A REVIEW ON BIOGAS PRODUCTION FROM TAPIOCA PROCESSING INDUSTRY

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ABSTRACT:

Tapioca industry is an agro- based processing industry involved mainly in the production of sago and starch. It is in the form of globules prepared out of tapioca. Tamilnadu accounts for 2/3rd production of Tapioca in the country. In Tamilnadu, Salem District alone consists of 34,000 hectares of Tapioca cultivating lands and stands first in the country in processing of tapioca into sago and starch. During this process several by products are produced which are used for several useful purposes. The main by product in tapioca industry is Thippi which is used as Thippi Flour, as a cattle feed and in several industries as a residue powder .Apart from this the sago production process generates large quantity of waste water that contains organic, inorganic and toxic constituents that are harmful to human health and environment. Thus the treatment of this waste water is utmost important and this can be done by using Bio-Methanation technology. This treatment process generates considerable amount of Bio gas that contains methane and carbon di oxide. . At a time where there is great demand for electricity, the production and utilization of bio-gas from Tapioca industrial wastes can be of significant importance and also helps to solve the power crisis of the state. This paper mainly focusses on the efficient utilization of the by products from tapioca industry.

INTRODUCTION:

India acquires significance in the global tapioca (Cassava) scenario due to its highest productivity in the world (34.37 t ha-1) (FAOSTAT, 2009). Similarly within India, Tamil Nadu prides itself in having the highest productivity of Tapioca of about 38 t ha-1. Also 70% of the sago produced in India is from Tamil Nadu as 90% of the tapioca produced in the state is processed into sago and starch (D. Rajakumari et al., 2012). As high as 60% of the sago produced in Tamil Nadu is marketed through SAGOSERVE

According to Food and Agriculture Organization, root and tuber crops form staple diet for three percent of the global population. Cassava is mostly used as a staple food in the African continent and in the South America. Industrial utilization of cassava is common in Thailand, Indonesia, Vietnam and India in the form of starch, sago, dried chips, flour etc (J.I. Eze et al., 2010). In India, it is cultivated in an area of 0.28 mha producing 9.62 mt. It is an important food crop in Kerala. Due to its diversified uses, tapioca has become an important commercial crop in the state of Tamil Nadu especially Salem District (Veeramani. R et al., 2014).

Biogas is another source of renewable energy, it is produced when biomass is subjected to biological gasification and a methane-rich gas is produced from the anaerobic digestion of organic materials. Achieving solutions to possible shortage in fossil fuels and environmental problems that the world is facing today requires long-term potential actions for sustainable development. (Sathya Geetha G et al., 2014). In this regard, renewable energy resources appear to be one of the most efficient and effective solutions (Akuzuo U *et al., 2010).* The biomass wastes are held in a digester or reactor. The gas is produced from a three-phase process namely, hydrolysis, acid-forming and methane-forming phases. It is a biological engineering process in which a complex set of environmentally sensitive micro-organisms are involved. The gas is typically composed of 50-70% Methane, 30-40% Carbon dioxide, 1-10% Hydrogen, 1-3% Nitrogen, 0.1% Oxygen and Carbon monoxide and trace of Hydrogen sulphide (Hashimoto G et al., 1978).

SALEM-SAGOLAND:

Tamil Nadu stands first in respect of processing of tapioca into sago and starch throughout the country, meeting about 80% of country's demand. There are about 450 sago and starch industries in the small scale sector in the State. Salem has traditionally been the land of sago and starch. The cultivation area and processing units are concentrated in Salem and the adjoining districts such as Namakkal, Dharmapuri etc. The industry got a boost during the IInd World War when imports from the Far East were not possible (K.K. Kaushal et al., 2012). The Salem Region offers good raw material, cheap labour and good sunshine for a longer period of the day throughout the year, helping manufacturers to produce more tapioca based products eg. Sago and starch and therefore this area is known as the Land of sago/starch, even at the International level. (C.Sudhandhiran et al., 2001).

