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The exploration and application of a new dry fermentation biogas-pool

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Abstract

A new dry fermentation biogas-pool(DFBP) was explored for family using in the countryside of Leting, Hebei province, China. The results showed that the biogas can be produced in a short time, and the methane percentage was over 40% on the second day by co-digestion of cornstalk and garden leaves. This kind of biogas was already suitable for the ignition. The daily biogas production was nearby 1 m^3 with the methane percentage around 54% which can satisfy the needs of daily biogas using by family of three people. The biogas residue can be reused as fertilizer to return to field. The construction of DFBP can solve the problem of living garbage disposal and realize recycling utilization of the energy which is helpful to the environmental improvement in the countryside.

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Keywords: Dry fermentation biogas-pool; anaerobic digestion; biogas production; rural organic solid waste;;

Main Text

1. Introduction

In a long period, the energy source of countryside family in China depended on the burning of coal, straw and firewood. The using of these kinds of traditional fuels not only have a low energy utilization and harmful to the environment, but also severely restricted the economic and society development[1,2]. From another point of view, there were more than 15 billion tons of residues of agriculture produced in the countryside in China[3]. The residues of

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agriculture contained straw, household garbage and poultry excrement. Casually disposing of these waste will do harm to the ecological environment. So reducing the use of traditional fuels and exploring technology to recycle residues of agriculture is the problems that need urgent solution for modern agriculture development in China[4].

Biogas, as a kind of clean energy, can use residues of agriculture as raw material. So the main development and utilization of clean energy new technology in countryside was the exploration of biogas. China is an earlier country in research and development of biogas. Early in the latter part of 19th century, a kind of simple fermentation equipment for producing biogas appeared in the countryside around coastal areas of Guangdong province, China[5,6]. After a long time of development, the biogas utilization technology gradually became mature. And the biogas production installations had been generalized[7,8]. Among the biogas production installations, hydraulic biogas digester (HBD) was most widely used. Most of the agricultural organic wastes can be handled by anaerobic digestion process with HBD. And clean biogas energy and organic fertilizer can be got at the same time. While, when the material was solid state, there would be some disadvantages for HBD just like: (1) hard to discharge the material, (2) difficult to manage and control, (3) low volume biogas production. So the HBD was not fit for the anaerobic digestion of solid organic waste to produce biogas[9,10].

In our research, a new dry fermentation biogas-pool(DFBP) with advantages of easy to operate and manage was explored for family using in the countryside. Aim to solve the difficult of feeding or discharging the agricultural organic solid wastes, alleviate the pressure of the environment and produce clean energy.

2. Materials and methods

2.1 Design of dry fermentation biogas-pool (DFBP) for family using in the countryside.

2.1.1 Design principle

The most important factor of DFBP was the seal of feed-discharge hole. For traditional hydraulic biogas digester, the TS (total solid) of substrates was between 5% to 8%. A low TS of substrates caused a liquid fermentation broth, which can realize the seal of feed-discharge hole. While in the system of DFBP, the TS of substrates was high from 15% to 20%. The semisolid fermentation broth was week in liquidity, so it can't be used for sealing the feed-discharge hole. After our unceasingly study, an external water sealing device have been explored. First, a gutterway was dug along the feed-discharge hole. At the bottom of the gutterway, we installed the hook which matching up with the ones on the half opening airbag. And then, the half opening airbag was fixed steady by the hook. Finally, The gutterway was filled with water to generate the sealing technology. We named this kind of new sealing method water sealing ring (WSR).

2.1.2 The shape and material of dry fermentation biogas-pool

The circular reactor has a kind of structure of uniformly forced and stabilization.. And for the same sectional area, the perimeter of circular reactor is 12% less than that of square reactor. So we chose circular reactor as the structure of DFBP in this study[11].In consideration of economy factor and the corrosive of substrates to the reactor in countryside, the DFBP was built with reinforced concrete and brick construction.

2.1.3 The way of feed-discharge material and feed-discharge hole

Traditional feeding method was not suitable for adding substrates with high TS. And mechanical feed method was difficult to implement in the countryside of China. So we paved a new way for the feeding problem. First, the substrates were moved into woven bags. Second, the woven bags were put into the biogas-pool. All the woven bags were taken out in the end of the fermentation. And the biogas-pool was filled with new substrates in the same form to continue producing biogas. In order to satisfy the adding substrates method, the feed-discharge hole should be wider than that of traditional hydraulic biogas digester. So the DFBP was designed to be cylinder shape. And the top of the cylinder was used as feed-discharge hole. Then the DFBP was covered by half opening airbag which was fixed steady in WSR.

2.1.4 Storage and use of biogas

The biogas was stored in the half opening airbag. The half opening airbag was made by red-sludge soft plastic.