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Development of Integrated Plant For Bio Energy From Water Hyacinth

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Abstract—

The world fresh water is affected by the unwanted wastes, both liquid and solid wastes and also by some aquatic weeds. water hyacinth(Eichhornia crassipes) plants are the major weed that polluting the fresh water like lakes, dams ponds. Water hyacinth plants are free floating aquatic weed which are fast growing throughout the water , leads to fresh water crisis. This water hyacinth induces various problems like water drainage, clogging of canals, irrigation system, hydro-electricity production and also to living organisms. These kind of problems induces an idea to design a mechanical machine to remove water hyacinth plant from water and also to extract a juice from that weed to use as a alternative fuel. The bio diesel B30 (30% Biodiesel) which produced from the water hyacinth are tested in a CI engine and compared with 100% diesel.

Keywords— Eichhornia Crassipes, Aquatic weed remover, Bio energy production, Transesterification

I. INTRODUCTION

Water pollution is one of the most dangerous thing in this growing world. It leads to the scarcity of fresh water both in rural and developed areas. Mainly water is contaminated by the wastages due to increase in population and the unwanted growth of aquatic plants. Normally, Aquatic plants are categorized into three groups which are "Floating aquatic weeds, Submerged aquatic weeds, Emergent aquatic weeds. The common aquatic weeds are hydrilla, water hyacinth, water lettuce, Salvinia /Kariba weed, parrot's feather, spiked water – milfoil are also leads to the fresh water pollution. Among these aquatic plants water hyacinth are most dangerous and fast growing plant. Water hyacinth plants can grow all around the world , mostly in India as a developing nation. It can grow everywhere like shallow ponds, dams , canals, even fast flowing rivers also. It can survive at most temperature, ph level, and alsoin toxic water. It will grow rapidly in slow moving and still water bodies.

These plants have been originated from South America. Water hyacinth an ornamental aquatic plant but due to its fast reproductivity, it spreads faster over water bodies. This plants can almost double its mass in two weeks.Water hyacinth is a free floating aquatic plant whose roots are detached from the soil. The water hyacinth has a fibrous roots which are capable of trapping oxygen which helps the plant to floatingfreely. The reason behind the rapid growth of water hyacinth plant is the water pollution by several organic and sewage wastes. These waste contain the several nutrients like potassium, nitrogen and phosphorus which are essential for plant growth. Water hyacinth absorbs these contaminated waste nutrients and consume more oxygen from the fresh water leads to the depletion of oxygen level in the water bodies. It results in eutrophication and reduces the water quality. Decreasing bio-diversity and survival of fresh water living organism. Due to its densemass, water hyacinth clog on the water surface and limiting the sunlight to the submerged plants.Under water biodiversity also affects badly by its decay wastes and some allelochemicals released by its decay. This plant vegetative reproduced by producing three celled seed and also by daughter plants. The breeding season water hyacinth are October month flowering and throughout the entire summer season. Water hyacinth flowers are bluish – purple attractively colored and maximum 50-80mm diameter. Flowers are projected above the plant with dense spike like stalk. This purple flowers disperse the seeds throughout the water after 18 days.

Its fast spreading capability and dense mass leads to the blockage of canals, water way transportation, irrigation and also agricultural usages. Another major problem is the reduction of bio diversity, water quality contamination, oxygen depletion, preventing feed for anotheraquatic living organisms. Water hyacinth growthcan be managed by physical, chemical and also in biological methods also. Chemical like glyphosate are sprayed on the water surface to

slow down its growth. This herbicide contain 2,4 – dichlorophenoxyacetic acid which kills the plant. But this herbicide pollute the fresh water and turns it into toxic, so this method is rarely used. The biological pest like myriad bugs, moths, fungal parasites and some pathogens are also used to control its growth. This parasites will feed up the water hyacinth and limiting its growth. The physical control includes both manual and mechanical removal of aquatic weeds. By using labors and hand tools , these weeds are removed manually. Due to this lot of limitations , mechanical method is opted for the safer side removal of water hyacinth. The design of mechanical water hyacinth remover and squeezer prototype gives the efficient output without disturbing the bio-diversity.

