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Anaerobic treatment of spentwash for recovery of clean energy

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ABSTRACT

A laboratory scale anaerobic Continuous Stirrer Tank Reactor (CSTR) was established to treat synthetic wastewater simulating diluted spentwash from molasses-based distillery. A CSTR of effective volume 4.75 L was seeded by the seed sludge obtained from Sewage Treatment Plant (STP) and slurry from the biogas plant, both situated at IIT Mandi. The reactor was in operation for 151 days with the influent COD (amount of equivalent oxygen required to oxidise organic as well as inorganic matter completely) of 6000–8000 mg/l and loading rate of 0.15–0.61 g COD/L.d. The reactor was operated in the temperature range of 30–38 °C and pH of influent was maintained in the range 6.5–8.0. Results obtained from the study indicates that COD removal efficiency about 85% with methane production of 0.60 L/d. Methane content in the biogas was around 68%, which indicates high quality biogas production and the methane yield of 0.2932 L/(g COD removed). In parallel with the CSTR, an Upflow Anaerobic Sludge Blanket (UASB) reactor with effective volume 7.1 L was also established. The preliminary results during the start-up phase of 60 days of the UASB reactor indicated the maximum COD removal efficiency of 66% and the biogas production of 0.34 L/d.

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1. Introduction

Currently, India imports around 80% of crude oil and 61% of coal to fulfill the energy demand [1,2]. Developing countries like India need to, focus on the renewable energy sources such as biomass, effluent of the industries, wind and solar rather than on the energy generated from fossil fuels. It reduces the crude-oil, coal and natural gas import and helps in meeting the energy demand. Use of renewable energy leads to reduced and overdependence on fossil fuels. Due to this, pollution will also reduce that is generated by the burning of all form of fossil fuels which were used to produce energy.

Biomass like cattle dung, municipal solid waste, press mud and organic industrial wastewater leads to severe water and air pollution, causes various health issues by degrading the ecosystem if not treated properly [3]. Conversion of biomass into various form of energy like biodiesel, methane, ethanol, electricity, butanol and hydrogen can be achieved through various techniques [4]. Anaerobic digestion is one of the efficient and cost-effective method to convert biomass and wastewater into biogas [5]. It produces energy in the form of methane and produces digestate as by product which can be utilized as organic manure in the field to enhance the crop production. India has the potential to generate 40,734 million cubic meters per year of biogas from the biomass excluding the industrial wastewater [6]. Indian sugar industry is one of the major producers of sugar and its by-product in the world. India also export sugar to several countries throughout the world. As a result, sugar industries in India play an important role in the economic development of the country [7]. India has 579 sugar industry and 285 distillery industry [8,9]. From the past few years various co-digestion methods were employed for anaerobic treatment of various organic wastes [10] and also the pretreatment method was employed on organic waste to enhance the biogas and methane content [11].

Spentwash is generated in large quantity from the distillery industry in a process to produce ethanol from molasses. For production of one litre of ethanol about 12–15 L of spentwash is generated. Spentwash has COD of 90,000–210,000 mg/l and BOD:COD ratio of 0.4–0.6 [8]. Various methods have been employed for use of spentwash such as mixing with press mud, washing of the sugarcane, diluting molasses and for making the cattle feed. Anaerobic treatment of the spentwash offers a profitable alternative since this process can generate energy. By diluting the spentwash 10–15

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