PROCESS OF SAGO PRODUCTION:

PEELING and WASHING:

200 tonnes of Tapioca tuber was taken for the production of Sago and Starch. The Raw materials were unloaded in the unloader and then passed through the conveyor belt. The tubers were then allowed to pass through a roller where the dust was removed with the help of pressure pipes. (D. Rajakumari et al., 2012).This enabled the complete removal of the dust present in its surface.The tubers are then passed over the conveyor belt to the root washer where the skin is peeled off by mechanical methods. (C.Sudhandhiran et al., 2001). This enabled the complete removal of the skin of the Tapioca tuber. They are stored in storage tanks to soften the tubers.

RASPING or PULPING:

It is necessary to rupture cell walls, in order to release the starch granules. Pressing the roots against a swiftly moving surface provided with sharp protrusions usually carries this out. During this process, the cell walls get ruptured and the whole of the root is turned into a mass in which a substantial portion of the starch granules are released. It is difficult to remove all the starch even with efficient rasping devices, in a single operation. Therefore, the pulp is generally subjected to a second rasping process after screening. (D. Rajakumari et al., 2012) It may be estimated that an efficiency of about 85 percent is attained at first rasping. In the secondary rasper, the indentation of the blades should be more fine about 10 cm as compared with 8 cm. for the primary rasper. The overall rasping efficiency can there be raised to over 90 per cent by the secondary rasper.

SEPARATION OF STARCH and THIPPI:

The crushed tubers which were in a Semi - liquid state were passed through a serious of filters .The filtration process allowed for the separation of starch and thippi –the major byproduct in sago industry. This process was repeated again and again to achieve complete separation of starch and thippi. Thippi was extracted in the form of cakes and starch was extracted in the form of milk. The extracted Thippi was spread on concrete floors and dried in the Sun. Later it was packed and sent to the industries for a variety of purposes (SABUINDIA)

STARCH SEPARATION:

The milk containing starch was stored in a large settling tank where the starch settled down at the bottom and the wastewater –the influent used for Biogas production, are separated. The waste water was stored in large tanks which was sent to the biogas digester plants through a pipeline system. (Veeramani. R et al., 2014). The separated starch was taken to a shallow tank where the workers were allowed to walk over it for several hours so that excess moisture present in the starch was removed .This process also caused the hardening of starch.

SAGO:

The starch was then sent through a series of conveyor belts to the grinding machine where it was grinded, sized with the help of a sizing machine and then roasted. After roasting, it was dried with the help of driers. Hot air was passed through them to remove excess moisture content. (Veeramani R et al., 2014). This hot air was obtained from the biogas that's been produced by the treatment of waste water in the same industry. At the end of this process sago was obtained which was collected according to the difference in size of the particles. The sago obtained was packed in bags and sent to the market. (D. Rajakumari et al., 2012, SABUINDIA).

GENERATION OF BIOGAS FROM EFFLUENT:

Every factory producing sago and starch is a mini power station which will meet its need for running the generators and/or it could be used for sago roasting purposes. Having got convinced that the effluent is a source of energy a private factory sought my assistance to put the effluent gas into use. However the owners while appreciating the state-of-art technology of NJIT pleaded that they would like to have a simple system due to pecuniary circumstances (SABUINDIA).

BIOGAS PLANTS (Ludwig Sasse):

BALLOON PLANT:

A balloon plant consists of a plastic or rubber digester bag, in the upper part of which the gas is stored. The inlet and outlet are attached direct to the skin of the balloon. When the gas space is full, the plant works like a fixed-dome plant - i.e., the balloon is not inflated; it is not very elastic. The fermentation slurry is agitated slightly by the movement of the balloon skin. This is favourable to the digestion process. Even difficult feed materials, such as water hyacinths, can be used in a balloon plant. The balloon material must be UV-resistant. Materials which have been used successfully include RMP (red mud plastic), Trevira and butyl.

FIXED-DOME PLANTS:

A fixed-dome plant consists of an enclosed digester with a fixed, non-movable gas space. The gas is stored in the upper part of the digester. When gas production commences, the slurry is displaced into the compensating tank. Gas pressure increases with the volume of gas stored, therefore the volume of the digester should not exceed 20 m³.

