International Conference on Latest Trends in Engineering, Science, Humanities and Management
Indian Federation of United Nations Associations, New Delhi (India) ICLTESHM-17
04 February 2017, www.conferenceworld.in ISBN: 978-93-86171-24-5

WATER HYACINTH: A POTENTIAL BIOGAS RESOURCE

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ABSTRACT

Due to continuous depletion of the natural resources by an increased consumption of the energy, alternatives of fossil fuels must be searched out. Bio-energy is the only alternative and cheap source of energy which can be made easily available. Water hyacinth (Eichhorniacrassipes), one of the important invasive aquatic species, commonly covers the surface of rivers and lakes and causes a series of environmental problems due to its rapid growth and high reproducibility in both clear water and wastewater. Thus, it is also considered as a noxious weed as it grows very fast and depletes nutrients and oxygen rapidly from water bodies, adversely affecting flora and fauna. There have been instances of complete blockage of waterways by water hyacinth thus, making fishing and recreation very difficult. Under favourable conditions, water hyacinth can achieve a growth rate of 17.5 metric tonnes per hectare per day. Loss of water, through evapo-transpiration, also occurs due to the presence of water hyacinth in water bodies, such as lakes and dams. It also provides a favourable habitat for mosquitoes and diseases. Since the plant has abundant nitrogen content, it can be used a substrate for biogas production. Studies have been carried out which establish that methane can be produced from water hyacinth. However, aquatic weeds have a tendency to float due to air gaps, makes a scum layer at the top of slurry which hinders the biogas production for efficient bio-methanation of water hyacinth integrated with bubble gun technology.

Keywords: Bio-energy, Evapo-transpiration, Water Hyacinth, Fossil Fuels etc.

I INTRODUCTION

Biogas Potential of Water Hyacinth: Fresh water hyacinth was collected from nearby ponds/lakes and chopped to 2–4 cm size.

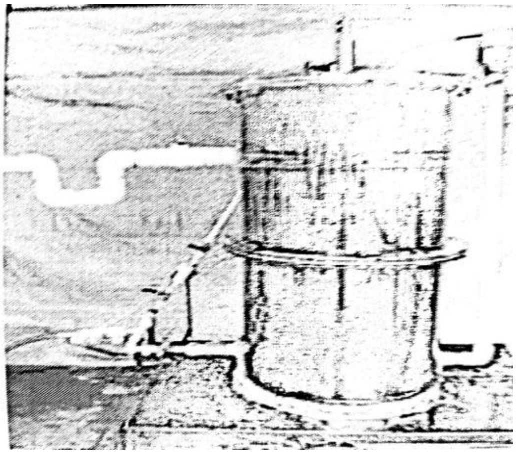
PICTURE 1:WATER HYACINTH

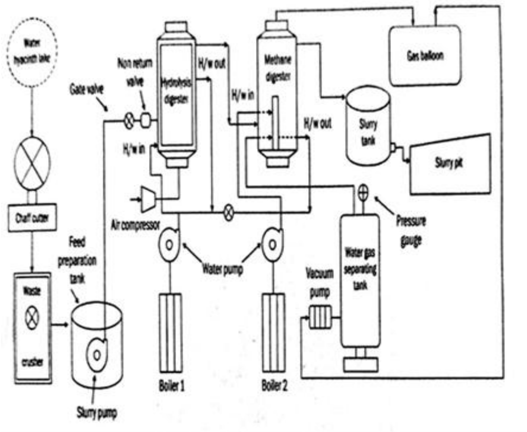
ISBN: 978-93-86171-24-5

Physicochemical properties of water hyacinth were measured using standard protocols (Table 1).

PARAMETERS	VALUES
Total Solids (%) (wb)	9.62
Volatile Solids (%) (db)	79.41
Ash (%) (db)	20.38
Cellulose (%)	22.11
Hemi-cellulose (%)	16.61
Lignin (%)	9.60
C(%)	36.00
N(%)	1.811
P(%)	0.85
K(%)	2.10
CV(Cal/gm)	3,772.69

