The biological quantitative reduction experimental research on aerobic excess sludge in papermaking wastewater

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Abstract—**This paper research aerobic excess sludge come from A / O process in sewage treatment plant of a paper mill in Shandong, china. The content of TCOD, SCOD, TSS, VSS, PO_4^{3-}-P and $NH4^+$-N in this sludge is studied ,while, the feasibility that aerobic excess sludge and papermaking wastewater in the same time. The results showed that the theoretical gas production is $1.2m^3$/VSS.kg in mesophilic digestion;The release of PO_4^{3-}-P and NH_4^+-N achieve the best emissions in pH 7.0 ~ 8.0. Within 20 days of continuous experiment, the release of PO_4^{3-}-P and $NH4^+$-N comes from aerobic excess sludge is 1.5mg/ L and 5.0mg/ L, respectively. The SCOD increase 50-100 mg /L, in this process. The treatment efficiency of papermaking wastewater is not greater impacted. The release of PO_4^{3-}-P and NH_4^+-N in this process can replace the added urea and phosphate in water treatment water treatment.**

Keywords— **Papermaking wastewater, anaerobic sludge, quantitative reduction**

INTRODUCTION

The treatment of waste paper making Wastewater generally has a large number of high moisture content of sludge, which must be off as much as possible before final disposal to enhance the solid, in order to further be treated. After treated by physico-chemical, biological and chemical methods, more than 90% suspended solids became sludge [1]. Because aerobic sludge containing a large number of biodegradable ingredients, so when treat the aerobic sludge and wastewater at the same time they can reduce of sludge, Therefore, this method, which can deal with these sludge, benefit for the enterprises and social. It has a certain significance study.

Since the 80's, more and more foreign country had to study the stage of hydrolysis in anaerobic digestion [2]. Most of them generate VFA by fermented and hydrolyzed the primary sedimentation sludge which come from Sewage Treatment Plant, others study the sludge mixed by primary sludge and excess sludge [3-5]. The majority of domestic research the acid hydrolysis of high concentration wastewater.There is little study about the sludge comes from municipal wastewater, directed at the treatment plant less acidogenic study [6], not to mention the sludge comes from papermaking.

The pH is one of important parameters in the anaerobic fermentation . Many researchers found that the sludge after the alkali treatment or the adjusted the pH over 8.0 can increase the hydrolysis rate of sludge. Vlyssides [7] found that the sludge, after l0 h treat, when pH adjusted to 11.0, and temperature is 90 ℃, the solubility COD (soluble chemical oxygen demand, SCOD) reached 70000 mg/L. Which is more than 90% of the total COD (total chemical oxgen demand, TCOD) .This paper mainly study the law of SCOD、V FA、PO_4^{3-}-P and NH_4^+-N, when anaerobic ferment the excess sludge. in 36 ~ 38 ℃ pH of 4.0 ~ 11.0.

METHOD OF TEST AND ANALYSIS

test device and operation

DF-2 type constant agitator and TF-1 A-type biochemical incubator are used in the study. A 0.5L cone-shaped bottle with hose was place in the which the test device, Temperature 36 ~ 38 ℃, which simulation anaerobic reactor (ANAMET) used in the factory. Turn speed on 60 ~ 70 r/min, in order to mixed evenly, not to have a whirlpool. Anaerobic reaction is 15 d, 2

mol / L NaOH or 2 mol / L HCl are used to adjust pH. During the stagere gulate pH per 12 hours, keeping pH in the range of between 0 ~ 0.3.

2 .2 The sources and characteristics of aerobic excess sludge

The characteristics of excess sludge come from middle part waterworks in a paper mill. in Table 1.

TABLE 1 CHARACTERISTICS OF THE EXCESS ACTIVATED SLUDGE/MG Ŀ

project	average	standard deviation
pH	7.32	0.2
TSS	9580	621
VSS	6969	121
SCOD	285	18
TCOD	10566	585
BOD_5	4115	410
PO_4^{3-}-P	0.38	0.3
NH_4^+-N	4.5	1.2

Determination method

The pH, TSS (total suspended solids), VSS (volatile suspended solids), SCOD, TCOD, BOD_5, PO_4^{3-}-P, NH_4^+-N, according to the latest compilation of environmental standards in China. VFA (volatile fatty acid) is exterminated by Acid-base titration.

The calculation of oretical gas production

The gas made by fermented Sludge is methane, which major components of CH_4 and CO_2. Under normal circumstances, other gases (such as N_2, H_2, H_2S, O_2) very little content, which may be negligible. Assumed that in the sludge digestion process, all the loss carbon transformed CH_4 and CO_2, according to carbons′ material conservation and Moshi curve,in order to find that under the conditions of mesophilic digestion ,the relationship between organic content and decomposition rate,which can calculation of oretical gas production.

