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Solid state bio methane production from vegetable wastes Current state and perception

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ABSTRACT

The energy crisis and climate change are being the global challenge for the present debate since the world is in need of a green, efficient, carbon-neutral energy source to replace fossil fuels. Bio- gas, produced by biomethanation from organic materials, contributes to durable, reliable and renewable energy. Production of bio methane from vegetable wastes provides a flexible carrier for renewable energy; methane can be used as a substitute fuel for both heat and power production. In this context, the Indian Government invited the support of the private sectors as before, for the development and utilization of Eco-friendly new and renewable sources of energy to cover the demand. The paper also reviews the current state of vegetables purposes for bio methane production, including their preparation methods and performance. The vegetable wastes for bio methane production are presented and their main advantages described in comparison with the other available method of mixture of vegetable wastes for methane production. The waste generated may cause health hazards, so, setting up a waste treatment plant based on biomethanation process is the solution to use the technology to generate electricity.

Contents

1. Introduction

The energy sector has been playing an important role in the environment of the global economy as well as the socio economic development. The world energy consumption is growing at the

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rate of 2.3% per year. The Energy Information Administration (EIA), estimated that the primary sources of energy consisted of petroleum 36.0%, coal 27.4% and amounting to 86.4% share for fossil fuels in primary energy consumption in the world [1]. The global energy demand for non-renewable resource created approximately 39,375 exa joule ($= 10^{18}$ joule) focusing on the current scenario the economically improved energy demand is growing approximately around 88% of demand on the fossil fuels. With current scenario energy calamity and change in climate are key issues all over the world. There will be a severe demand for energy in the next few decades [2]. In this time, concentrations of greenhouse gases in the atmosphere are increasing rapidly, with fossil fuel-derived CO_2 emissions. In order to decrease the global warming and climate change impacts, CO_2 emissions must be below the part of global emission levels of 1990 [3].

As fossil fuel resources are limited and their demand is high, this gap would be met with the energy generation resources. One of the feasible renewable energy sources in support of India is from biomass.

Biomass availability in the country is high as 150 tons per annum. Production of biomass would slow down the climate change, that contributes to reduce the greenhouse emissions [4]. The use of fossil fuel is an important energy source for global climate change, environmental degradation and human health problems [5]. Global climate change will predictably show the way to drought, flooding, increases in hurricanes and tornadoes and possibly failures on global warming [6]. Security of energy supply, especially sustainable energy and reduction of priorities are the agenda in worldwide.

In today's world, there has been a shift in focus to renew supplies from wastes, which are found in abundance as a by-product of any process. India's population is widely expanding. In lieu of this, it is appropriate to conceive the fact of waste generation [7]. Liveliness is an essential need for human existence. Scarcity of energy through fast depletion of fossil fuels and the increase in requirement for energy. India ranks sixth in the world for energy demand with total energy consumption of around 480.4 million tonnes, of that 46% are from biomass energy [8] and accounting for 3.5% of world commercial energy demand. In recent times when fossil fuels are gradually depleting in addition to rising costs and instability in the developed countries, renewable energy has become the best alternatives for sustainable energy development [9–10].

2. Biomethanation process

2.1. Anaerobic digestion

In the bio-methanation process, the organic waste is converted into methane and enriched manure by a large consortium of microorganisms in the absence of air, also known as anaerobic digestion [11]. Anaerobic digestion is a biological process in which untreated material is decayed by bacteria in the lack of air to yield methane and carbon dioxide. The universal technology of anaerobic digestion of complex organic matter is well known municipal and industrial waste treatment to stabilize organic wastes. The anaerobic process is more beneficial because the aerobic method in organic waste treatment and the high degree of waste stabilization, low manufacture of excess biological sludge, low nutrient prerequisite and high production of methane gas [12].

Anaerobic digestion (AD) is a process in which the microorganisms break down the biodegradable material in the absence of oxygen. Anaerobic digestion may be used to treat various organic wastes and recover bio-energy in the form of biogas, that contains mainly CH_4 and CO_2. Methane may be a source of renewable energy producing electricity in combined with heat and power sectors [13]. The Organic Loading Rate (OLR) and hydraulic retention time are two major parameters purposes for sizing the digester and their optimum values are specific to the substrate as well as the operating temperature of digester [14]. Several studies have been conducted by many researchers to increase biogas yield from biomethanation of wastes. An effort to improve biomass conversion efficiency and biogas yield by using different pre-treatment methods [15–17], optimization of biomethanation fresh water hyacinth [18]; and effects of particle size, plant nitrogen content and inoculum volume [19].

2.2. Digester plants

Digester plants are constructed of a 55-gallon plastic drum laid horizontally at 15°F, plumbed with an inlet, and two outlets for wasting out light and heavy solids. The digests are all insulated temperatures maintained at approximately 100°F. Surface to volume ratio for the fixed-film digester was approximately 45 m^3 whereas the same ratio for the control was roughly 9 m^3. Fed material was agitated and screened through a 1.5” × 2.5” mesh to remove large solid particles over 1.5”. The loading rate was determined by measuring a set quantity of fresh vegetable waste loaded daily into individual tanks, indicated by gradually on floating depth indicators. Biogas production, using a water displacement device designed and carbon dioxide content, recorded daily. Biomethanation is a feasible and effective method of treatment of vegetable waste generated. Vegetable wastes are solid organic waste having high calorific value and nutritive value to microbes that's why the efficiency of methane production be increased by higher order [20]. The waste causes health hazards, and also a risk of epidemic.

3. Different vegetable wastes and their methane yields

Most of the researchers [21–30], have noted down that the Municipal Solid Waste (MSW) generation rates in the small towns are lower than those of major cities, and the per capita pace of MSW in India ranges at 0.2 to 0.5 kg/day. In 1980, Stewart described the potential use of oats, grass and straw in New Zealand, results methane yields of 170–280 $m^3.t-1$ TS [72]. Even water hyacinths and fresh water algae were shown to result in medium methane yields choose between 150–240 $m^3.t-1$ TS. Recent German practical experience showed mean methane yields of 348 m^3/t VS for maize and 380 m^3/t VS for barley [31].

Fruits and Vegetable waste were an aerobically digested in a microbiological foments laboratory scale reactor at mesophilic conditions. Each has the biogas yield as 0.429–0.568 L/g VS fed. [32]; and fruit waste the yield ranged from 0.18–0.732 vegetable waste 0.19–0.4 L/g VS added [33], 0.2–0.63 L/g of VS added [34], [35] checked the feasibility of using 2.5 liter capacity of amber colored bottle for the production of biogas 9.22 L/kg TS added to banana waste and 1.69 L/kg TS added on coir pith. An organic fraction of municipal solid waste uses a minimum production of biogas on 5 liter capacity of laboratory scale digester [36]. Researchers have reported that the biogas yield of 0.36 L/g VS fed. The municipal garbage for the production of biogas of 0.485–0.5 L/g VS fed was used normally [37].

The studies showed that the maximum biogas yields sources such as Korean food waste [38], Pineapple processing waste [39], Mango peel [40], Banana and pineapple waste [41], Potato waste and sugar beet leaves [42], Banana stem waste [43], Vegetable waste [44]. Anaerobic co-digestion of grass silage, sugar beet tops and oat straw with cow manure was evaluated by [69] in semi-continuously fed laboratory. The highest specific methane