Table1:Physico-chemical properties of water hyacinth



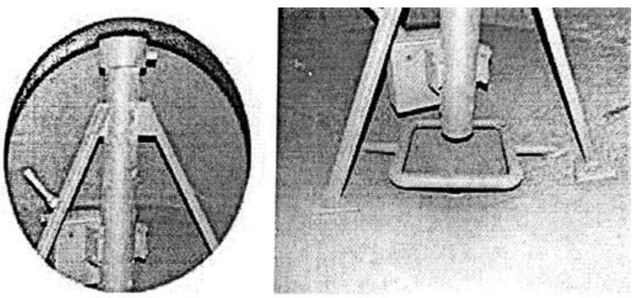


Picture2: Daily Fed Water Hyacinth Reactor Figure1: Bio-methanation Plant Layout

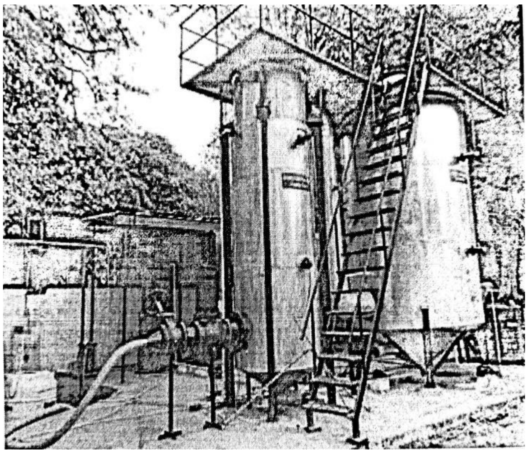
Initially, a semi-continuous biogas digester having the volume of 200 L was developed with inclusion of agitation system where agitation process is carried out with biogas in a closed loop. Foot pump was used to create the pressure and bubbles were formed in a GI pipe which was kept vertical at the centre of the digester (Picture 2). The chopped and crushed water hyacinth is fed at 4 percent total solid content in the daily fed reactor through the inlet and stirring with the recirculation of biogas through pipe is carried out with a foot pump three times a day with 10 minutes duration each time. Hydraulic retention time was 25 days. Biogas production was found to be 20–22 L d^{-1},i.e.,262.5 L kg^{-1} TS water hyacinth.Water Hyacinth Bio-Methanation Demonstration PlantBased on the laboratory data, a high rate scale-up bio-methanation demonstration plant with a feeding capacity of 1–1.20 tonne water hyacinth and water per day was developed. All necessary components required for bio-methanation of water hyacinth, that is, waste crusher, hydrolysis ($3m^3$capacity) and methane digesters (15 m^3 capacity), bubble gun for stirring and mixing the digester contents, geysers to maintain thermo-philic conditions in both the digesters by hot water circulation, storage biogas balloon, water ring compressor pump for homogeneous mixing of the digester contents by re-circulating the biogas through the bubble gun were installed and commissioned. The plant layout comprising all components of bio-methanation plant has been shown in Figure 1. Fresh water hyacinth was chopped to 2–4 cm size and slurry was prepared with addition of water. Acclimatization of the culture with crushed water hyacinth has been initiated by feeding 100 kg of

 ISBN: 978-93-86171-24-5

material and 900 L water. Once the process was stabilized, feeding was increased up to 500 kg water hyacinth and 500 L water. The prepared slurry was pumped into the hydrolysis tank and compressed air passed from the bottom for mixing the contents of the hydrolysis digester. Mixing was done for 30 minutes three times a day. The hydrolysed material was fed into the methane digester. The mixing bubble gun (Picture 3) which was installed inside the methane digester re-circulated the compressed biogas (pressure 0.5 bar) for 15 minutes three times a day. Recirculation of biogas was designed to burst a bubble from the bubble gun every 60 seconds. Both the hydrolysis and methane digesters were operated at thermo-philic conditions by circulating hot water at 50^oC. The pictorial view of a demonstration plant is shown in Picture 4.The average biogas production was observed as 245 L kg^{-1} TS or about 20 L per kg of fresh material with 62 percent methane content. The feeding was maintained at 1 to 1.2 T, thus, keeping the retention time from 12–15 days in the methanedigester. The biogas produced was stored in a 25 m^3 capacity biogas storage balloon, compressed by a vacuum pump and used for recirculation through the methane digester. Energy consumption was measured during the operation for the demonstration plant and it was about 21 kWh which can further be reduced to 11 kWh after optimizing the prime movers and skipping the hydrolysis digester. It was observed that total revenue accrued from the project at the presently installed cost of Rs.3,000,000 was Rs.34,710. Since the cost of project can further be reduced by using only methane digester and escaping the hydrolysis digester and also optimizing the other equipment, the cost of biogas plant can be reduced to Rs.1,500,000and revenue generation will be Rs.79,712. If a financial assistance of 30 percent is provided on its project cost, the payback period may be reduced further. The results revealed that the project is economically feasible and includes a desirable energy gain. The current approach to control water hyacinth does not represent a good social investment because of two major disadvantages: first, the biomass of water hyacinth is not used but is disposed of as waste; and second, the emissions from the thrown water hyacinth enter the atmosphere, thus, adding to greenhouse gas (GHG) emissions. Therefore, the proposed project is a good alternative to the current approach because the methane emission can be avoided and water hyacinth can be used as a substrate for high rate bio-methanation system by mixing bubble gun technology at thermo-philic temperatures for eradication of water hyacinth and other aquatic weeds. Municipalities and other government agencies involved in the disposal of water hyacinth may be benefitted. This bio-methanation system may be used for different wastes, such as vegetable wastes, industrial effluents, etc., where slight modifications may be required as per the substrate.



PICTURE 3: Mixing Bubble Gun with Draft Tube



PICTURE 4:Pictorial View of a Demonstration Plant

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