The density of CH_4 and CO_2 gas are 0. 7168 g/L and gas 1.9769 g /L, respectively ,while the carbon content in them are 0. 5367 g/L、0. 5395 g /L, respectively . The gas is making up of 75% CH_4 and 25% CO_2. According to this, the gas came from TOC which can be decomposed in can produce 1. 861 L/g. The organic compounds in this sludge is 72.75% and

decomposing rate is 71.0%,the TOC in VSS is 55%.So that the gas comes from this experimental is 5.0 m^3 / m^3 ·VSS..

RESULTS

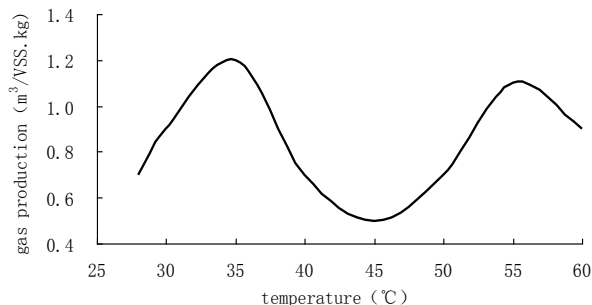*The impact of temperature to gas production*

Figure 1 Correlation between temperature and gas production

From Figure 1, methane production in a wave band changes with temperature. There is a largest gas production 1.2 m^3/VSS.kg, in the mesophilic digestion. With increasing temperature, is declining, there is smallest value in 45 ℃.When the temperature continues to rise, in 55 ℃ gas production is the same as that in 45 ℃ .The anaerobic reactor (ANAMET)in paper mill has a better effect in 34~36℃，so that the temperature in this experiment is sat in 34~36℃.
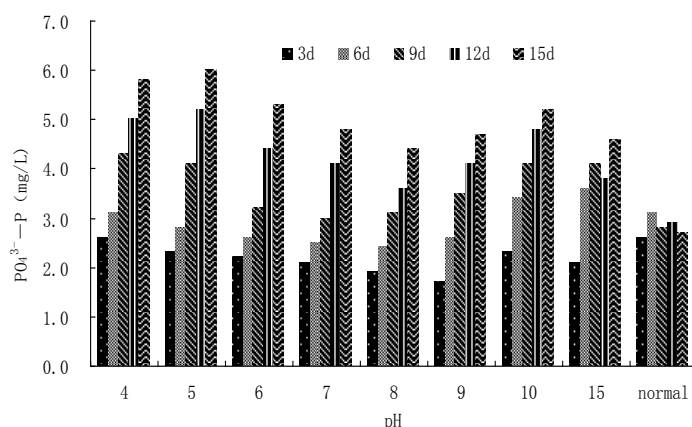
The impact of pH to PO_4^{3-}-P

Fig. 2 Changes of PO_4^{3-}-P at different pH (within 15d)

From Figure 2, we can find that under acidic conditions, the PO_4^{3-}-P is slightly higher than alkaline. In near neutral conditions (pH = 7.0 and pH = 8.0), the PO_4^{3-}-P concentrations

have a minimum, which is same as in the normal conditions. The PO_4^{3-}-P have a same trend in pH=9.0 and pH=11.0.There is a maximum value on pH=5.0. In addition, except for the normal pH, the dissolution of PO_4^{3-}-P essentially increased. with the anaerobic fermentation time.
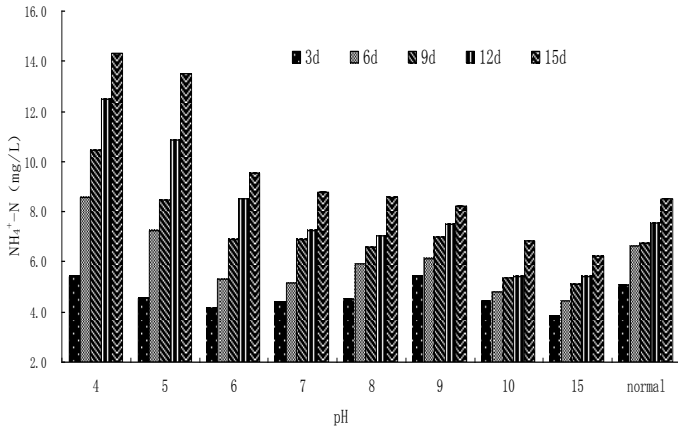
The impact of pH to NH_4^+-N

Fig. 3 Changes of NH_4^+-N at different pH (within 20d)

The dissolution of NH_4^+-N in Figure 3 is similar with PO_4^{3-}-P in Figure 2,which different is that there is a maximum value pH = 4.0 and the dissolution of the NH_4^+-N have changed little with anaerobic fermentation time.

