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ScienceDirect

Procedia Environmental Sciences 31 (2016) 497 – 504

Procedia Environmental Sciences

The Tenth International Conference on Waste Management and Technology (ICWMT)

Study of the craftwork inpilot scale reactor of hydrogen generation from kitchen waste

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Abstract:

Kitchen waste disposal was laid more and more importance since its using as forage was forbidden.On the other hand, as one kind of reproducible, clean and efficient resource, H2 biological producing attracted much interesting these years. This paper focus on influences of substrate refreshing manners on the hydrogen generation in SARD with mixed substrate kitchen waste and sludge, in which kitchen waste was inoculated with sludge, and mineralized garbage and composite alkali as buffering agent and activator. It was concluded that the less ratio and more frequent refreshingof substrate manner (plan A) could gain better performances, which include higher hydrogen generation rate (102.5 mL/g-VS) and longer operation period of the reactor. These results were 76 % and 119 % better than the dramatic substrate refreshing manner of B.From the analysis reasons caused above difference could be attributed to their different influences extent on pH. Hydrogenogens was very sensitive to pH. Reasonable pH value could improve the effect of hydrogen production. When the accumulation of organic acid resulted in pH declined to 4.7 or below, the hydrogenogens would be inactivation and hydrogen production process would stop. It could be concluded that the dramatic refreshing manner resulted in the excess accumulation of organic acid and pH declining. Therefore, the refreshing of substrate afterwards should pay attention on this.

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific

Keywords: Kitchen waste, Anaerobic fermentation, Hydrogen production, Hydrogen production rate

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Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific
doi:10.1016/j.proenv.2016.02.063

1. Preface

Kitchen waste was occurred in the process of residents' daily life and food processing. It could be produced in those places such as residents' daily life, dining room, food service industry, and the farmer's market, which was one of the main parts of urban living garbage. In recent years, with the improvement of people's living standard in our country, discharge of kitchen waste increase rapidly.According to statistics[1], the kitchen waste of cities each year were not less than 60 million tons, the Beijing daily produce up to 1200 t/d, Shanghai of 1300 t/d, Hangzhou has around 1000 t/d. Kitchen waste in our country have characteristics such as large output, high moisture content, and complex components. Those characteristics restrict the applying of other methods. On the other hand, high organic matter content and rich of all types of nutrient created conditions for biological reusing of kitchen waste. With kitchen waste collection alone and biological resources has gradually become a hot topic of kitchen waste disposal at home and abroad research.Hydrogen was an ideal clean energy. When combustion it only generated water which could participate in the natural water recycling but will not cause any pollution.Furthermore, the calorific value of hydrogen was as high as 12.8 kJ/m^3[2].The thermal conversion rate was also high, so that hydrogen was expected to be as an alternative to fossil fuel in the future to solve the increasingly serious energy crisis and environmental problems.

The research and developing on an efficient and environment friendly hydrogen production technology has become a direction of many researchers in recent years [3].

Traditional chemical hydrogen production methods use pyrolysis oil, gas or water electrolysis. These methods take a lot of power or mineral resources,andproduction costs were generally higher[4-6] which could not fundamentally solve the problem of energy and environmental pollution. Biological hydrogen production technology was an effective way to solve above problems. The raw material of Biological hydrogen production was organic waste-water treatment, municipal waste or biomass which could be biologically decomposed by anaerobic microbial metabolic process to produce hydrogen gas. Obviously those materials were environment pollution,and the using of them was recyclable. Therefore,the biological hydrogen generation technology attracted more and more attention of people.

Anaerobic fermentation technology was one of the main technical energy transformation of organic matter. Organic waste fermentation hydrogen production has become the focus of widespread concern around the world. Hydrogen by its unique superiority, as a kind of renewable "green energy" received extensive attention of the world [7, 8]. In the methods of biological hydrogen production, anaerobic dark fermentation biologically hydrogen production technology showed more advantages in many ways [9-11]. The features of kitchen waste make people gradually began to interested in the anaerobic fermentation hydrogen production. The characteristics of its high content of easily degradable organic matter and rich with all types of nutrients also create conditions for the anaerobic hydrogen production.

Activated sludge was another kind of main substrate for anaerobic fermentation to produce hydrogen which was also a research hotspot in recent years[12, 13]. However, sludge matrix was not suitable to produce hydrogen because its poor capacity of producing hydrogen[14-16]. CAI have carried on the research with municipal activated sludge as substrate to produce hydrogen[17]. Continuous operation conditions the maximum production rate of hydrogen was up to 11.0 mL/g DS, and the maximum hydrogen content in the reactor reached 94%. But short-term running results showed that the stability of the hydrogen production was poorer. This study using sludge as the inoculum material was mainly to make use of microbial strains in order to improve the reactor startup time.

According to the related research results, mineralized garbage could improve the stability of reactors under the condition of kitchen waste anaerobic fermentation to produce hydrogen. The adding of compound alkali in serum bottle experiments expressed the promotion on hydrogen production rate. To give consideration of high hydrogen production rate and the continuity of reactor run, the experiment of this study was carried out in SARD with inoculate sludge, to kitchen waste, mineralized garbage and composite alkali were used as additive.