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# Study Progress of Biodegradability

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***Abstract: -*** *Biodegradability , are known as biological degradation degree of biodegradable organic pollutants by microorganisms. Organic biodegradability can be divided into aerobic biodegradability and anaerobic biodegradability. At present, evaluation methods for biological degradation degree include aerobic biodegradability method of relative oxygen consumption or rate method, integrated test evaluation method and water quality index evaluation; evaluation anaerobic biodegradability include CH4 gas production method, CO2 gas production method, gas production method and COD synthesis method. In this paper the aerobic biodegradability and anaerobic biodegradability evaluation method are commended, and appraise biodegradability methods for next research.*

***Keywords:*** *- biological degradation degree; aerobic evaluation biodegradability method ; anaerobic biodegradability evaluation method*

## I. INTRODUCTION

The biodegradability of organic compounds determines the processing method and degradation rate and degree of a kind of organic compounds[1]. In the 70s, some foreign scholars had studied about biodegradability of wastewater. Usually because of different reaction condition, the ingredient of microorganism, enzyme system, the degradation pathway of organic compounds are different, and degradation pathway were divided into aerobic and anaerobic pathway. So biodegradability of organic compounds was divided into aerobic and anaerobic biodegradability, and there are differences in these two kinds of biodegradability. At present, evaluation methods for biological degradation degree include aerobic biodegradability method of relative oxygen consumption or rate method, integrated test evaluation method and water quality index evaluation method; evaluation anaerobic biodegradability include CH4 gas production method, CO2 gas production method, gas production method and COD synthesis method.

## II. RESEARCH STATUS AT HOME AND ABROAD

### 2.1 The evaluation method of aerobic biodegradability

#### 2.1.1 Relative oxygen consumption or rate method

Because the biological treatment unit was often damaged by special inflow and toxicant, so Fuxia Chen et al [2]propose the method can evaluate biodegradability quickly, the index of this method is relative oxygen consumption.

A certain amount of wastewater and activated sludge was added to determination of oxygen bottles, the content of dissolved oxygen was measured by dissolved oxygen meter, and the microorganism oxygen consumption rate of wastewater can be measured in accordance with reaction time and the concentration of sludge mixed liquor. The ratio of oxygen consumption rate of sludge in different concentration wastewater and oxygen consumption rate of sludge endogenous respiration was defined as relative oxygen consumption rate. If the relative oxygen consumption rate of wastewater more than 1, then it show that the organic compounds in this wastewater can be degraded by microorganism. If the relative oxygen consumption rate of wastewater was 1, then it show that the organic compounds in this wastewater can not be degraded by microorganism, and the organic compounds had no poisoning effect and inhibition. If the elative oxygen consumption rate of wastewater less than 1, then it show that the organic compounds in this wastewater can not be degraded by microorganism, and the organic compounds had poisoning effect and inhibition. But both oxygen consumption rate and relative oxygen consumption rate were of high sensitivity, and varied with operating condition and parameters, such as pH, temperature, the concentration of sludge, the concentration of dissolved oxygen and so on.

The domestic scholars Xin Li et al[3] invented a kind of biodegradability evaluation method for industrial wastewater, they evaluated biodegradability by relative oxygen consumption, Wastewater biochemical oxygen consumption and microorganism endogenous breathing oxygen consumption were measured by dissolved oxygen meter. The rate of Wastewater biochemical oxygen consumption and microorganism endogenous breathing oxygen consumption was defined as relative oxygen consumption. If relative oxygen consumption of water sample more than 1, then it show that the organic pollutant in wastewater han no poisoning effect and inhibition, the higher the relative oxygen consumption that wastewater biodegradability the

better. If relative oxygen consumption of water sample less than 1, then it show that the organic pollutant in wastewater han poisoning effect and inhibition, the smaller the relative oxygen consumption that poisoning effect and inhibition the stronger, biodegradability can be worse. This method was convenient and quick, we got results after 30~60min. But when we determining oxygen consumption, operating conditions and process parameters were controled strictly, and repeatability was bad.

Foreign scholars C Norr et al[4] studied on a kind of biodegradability evaluation method, this method evaluated biodegradability by relative oxygen consumption, the results show that this method was efficient and feasible.

**2.1.2 Static flask shaker evaluation method**

The domestic scholars Jie Wu et al[5] studied on Static flask shaker evaluation method that evaluated biodegradability of organic compounds. They used a certain amount of precipitated domestic sewage as inoculum, added yeast extract and BOD5 dilution water of organic compounds into it, and prepared a certain concentration of organic compounds. Static culture under room temperature, after a week, they taken tenth of culture solution as next week′s inoculum, and added fresh culture solution to original volume, repeated for four weeks, and concentration and CODcr were determinated when one week start and end, degradation rate was measured. Meanwhile, because phenol was easily biodegradable under low concentration condition, so they used phenol as reference. This method easy and simple to handle, and repeatability was good. But the organic compounds and inoculum can not mixed completely, it would affect oxygennate, esperiment time would become longer, so this method was not unfit for special condition that the amount or variety of organic compounds changed suddenly.