The release of the PO_4^{3-}-P in continuous culture

In the pre-anaerobic wastewater experiment we found that the best pH value is range of 7.0 ~ 7.5. In order to achieve the aerobic wastewater sludge and the best treatment effect, the experiment of continuous culture without adjustment pH .This experiment simulated the actual, adding 15 days of aerobic sludge production in the anaerobic sludge, adding fresh water to the paper continuous culture experiments every day. The changes of PO_4^{3-}-P with culture times and changes of COD with culture times in Figure 4.
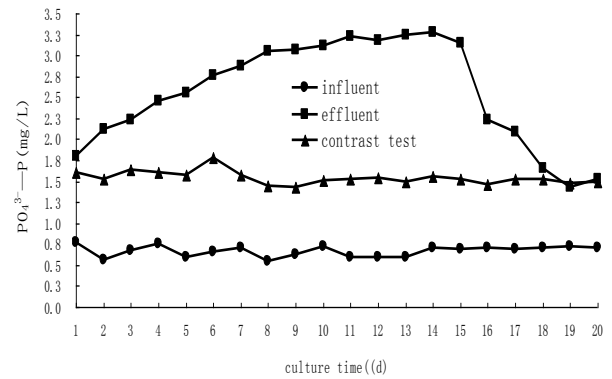

Figure 6 Changes of PO_4^{3-}-P with culture times

As can be seen from Figure 4, the PO_4^{3-}-P in influent is about 0.6 ~ 0.8mg / L, PO_4^{3-}-P in effluent significant changed in the three stages. The first stage is 1-9 days, the PO_4^{3-}-P has a faster rate, from 1.8 mg /L to 3.0 mg/L; the second phase for 10-15 days, the release PO_4^{3-}-P at this time have a slow pace of growth, after 12 days f the release of PO_4^{3-}-P is 3.2 mg/L, which is as 3 times as that in influent, reach stability. The third stag is 16-20 days, in which the PO_4^{3-}-P apparent downward trend in effluent.This phenomenon mainly because that we just 15 days aerobic excess sludge. With the reaction time, most of the PO_4^{3-}-P has been released a few of them residued. So that in16-18 d, there is a small of the PO_4^{3-}-P release. The release of PO_4^{3-}-P in contrast text also has the same trend.In addition PO_4^{3}-P in content is as 2 times as that in influent，which is probably response to the microbial in anaerobic sludge phosphorus accumulating in release in their life then release in the experimen [8].
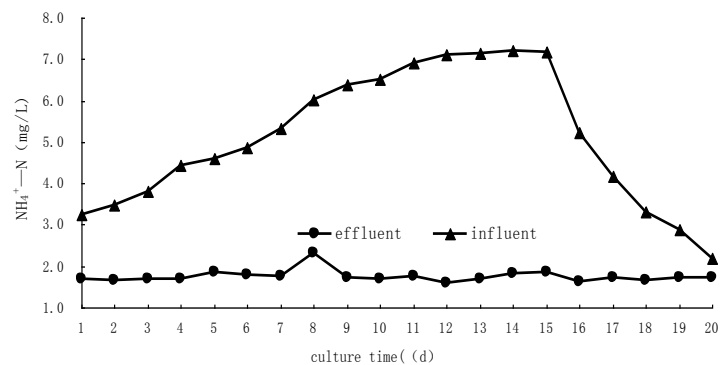
The release of NH_4^+-N in continuous culture

Figure 5 Changes of NH_4^+-N with culture times

As can be seen from Figure 5, the NH_4^+-N in influent is 1.60 ~ 2.2 mg/L, while the NH_4^+-N in effluent also showed three changes in trend and also positively correlated with the increase of SCOD .The release of NH_4^+-N has a stability value that about 7.1 mg/L in the12th day, which is as 4 times as that in influent.This phenomenon is mainly due to the NH_4^+-N has a high value that is 4.5 mg/ L in aerobic excess sludge.

In short, the research of hydrolysis and fermentation of activated sludge is still in the preliminary stages of the phenomenon described, and its mechanism of acid production, the impact of emissions factors in PO_4^{3-}-P and NH_4^+-N and the key mechanism of micro-organisms still need further study .

CONCLUSIONS

A. In the process of pH impact to the experiment, the release of PO_4^{3-}-P and NH_4^+-N increased with the fermentation time. Extreme pH values (pH = 4.0 and pH = 11.0) are not conducive to VFA.

B. In course of 20-days continuous culture, PO_4^{3-}-P and NH_4^+-N emissions, which has positive correlation with the increase in SCOD, were both have three changes trend and have stable value in 11 days.

C. In achieve stability, the release of PO_4^{3-}-P is 3.2 mg/L that is two times of the contrast text. While the release of NH_4^+-N is about 7.0 mg/L that is four times of the contrast text. So that we can concluded that aerobic excess sludge can be used in place of the actual process of addition of N 、 P, which can reduce the cost of inputs, reducing the cost of the remaining sludge treatment.

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