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Putrid Potatoes as Biomass Charge to an Agricultural Biomass-to-Biogas Power Plant

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Abstract

The paper presents results on fermentation process of putrid potatoes, which are useless as food, by applying the biomass-to-biogas conversion technology. The experiment was conducted at laboratory scale in the reactor with volume of 140 dm^3. It was found that putrid potatoes (putrid in 10 to 20% by volume) can be managed as satisfactory charge to the fermentation tank. However, their potential for biogas generation is worse than maize. The power in biogas from potatoes fermentation in comparison to maize is lower by approximately 35%. Even though the putrid potatoes are not as good as maize for biogas generation in the agricultural biomass-to-biogas power plant, but they do not spoil the fermentation process, thus, they can be added to the fermentation tanks without any risk of either reducing fermentation process capability or killing the methanogenic bacteria.

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Keywords: fermentation; pottoes; maize; biogas;

1. Introduction

Utilization of waste biomass with its conversion to useful energy through its fermentation process can be treated as the most effective technology for this purpose. Research in this field is also focused on various waste food digestion technologies with respect to obtain sufficient biogas yield [1-3]. A small-scale anaerobic digestion system design for an urban building was proposed and analyzed by Curry and Pillay [3]. However, several types of biomass

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due to their specific physical-chemical structure cannot be utilized in this way. The problem is in breaking up lignocellulosic structure, what is required for effective fermentation process [4]. Crumbling and grinding biomass to micro size requires additional amounts of energy that does not make the overall process economically justified. As recommended, the mechanical grinding is first step in the lignocellulosic material preparation into the fermentation tank under enzymatic process [5]. The basic target for mechanical pretreatment is to obtain small fraction of plant based biomass as well as to increase calorific value of the biomass through its higher density. From another hand, potatoes can be easily crumbled even mashed to pulp consistency without significant energy delivered. Thus, potatoes can be considered as such biomass which does not require any sophisticated technological pretreatment processes before charging them into the fermentation tank in the biomass-to-biogas power plant. Among others, research on biomethanation process of potatoes was conducted by Adeyosoye et al [6]. They confirmed that potatoes can be utilized trough mesophilic fermentation for both domestic and industrial use. Currently, potatoes are usually processed to obtain bioethanol. Several investigations concentrate on applying various cultures to potatoes to minimize economical costs for bioethanol production [7]. Another technology on potatoes processing is focused on obtaining lactic acid for further processing for polylactic acid [8]. Pistis et al. [9] conducted research on thermophilic digestion (50°C) of potatoes by-products. They recommended to use potatoes at rate of 2 kg/day/m^3. They found process instable at higher amounts of potatoes to a fermentation tank. As Gruber said [10] potato cultivation just for biogas production is financially not feasible. Only potato waste could be financially interesting. Thus, the easiest way to utilize putrid potatoes for energetic purpose can be to use mesophilic fermentation process as is typical in agricultural fermentation plants [6,10]. Such approach of utilizing waste mash biomass including potatoes can be applied to a small scale biogas power plant with power output of 6…7 kW, that is good solution for energy generation in agricultural farms with area of 30…60 ha [11]. The paper describes fermentation potential of partially putrid potatoes in comparison to the reference biomass which was maize in this investigation.

2. Test Bed Description

Investigation on identifying fermentation potential of putrid potatoes was conducted at laboratory scale in the fermentation reactor presented in Fig. 1. The reactor is a tank with a water coat for heating the biomass charge inside. Specifications of the reactor are showed in Table 1.

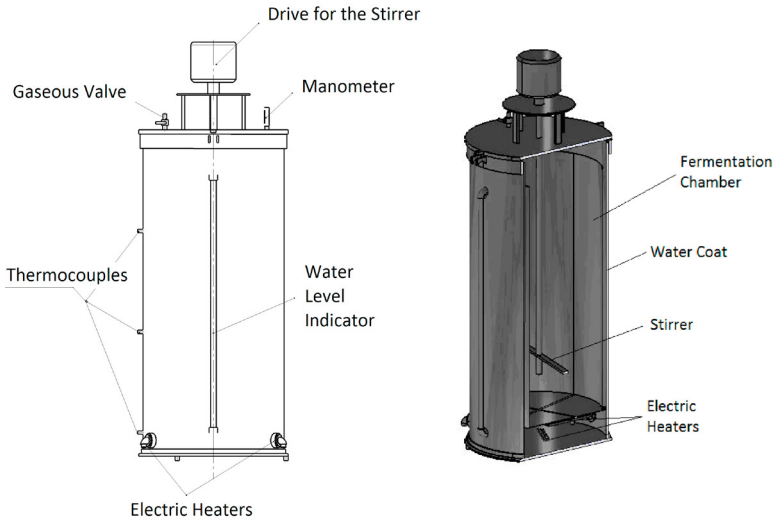

Fig. 1. Bioreactor for fermentation process of various biomass.

The fermentation reactor was equipped with the manometer and the gaseous valve which maintains pressure inside at constant level of 5 kPa ± 1 kPa. During fermentation process in the reactor biogas was released and gathered in an elastic tank. The biogas mainly consists of methane, carbon dioxide, nitrogen, hydrogen sulphide and