**2.1.3 water quality index evaluation method**

The domestic scholars Qingqiong Hu et al[6] evaluated the biodegradability of three kinds of water samples by water quality index evaluation method, water samples were standard biochemical oxygen demand sample, native surface water, native typical industrial sewage. water quality index evaluation method was BOD5/CODcr method, they taken many samples of each type, BOD5 was measured by dilution and vaccination method(HJ505-2009), CODcr was measued by GB/T11914-89. If BOD5/CODcr more than 0.30, then it show that pollutant in watre can be degraded. If BOD5/CODcr less than 0.30, then it show that pollutant in watre can not be degraded. Actual evaluation was consistent with empirical data and local environment. This method was simple and accurate. But period was long, experiment condition was controled strictly, otherwise the experiment was inaccurate, BOD5/CODcr only indicated the ratio of the amount of biodegradable organic compounds and the amount of total organic compounds, and can not indicated the poisoning and inhibition for microorganism.

Domestic scholars Qi Han et al[7] evaluated biodegradability of wastewater by BOD5/TOD, organic compounds were divided three types based on BOD5/TOD. BOD5/TOD more than 0.4, it was easily degradation, such as glucose, starch and so on. BOD5/TOD between 0.2~0.4, it was medium degradation, such as acid crotonaldehyde. BOD5/TOD less than 0.2, it was less degradation, such as quadrol, benzene and so on. This method was more accurate than BOD5/CODcr, and BOD5/CODcr can not indicated the poisoning and inhibition for microorganism. BOD5/TOD method not only judge the biodegradation degree, but also know the degradation rate. But this method also involve the measurement of BOD5, so this method exist measurement error, and repeatability was bad. At present, someone evaluated biodegradation by BOD5/TOC.

Foreign scholars often evaluated biodegradability by BOD5/COD, such as A Hufschmid et al[8] studied on the evaluation of biodegradability by BOD5, this study show that although repeatability was bad, but this method was feasible. When some scholars study on phenol wastewater[9], they evaluate biodegradability by BOD5/COD method. When Tarek S. Jamila et al[10] study on the biodegradability of paper mill wastewater, they also used this method.

**2.1.4 Growth indicator TTC spectrophotometry**

Domestic scholars Yifeng Jiang et al[11] invented a evaluation method, they determinated the impact of organic compounds on microbial activity, thus they evaluated biodegradability. The reaction system of this method was microporous plate with 96 micropores, the active sludge after acclimation and chromogenic reagent and 2,3,5 - triphenyltetrazolium chloride triazole were added into each micropors, and then the gradient concentration of organic compounds were added into it, 30℃ constant temperature culture, absorbance of 96 micropors were measured every day. The ratio of the maximum absorbance of organic compounds and average of the absorbance was defined as relative strength index(Rsi). If Rsi more than 1, it show that organic compounds can be degraded by microorganism under this concentration condition, and the bigger the Rsi the biodegradability of organic the better. If Rsi less than 1, it show that organic compounds was difficult to degraded by microorganism under this concentration condition, and the smaller the Rsi the biodegradability of

organic the can be worse. The impact of different concentrations of single organic or mixed organic compounds on microbial activity were determinated by this method. But the time of this method was 48h, this method was not apply to special condition that the amount and type of organic compounds changed suddenly, and this method can ‘t got results fleetly, this method was complex.

**2.1.5 integrated test evaluation method**

Zhabpeng Jiang et al[12] at Tsinghua university evaluated biodegradability of organic compounds by integrated test evaluation method from four aspects, that was removal rate, oxygen consumption, the amount of final product, microbial activity. They selected three integrate evaluation factors that many-sided reflect biodegradability of organic compounds that was BOD5/COD, degradation products $CO_2$, physiological and biochemical index ATP. BOD5 and COD were measured by standard measuring method, according to measured values, IO was measured. The yield in $CO_2$ and the content of ATP were determinated by specific device, based on that, IA and IB were measured. Biodegradability was evaluated by fuzzy clustering integrated assessment method and weight estimation method. fuzzy clustering integrated assessment method based on classification and evaluation method of fuzzy mathematics, running on computer, classification and calculation were accurate, so this method removed personal error. But this method can’t subdivide the same type of organic compounds and expressed in concrete value. The weight estimation method overcomes the lack of fuzzy clustering integrated assessment method, the result of weight estimation method was more direct. But the determination of weight in this method lack rigorous theoretical basis, and errors may exist.

