生物具有一定程度的抑制性。

从图2还可看出，在试验的第1 d，含亚铵废液的4个试组受抑制的程度均较低；从第2 d开始，它们受抑制的程度明显提高；在第2—10 d的抑制阶段，活性炭缓解抑制的效果最好。由此可以推断，这一阶段的主要抑制因素不是硫化物，否则，投加硫酸亚铁的试组4应有很好的缓解效果[3]，因为亚铁盐可以控制发酵液中硫化物浓度。本研究认为，此阶段的主要抑制因素是挥发性脂肪酸，因为厌氧微生物在接触一个新的环境(此处为亚铵废液)时，产甲烷菌对环境的变化更为敏感，当其活性不及产酸菌时，就会引起挥发性脂肪酸的积累，形成酸抑制。这里，产甲烷菌和产酸菌之间平衡关系的失调，可能是由污泥负荷的突然提高引起[4]。

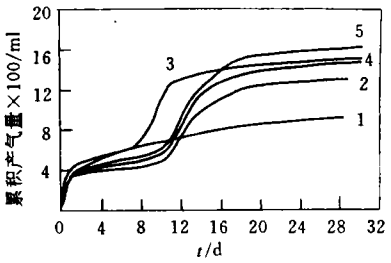

图2 累积产气量的历时变化曲线

图中编号同表2

4 小结

(1) 活性炭、硫酸亚铁和膨润土对亚铵废液的厌氧发酵均有显著的促进影响；与对照试组相比，它们将厌氧系统的30 d累积产气量分别提高了16.1%、13.9%和26.1%。按照这一指标进行评价，3者的促进影响强弱顺序是：膨润土>活性炭>硫酸亚铁。

(2) 3者的促进影响强度历时变化规律有所不同。活性炭、膨润土和硫酸亚铁的初期影响强度依次减弱，而膨润土的影响持续时间最长。

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tration increased; and the toxicity (EC_{50}, 96 h.) of rare-earth elements on *Chlorella pyrenoides* was insequence as: Nd > Ce > Pr > La > mixture of them, but little difference.

Key words: rare-earth element, *Chlorella pyrenoides*, effect on growth and reproduction.

Study on in-Bed Desulfurization within Fluidized Bed Coal Gasifier. Bu Xuepeng et al. (Beijing Research Institute of Coal Chemistry, Central Coal Mining Research Institute, Beijing 100013): *Chin. J. Environ. Sci.*, **17** (2), 1996, pp. 39—41

The data obtained from the tests indicated that both limestone and dolomite can be used effectively for capturing sulfur during the gasification of high sulfur coals. Desulfurization efficiencies can be improved with increasing the Ca/S molar ratio, the efficiencies were maximum when the ratio was 3, or by increasing total sulfur in raw coals. The effect of operating pressure on desulfurization efficiency is determined by temperature and partial pressure of carbon dioxide. The desulfurization rate was range of 50% —85% under different conditions.

Key words: fluidized bed gasification, in-bed desulfurization, desulfurizaiton sorbent.

Mass Transfer-Reaction Process Mechanism of Wet Flue Gas Desulfurization with Lime. Wu Zhongbiao and Tan Tian'en (Dept. of Chem. Eng., Zhejiang University, Hangzhou 310027): *Chin. J. Environ. Sci.*, **17** (2), 1996, pp. 42—44

By studying experimentally wet flue gas desulfurization with lime as absorbent and rotating-stream-tray scrubber as absorber, the mass transfer and reaction process on $Ca(OH)_2$ slurry absorbing SO_2 is analyzed. Furthermore, the process mechanism is proposed. According to the mechanism, the total reaction rate is controlled by SO_2 diffusion in gas phase and $Ca(OH)_2$ dissolution and diffusion in liquid phase. The reaction process can be divided into three stages, the stage controlled by gas phase resistance, by gas phase and liquid phase resistance, and by liquid phase resistance. The process mechanism has been verified by the experiment. These results will help to optimize the design and operation of the industrial installation of wet flue gas desulfurization with lime.

Key words: flue gas desulfurization, mechanism, mass transfer-reaction process, lime, wet.

Effects of Three Sorts of Anaerobic Promoter on Anaerobic Digestion of the Waste Liquor from Ammonium Sulfite Pulping of Straws. Zhang Renquan (Dept. of Resource and Environ. Sci., Hefei Univ. of Technol., Hefei 230009): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 45—46

The effects of activated carbon, ferrous sulphate and bentonite on anaerobic digestion of the waste liquor from ammonium sulfite pulping of straws have been analysed on the basis of the experimental results of anaerobic batch assays with the waste liquor. The results indicate that, with a dose of 2.5 g/L, each sort of the anaerobic promoter can substantially promote anaerobic digestion of the waste liquor, which can increase 30 day total gas production of the anaerobic system by 16.1%, 13.9% and 26.1% respectively compared with the control. The action mechanisms of the three sorts of anaerobic promoter have been discussed preliminarily.

Key words: anaerobic promoter, waste liquor from ammonium sulfite pulping of straws, anaerobic digestion, action mechanisms.

Using *Hydra* Reaggregations Evaluating the Safety of Two Kinds of Food Additives. Cheng Qinyao et al. (Dept. of Biology, Anhui University, Hefei 230039): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 47—48

This paper studied the safety of two kinds of food additives using *Hydra* reaggregations. The results showed that both sodium benzoate and sodium nitrite inhibited the growth of reaggregations. The minimum effective concentrations were 34.7×10^{-4} mol/L and 2.9×10^{-3} mol/L respectively. In addition, the negative correlation existed between the depolymerization time of the reaggregations and the concentration of food additives. Therefore, *Hydra* reaggregations technique will be a rapid screening method for predicting the potential toxicity of food additives.

Key words: *Hydra* reaggregation, food additive, evaluation safety, rapid screening.

A Study on Long-wave Pulsed Electromagnetic Fields Around A Long Range Navigation Station. Yao Gengdong et al. (School of Public Health, Zhejiang Medical University, Hangzhou 310031): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 49—50

A measurement and a theoretical calculation of long-wave pulsed electromagnetic fields (PEMF) around the antenna of the first long range navigation station in China were conducted. The results showed that the electric field intensities were 0.5—3.6 V/m (RMS) corresponding to peak values of 38.5—276.9 V/m in the PEMF generating room; in the residential area which is 850—1100 m away from the antenna, the electric fields were 0.7—3.9 V/m corresponding to peak values of 53.9—300.3 V/m; the PEMF decreased in environment with the distance away from the antenna and when the distance is over 1200 m from it, the fields tended towards minimum.

Key words: pulse, long-wave, environment, electric field intensity.

Determination of Hydraulic Load Cycle in Rapid Infiltration Treatment System of Waste Water. Wu Yongfeng et al. (Dept. of Environ. Sci., China University of Geosciences, Beijing, 100083): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 51—53

Hydraulic load cycle is the most important operation parameter in rapid infiltration treatment system of waste water. The decrease curve and recovery curve of infiltration rate in flooding and drying periods are obtained from the in situ test with the area of 80 m^2 and flooded with brewery waste water. The curves can be expressed with exponential and logarithmic equations respectively. A quantitative method is proposed to determine the hydraulic load cycle with maximum hydraulic load. The calculated result is 1.78 days flooding and 2.77 days drying, very similar with the test results.

Key words: rapid infiltration, hydraulic load, hydraulic load cycle, infiltration rate.

A New Way to Accelerate the Start-up of UASB Reac-