FLOATING-DRUM PLANTS:

Floating-drum plants consist of a digester and a moving gasholder. The gasholder floats either direct on the fermentation slurry or in a water jacket of its own. The gas collects in the gas drum, which thereby rises. If gas is drawn off, it falls again

HYBRID UP FLOW ANAEROBIC SLUDGE BLANKET (HUASB) REACTOR:

Hybrid Upflow Anaerobic Sludge Blanket (HUASB) reactor, which offers the advantages of both fixed film and up flowanaerobic sludge blanket treatment (M.M.C.Rajivgandhi et al., 2013). HUASB reactor with a volume of 5.6 L was operated at Organic Loading Rates varying from 10.7 to 24.7 kg COD/m3.day. After 130 days of startup, the reactor produced appreciable decrease in COD of wastewater and removed solids efficiently. The COD removal varied from 91-87%. While the removal of Total Solids was in the range of 61-57%, that of volatile solids varied from 70-67%. The ideal OLR for the reactor was 23.5 kg COD/m3.day.(*J. Rajesh Banu et al., 2006).*

UPFLOW ANAEROBIC SLUDGE BLANKET (UASB):

The system uses sludge granules as a means of achieving high mean cell residence time (MCRT). UASB processes have been found in a variety of applications in recent years in the treatment of high strength and low/medium strength waste water and a variety of other substrates. The process has been applied to wastewater generated from a wide cross-section of industries such as distilleries, food processing units, tanneries, etc., in addition to municipal wastewater. A UASB reactor essentially consists of a gas–solids separator (to retain the anaerobic sludge within the reactor), an influent distribution system, and effluent draw off facilities.(Rungrawee Yingyuad et al., 2007)

DISCUSSION:

High potential of biogas and power generation from tapioca processing industries is possible provided hybrid Upflow Anaerobic Sludge Blanket (UASB) bio-methanation plants should be installed (unlike existing conventional bio methanation plants) and the biogas produced from the effluent meets the energy requirements of the industries. Further, it can reduce the dependence on the grid power. (M.M.C.Rajivgandhi et al., 2013).

The UASB is the least preferable system. Disadvantages of UASB are its low stability and complication in operating, maintenance, and control. The start-up requires an experience operator to control the suitable conditions for forming granular of bacteria. A long period of start-up is not appropriate with the factory which has breaking time of operation. Complicated operation is not preferable for Thai operators who prefer convenient method of operating and control. In addition, financial factors are also the problem of UASB.

Its investment, operating and maintenance costs are high compared with other systems (*J. Rajesh Banu et al.*, 2006)

Sago industrial solid residues viz. cassava peel residue (CPR) and cassava fiber residue (CFR) were pretreated using DAcH-SE and DAlH-SE using H2SO4 and NaOH respectively. For diluted acid hydrolysis and steam explosion pretreatment, the samples were treated with various temperatures of about 100ÛC, 105ÛC, 110ÛC, 115ÛC and 120ÛC, at various residence times of about 5, 10, 15, 20 and 25 minutes and with various acid concentration of about 0%, 0.25%, 0.5%, 0.75% and 1% respectively. For the diluted alkali hydrolysis and steam explosion pretreatment, the industrial residues were treated with temperature 30ÛC, 35ÛC, 40ÛC, 45ÛC and 50ÛC, residence time of about 30, 60, 90, 120 and 150 minutes and the acid concentration of 0%, 5%, 10%, 15% and 20% were optimized. It was found that sago industry solid residues showed optimum hydrolysis using diluted alkali hydrolysis and steam explosion than diluted acid hydrolysis and steam explosion (Ukpai,P. A. et al., 2012).

The maximum and minimum daily temperatures recorded were 360C and 260C respectively (Fig. 2). The optimum operating temperature range was 30 – 350C. Below 300C, digestion proceeded more slowly. Lower temperatures appeared to favour acid-forming bacteria and the system became more susceptible to a reduction in pH. There was no defined pattern of pressure change during the period. The internal pressure reached a maximum of 55 cm SWG*. This was evident when gas evolution was rapid and the internal pressure exceeded 50 cm SWG; causing effluent overflow and a great leak of biogas from an air-tight gas tank of the digester (J.I.Eze et al., 2010).

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