**2.2 The evaluation method of anaerobic biodegradability**

**2.2.1 Gas output and COD value synthetic method**

Domestic scholar Xingzhi Wu[13] assessed anaerobic biodegradation of organic material according to the change of gas output and COD value on the basis of ISO11734 method. This method used stewing flask to test. “Duplex parallel device” was used in this experiment. One was used for assaying gas output, the other to assay COD value. Reaction liquid, inorganic nutrients, microelement and inoculum were feed into reaction flask. Anaerobic condition was kept by blowing nitrogen above liquid surface. The reaction flask was placed in thermostatic water bath of 35±1℃. The reaction flasks include endogenous flask (without the inoculum) and biochemical reaction flask. Produced gas was collected by drainage method and saturated salt water was feed into Shi fermentation tube. The COD was assayed by potassium dichromate method. Test result was presented with organic anaerobic biological degradation curve by construction on the basis of the accumulative total net gas production of organic (biochemical reaction gas output minus the endogenous gas production) and net COD (COD of biochemical reaction liquid minus the COD of endogenous reaction liquid). Time was used as abscissa, net gas production and net COD were used as the ordinate. When gas production rise and COD reduced rapidly in the curve, it showed that the organic material was fragile to biodegradation. When the trend of gas production rise and COD reduced were gentle, it showed that the organic material was avirulent for organisms and nitrogen degradation was slow. When the curve has a lag period initially, then degradation was rapid, the gas production rise rapidly and COD reduce, it showed that biological toxicity was existent in early degradation period. After domestication, the organic material could be degraded, but the rate was slow. When the amount of gas production almost was close to zero or less than endogenous gas production and COD wasn’t reduced, it showed that the organic material has high biological toxicity and was refractory and even restrained endogenous breathing of sludge. A kind of organic material could be degraded in initial stage, but couldn’t be degraded after a period of time, such as aminophenol, o-nitrodiphenol and others organic material. However, gas production and COD were referred to, so measure error was existent and reproducibility wasn’t so well. The curve couldn’t show the anaerobe degradability definitely.

**2.2.2 Gas production of methane and the rate of gas production method**

Domestic scholar Xingyuan Ma[14] and other scholars proposed a method to evaluate the anaerobe degradability of tannery wastewater. Two reactors were concerned, one was a kind of a certain COD tannery wastewater that was prepared by them, the other was sodium acetate liquid that has the same COD and the sodium acetate was easily anaerobic biological degradation organic material. When this method was used for evaluating anaerobe degradability, we need to make four diagrams. The charts were the curve of anaerobic degradation time and methane production, graphs of methane-production rate, specific methanogenic activity of sludge for sodium acetate water and tannery wastewater respectively. The anaerobe degradability of tannery wastewater was evaluated by comparing the graphs. Research results showed that tannery wastewater has good anaerobe degradability on the condition of moderate temperature and appropriate COD loading. However, the operation was very complicated. So it couldn’t show the biodegradability clear intuitive.

**2.2.3 CO2 formation amount test method**

Moffaft Centro de Investigaciones Quı′[15] micas and other people put forward a method to evaluate anaerobe degradability of organic material by the CO2 cargoes method. The key points were the following items. The sampling condition of reactor in this experiment was kept by pumping nitrogen at room temperature. The magnetic stirrer was used for stirring liquid on the experiment process. This experiment concerned two reactors. One was used for describing endogenous breathing. The other was used for describing the process of microorganism. The following method was used for assaying the quantity of CO2. The Ba(OH)2 liquid was back-titration by the standard concentration hydrochloric acid in the presence of phenolphthalein. The anaerobe degradability can be evaluated by actual CO2 formation amount / theoretical CO2formation amount ratios. However, the quantity of CO2 was assayed by titration method. So titration error was existent. When this method applied to larger scale, the veracity of titration would be worse. This method was unsuited for applying to larger scale and the operation was very complicated. Moffaft Ingvild Eide-Haugmo et al[16] also made a lot of research on this method. And the results showed that this method could be used for evaluating anaerobe degradability accurately.

**2.2.4 The improvement methods on the basis of ISO 14852**

GuoWenBin[17] proposed an anaerobe degradability method through improving the ISO 14852 method. This method could evaluate anaerobe degradability fast. The main point of this method was that screening 20 kind of bacteria with strong degradability from 216 kind of bacteria by the 16 S rRNA series analysis and BIOLOG MicroLog ™ system analysis. In this method, natural medium in ISO 14852 method was replaced by the microbial community and 14 kind of biodegradable materials. The test results showed that the improved method could evaluate anaerobic biodegradation more efficiently. However, the operation of this method was complex due to bacteria with high degradability need to be screened.

## III. THE CURRENT PROBLEMS OF THE TECHNOLOGY FOR EVALUATING BIODEGRADABILITY

Weather an organic material could be treated with biological method dependeds on the biodegradability of this organic material, the speed and the degree of the microorganism degraded the organic material. This paper introduced the methods for evaluation of aerobic biodegradation. The methods contained the oxygen consumption of microorganism, velocity method, the test method of standing flask screening, the method of comprehensive test evolution, the method of water index evaluation, growth indicator TTC spectrophotometer; the methods of evaluation of anaerobic biodegradability contains the method of CH4 gas production, the method of CO2 gas production, the gas production, the comprehensive method of COD value and the improved method based on ISO 14852. Defects were existent in the aerobic biodegradation and the anaerobic biodegradability. Because the methods needed strict operation, the evaluation cost much time, reproducibility wasn't so well. So, the research direction for the evaluation of biodegradability is developing a convenient, quick and high reproducibility evaluation method.

## IV. Acknowledge

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