Bioenergy Production from Waste and Wastewater in China

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ABSTRACT

China is investing billions of US dollars annually on renewable energy production. China is leading the world not only in wind and solar energy production, but also in harnessing bioenergy from wastes and wastewater. The recovered bioenergy, mostly in the form of purified methane, is either converted to electricity, or for uses as industrial raw material, or as a supplement of natural gas for vehicle fuel. In this poster, a number of case studies in China on this subject will be presented. These are merely a few selected examples of thousands of similar installations all over China, many of which treating daily 5,000-10,000 tons of wastewater with ~10,000 mg-COD/l (in particular from starch, brewery and distillery industries). Case studies of treating rural household wastes and livestock wastes will also be presented. In one particular case, the treatment facility processes manure collected from several farms (within a 10-km radius) with a total capacity of 13 million chickens; this zero-discharge treatment facility was the first in China earning carbon credit (>US$1.2M annually) with certification from the World Bank.

Keywords: Bioenergy production, China, methane, waste, wastewater.

INTRODUCTION

Chemical energy of pollutants in wastewater may be effectively converted by anaerobes into methane-rich biogas. Although the feasibility of such technology was first demonstrated in the US in the 1960's, full-scale operations were not successful until the development of UASB technology in Europe in the 1980's. Since then, many anaerobic treatment systems have been designed and installed in East Asia for bioenergy production from wastes and wastewater. In Taiwan, anaerobic fluidized reactors were developed to treat petrochemical effluents containing highly toxic aromatic pollutants. In China, UASB and EGSB technologies have been used for the treatment of effluents from alcohol, starch, sugar, brewery, slaughterhouse, biochemical and pulp/paper industries; many of these reactors in operation are up to 5000 m^3 in size. In addition, an anaerobic hydrolytic pre-treatment process, replacing the conventional primary sedimentation, has also been applied in full-scale municipal wastewater treatment. More recently, China's government policies have encouraged the production of renewable energy, leading to the rapid spread of using anaerobic technology for the treatment of rural household wastes, agricultural wastes and livestock wastes. Bioenergy produced from these wastes and wastewater is used to produce either electricity or methane for industrial and vehicle uses. A few selected case studies of these are being discussed below.

CASE I

An in-house facility in Shangdong effectively treats 3,600 m^3/d of starch wastewater with 15,000 mg/l of chemical oxygen demand (COD), 8,000 mg/l of 5-day biochemical oxygen demand (BOD_5) and a pH of 4-5 using the upflow anaerobic sludge blanket (UASB) process. It produces an effluent containing 150 mg/l of COD, <60 mg/l of BOD_5 and 200 mg/l of suspended solids (SS). It also produces5,000 m^3/d of methane, which was purified from the biogas, for sales to local market.

Fig. 1. The top of the UASB reator treating starch wastewater.

Fig. 2. Biogas de-sulfurization facility.

Fig 3. Biogas purification facility producing methane with 97% purity.

CASE II

A communal centralized chicken waste treatment facility in Shangdong handles the wastes of 13 million chicken collected from farms within the 10km radius. Wastes containing 20-25% total solids and 180,000 g/l of COD are anaerobically digested in 8 x 3200 m^3 continuously stirred reactor (CSTR) with a retention time of HRT ~45 days at pH 8.1-8.2 and 38.5^{o}C. The effluent, which contains 2-3% of solids with 2.63g/l of N, 1.62 g/l of P and 5.15 g/l of K, is then discharged to a lagoon to be collected by farmers for use as organic fertilizers.

The methane-rich biogas produced is de-watered, de-sulfured and finally purified as feed to three power generers producting electricity for local network.

This facility is the first in China to be accredited by the World Bank to receive carbon credit of over 8 million of RMB (or US$10M) a year.

Fig. 4a. A centralized cummunal chicken waste treatment facility producing electricity for local network.

Fig. 4b. A centralized cummunal chicken waste treatment facility producing electricity for local network.

CASE III

An alcohol plant in Guangxi uses UASB process to treat its wastewater. Under mesophilic condition, the process effectively removes 90% of COD and produces methane rice biogas. The biogas is then dewatered and purified to 97-98% methane. Since Guangxi province in poor in energy resource and is heavily relies on imported energy, it was decided to use the methane produced from this facility as a substitute for natural gas for use by the local vehicles. This is the first successful case of such nature in Chins.

Fig 5. The alcohol producting facility using UASB procesws to produce methane-rich biogas.

Fig 6. Methane purified from biogas is used as natural gas substitute for used as fuel by the vehicles.

CONCLUSION

In this poster presentation, we use three case studies to demonstrate China's recent effort to apply anaerobic technology to process organic-rich wastes and wastewater not only to cost-effectively remove the pollutants but also to produce bioenergy, which are being used for industrial applications, electricity generation, as well as fuel for motor vehicles. China is poor in energy resources and it has been the national policy to develop renewable energy, including bioenergy production. The cases shown in this presentation represent the first step of such efforts in China and more developments are expected in the near future.

REFERENCES

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