Up Flow Anaerobic Sludge Blanket (UASB) In The Paper Industry

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Abstract. The paper industry is an activity that have a large impact on the quality of natural resources. The large amount of water used has an impact on the wastewater generated. Untreated liquid waste can cause pollution in water bodies (rivers). Wastewater treatment with Up flow Anaerobic Sludge Blanket (UASB) is able to process wastes with high COD content in the paper industry. This paper provides a basic review and UASB research that has been carried out in the wastewater treatment of the paper industry.

Keywords : wastewater, UASB, paper industry

1 Introduction

The paper industry is an industry that uses large amounts of water to support the process of making pulp. Water is needed for washing, cooking, bleaching, transportation, chemical dissolution and paper making processes [1]. The paper industry is considered the biggest source of pollutants because it produces hazardous and toxic waste [2]. The paper industry produces a high amount of wastewater containing lignin which causes brown color and high COD (Chemical Oxygen Demand) concentration [3]. The industry generally treats its liquid waste in the Waste Water Treatment Plant (WWTP). Wastewater treatment aims to meet quality standards set by the Government so as not to pollute the environment. Wastewater treatment in WWTPs includes physical, chemical and biological treatment. Physical processing by filtering and settling. Chemical processing using coagulant substances. Biological processing using microorganisms.

Biological waste treatment is the most effective and economical treatment. The biological process is divided into two process, they are aerobic and anaerobic. The disadvantage of the aerobic process is the amount of sludge produced per kg of COD processed is quite large [4]. While the anaerobic process has the advantage of reducing

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sludge production by as much as 90% [5]. Anaerobic processes can convert organic material in wastewater into biogas with methane (CH_4) as its main element [6].

Several attempts have been made by the paper industry to improve the efficiency of its production process through waste minimization [7]. The increasingly stringent government regulations in wastewater disposal have pushed the paper industry to treat its wastewater with an anaerobic system [8]. An anaerobic reactors have many types, but the Up flow Anaerobic Sludge Blanket (UASB) reactor is more suitable for wastewater handling in the pulp and paper industry. UASB reactors have the capability to process wastewater with high organic loads and tolerant of shock loads [8]. UASB can process liquid waste that has high COD content and is resistant to fluctuations in COD so that it is expected that wastewater treatment does not exceed established quality standards. In general, the application of WWTP with the UASB process in the paper industry can improve WWTP performance and save environmental management costs [9].

2 Literature Study

2.1 UASB reactor

The UASB reactor was first developed by Lettinga, van Velsen, de Zeeuw and Hobma (1979) which was applied to the treatment of industrial wastewater and some domestic wastewater treatment. UASB or anaerobic granular sludge is a system where wastewater is put into anaerobic tank in which there is a sludge containing microorganisms (sludge blanket) then processed to produce biogas [10]. According to the Dictionary of Food Science and Technology, UASB is an anaerobic processing reactor by micro organisms that form suspended flocks at the bottom of the reactor. UASB process compared to aerobic processes, needs lower energy, is efficient at higher loads, requires less nutrients, and produce less sludge [11].

The formation of granular sludge that has good deposition ability at the reactor and shows a low Sludge Volume Index (SVI) are the main key to the success of the UASB reactor [11]. The UASB reactor is shown in the figure below.

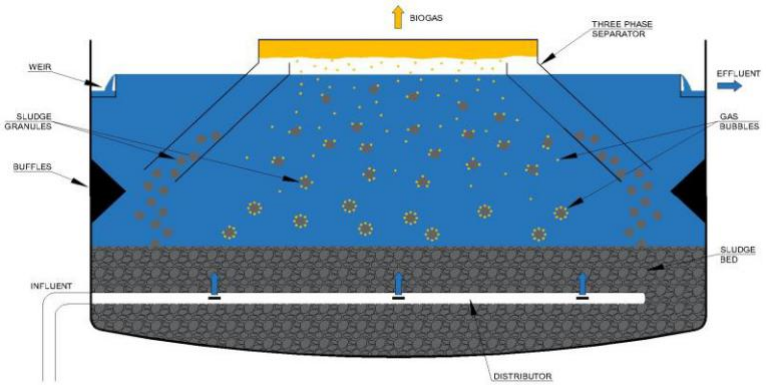

Fig. 1. UASB reactor

UASB has the advantage of being able to process liquid waste with a high organic load, tolerant of shock loading, large efficiency and cheap [12]. But UASB also has the disadvantages of a long start-up time, slow growth of methane microorganisms, and cannot

be used for low concentrations of organic pollutants (De Kreuk, 2006 in [13]). UASB processing performance is influenced by hydraulic capacity and load capacity, that is: [12]

a. Hydraulic Retention Time (HRT), is the average period of wastewater entering the aeration tank [14].
   HRT = 1 / D = V / Q, where:
   D: dilution rate (hour-1)
   V: capacity of aeration tank (m3)
   Q: Discharge of waste water entering the aeration tank (m3 / hour)
b. Hydraulic Loading Rate (HLR), which is the volume of waste treated. It is an important thing that influences the contact of bacteria with influents in the UASB reactor. The lower HLR, the longer the residence time (HRT) [15].
c. Velocity Up (Vup)
d. Influent debit
e. Concentration of Organic Waste
f. Organic Loading Rate (OLR), shows the total of organic material to be processed [16]. OLR is an important factor that influences the microbial ecology and the characteristics of the UASB reactor [17].
g. Temperature
h. Acidity (pH)

2.2 The process in UASB reactor

The workings of the UASB reactor are waste water entering from the bottom, flowing vertically upwards. Waste water will pass through the sludge bed. In this stage, wastewater will come into contact with anaerobic microbes in the form of granules. Biogas formed from anaerobic metabolism will go up and cause the vertical stirring process in the reactor. Biogas helps mixture and contact between sludge and liquid waste, and the three phase separator located above is used to separate biogas, liquid waste and sludge [11].

The operational stability and performance of UASB depends on the quality of the sludge which has a large deposition speed and high methanogenic activity, usually in the form of granule sludge. The nature of the granule mud will cause fluidized microbial biomass and better contact so the system can operate at a greater organic load. Wastewater treatment with granule sludge has advantages compared to flocculent sludge, which is greater deposition speed so that the wastewater treatment capacity is greater [9]. Granule sludge will have a long residence time in the reactor, so there will be accumulation of methanogenic bacteria that have high activity. Granul mud biofilms will protect these bacteria against shock loading and low pH [8]. The following is an example image of a granule sludge seed [9].

Fig. 2. Granule sludge seed

COD is an important parameter that exists in wastewater contaminants, especially in industrial wastewater [5]. Decrease in COD levels in UASB occurs when the process of producing gas in the form of H_2, CO_2, and CH_4 which is the result of an overhaul of organic materials by microorganisms [4].

2.3 Application of UASB in the paper industry

A number of researchers from the Indonesian Pollution Prevention Technology Center (BBTPPI) tried to apply UASB in a number of industries, one of them Moertinah et al (2014) in their research aimed at finding the optimum hydraulic retention time in kraft paper industry wastewater treatment, succeeded in making a UASB reactor for treat the wastewater. The optimum conditions for anaerobic treatment were obtained: OLR 1.44 - 6.88 g / L day at room temperature showed that the optimum hydraulic residence time was 24 hours with a reduction in COD of 84%; OLR 1.16 - 6.76 g / L day at temperatur of 40^{o}C showed an optimum residence time of 24 hours with a COD reduction of 84.01%; thermophilic 55oC at OLR 1.21 - 7.3 g / L day showed an optimum residence time of 20 hours with a percentage reduction in COD of 87.5% [18].

Setiawan, et al (2008) have also conducted research to improve the performance of pulp and paper industry liquid waste treatment using a UASB reactor combined with activated sludge reactor to reduce levels of COD, TSS and AOX. From the research, it was obtained that UASB reactors with a residence time of 12 hours can reduce COD by 90%, TSS by 91% and AOX by 84%. Wastewater treatment with UASB reactors and mobilized activated sludge can increase processing effectiveness to above 94% with effluent quality meeting quality standards [8].

3 Methodology

This review uses literature studies by journals and books relating to the Up flow Anaerobic Sludge Blanket (UASB) process. The results of this literature review can be used to increase knowledge and improve UASB performance, especially in the paper industry.

4 Conclusions

UASB reactors are increasingly being applied in industry, because they have the capability to treat liquid waste with high organic loads and are tolerant to shock loads. Moreover, it can be used to produce renewable energy from biogas. From the research that has been done, the use of UASB can reduce COD levels up to 90%.

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