II. SIMILAR STUDIES

[1] Akshay Amore, shubam jhagtapet al stated that the most effective and efficient water hyacinth removal technique. Mechanical removal of water hyacinth by a shredder which is most effective in cost basis also when compare to other technique. Easy and safer operation of shredder from start to end. Not only water hyacinth this shredder can be used for removing all kind of aquatic weeds, algae and floating debris. **[2] Prasad shastri , abishek bende et al** stated an economically effective water hyacinth harvester design was proposed. It is cost effective and simple in operation, easy to handle from the beginning to end. It is adjustable to cut and pull the weeds even in shallow water. weed pulling capacity of shredder is 95% and is most effective.pneumatic processor and also electrical utility. The pneumatic cylinder associated with cutter are adjustable and are weeds are pulled through the conveyor belt. The belt which are mounted on the storage tank and the weeds are collected separately in the storage tank and disposed off. This is the combined approach of pneumatic and electrical system which is highly effective to remove waste from water. **[4] Punitha and Sangeetha et al** stated that the water hyacinth is the huge biomass it induces the researchers to use the waste alternatively. The water hyacinth waste is mainly utilized by fibre extraction and it can be used for textile item. Generally water hyacinth fibre is harsh, so it is pretreated with some chemicals to soften the fibre and also to improve its absorbency. By using this method we can improve more than 5 to 11 times its absorbency and it can be used for various purposes. **[5] Harshit sharma and Schauhan** stated The mechanical control of water hyacinth growth and a utilization ideas were discussed in this paper. The water hyacinth plants are highly useful for the production of bio gas and bioethanol production. The biogas is produced by the anaerobic digestion process. Another use of water hyacinth are waste water treatment. water hyacinth plants are used to purify the water by removing nutrient and heavy metals from it. **[6] Nevena nesic et al** stated The collected weeds of water hyacinth plants are used for water purification process. It contain some heavy, so it is necessaryto remove from it. After the removal of heavy metals from it , it can be used as a fertilizer. It can also be used a ash for soil improvement. **[7] Ponpitak Prabkate and Virapong Prachayasittikul et al** stated an new emerging technology to produce the alternative fuel from the renewable sources. Two steps such as acid hydrolysis and fermentation with yeast will results in a bio ethanol production. The bioconversion of aquatic weed to liquid ethanol was performed and the maximum yield is obtained about productivity of 0.008 g $l^{-1}h^{-1}$. **[8] Shailendra Mathur and P.Singh** stated a new cutter machine which was used to reduce the size of the water hyacinth plant and also other weed plants. It comprises the two knife supporting with the holder where the feed waste are chopped. At maximum it reduces theweight of water hyacinth upto 32% and the specific volume reduction upto 64%. It can also used for chopping the other aquatic weeds and also algae. **[9] Omofunmi and Ebifemi et al** stated a harvesting system of water hyacinth plants with the mower disc and shaft associated with blades. The electrical motor are used to drive the shaft which rotates at anticlockwise direction to harvest the hyacinth. The harvester with the high capacity of loading about 846 tons / hr and also the delivery capacity about 538 tons / hr.

SUMMARY

An overview of the literature review gives the fundamental knowledge about the water hyacinth plant habitat and its usage abilities. Use of water hyacinth are waste water treatment suchas purifying the waste water by removing nutrient and heavy metals from it. By performing the acid hydrolysis and fermentation process bio ethanol production can be produced. The water hyacinth are good absorbency in nature, so it can be used in textile production also. To increase itsabsorbency it can be treated with some chemicals. Fully matured plants are used as a fertilizer and also use like a ash to improve soil fertility.

III. METHODOLOGY

A. System Design

This approach is to design the water hyacinth remover to collect the hyacinth plant from the fresh water ponds and also extractthe juice from it. The lab level biofuel production also done based on its chemical composition of the hyacinth juice.

B. Biodiesel Characteristics

Properties	B30 - Biodiesel	ASTM
Density (kg/m³)	875	870-900
Viscosity (mm²/s)	6.8	1.9-7.0
Flash point °C	132	>120
Gross Calorific Value (mj/kg)	38.0	---

C. Engine Specification

Parameters	Specification
Engine Type	Kirloskar 4 Stroke, single Cylinder, constant speed
Power Rating	5.20KW at 1500rpm
Stroke	110mm
Bore	87.5mm
Capacity	661cc
Compression Ratio	17.5 ∶ 1

D. Procedure

One liter of water hyacinth crude oil was heated up to 40°C using electrical hater. A methanol solution(300ml) with NAOH crystals(1% by weight) are added gradually into it. The mixture is continuously stirred and 1% H2SO4 is added. Then it has to settled down for 24 hours, the glycerolsettled down at the bottom and biodiesel floats on the surface.

The testing was done in the 4 stroke, single cylinder diesel engine which run in the constant speed of 1500rpm. The load variation was done using the eddy current dynamometer. Initially the test was done with the D100 (100% diesel) and then with B30 (30% Biodiesel). The emission ofHC,CO,NOX was analyzed by the flue gas analyzer. Fuel consumption was measured with the help of Data Acquisition System. Various Engine parameters were measured and plotted in the graph with respect to load.

INNOVATION

The Both the chemical and biological control methods having the possibilities of pollution the water, mechanical control method is opted forthe safer side removal of water hyacinth. Manual method of control is purely impossible because it consume more work and time. So, the design ofmechanical water hyacinth remover and squeezer prototype will give the efficient output without disturbing the bio-diversity.

V. THEORITICAL CALCULATION

IV. DESIGN AND IMPLEMENTATION

A. Motors

There are two d.c motors are needed for our hyacinth remover. The motor 1with high torqueis connected to the rotary shaft which picks up the waste hyacinth and fed into the conveyorbelt. Motor 2 is connected to the driven pulley of the conveyor belt. Both these motors are mounted separately on the frame of the remover.

B. Rotary guider and Blades

The rotary shaft attached with blades are rotated by the primary motor connected with pulley and belt arrangement. The guider shaft are semi submerged into the water level. When the motor starts running , the shaft will rotate in anticlockwise direction and the curved blades will pick up the weed.

C. Conveyor Belt

Conveyor belt which are mounted on the secondary frame where the driven and driver pulley rollers are attached. The conveyor belt is rotated by these both rollers which are connected to the motor 2. With the help of Conveyor belt the water hyacinth leaves were transported into the collection tank.

D. Collection Tank

It is the skeleton of the device which act as a supporting part. The secondary frame is mounted on the collection tank in inclined position with the help of clamps. The collection tank is fixed in the boat where the conveyor belt drops the collected aquatic weeds

E. Secondary Frame

This is the main theme of the whole mechanism. The secondary frame which is inclined to the boat where the conveyor belt and pulleys are mounted. Drive pulley is mounted on the top of the secondary frame and driven pulley is mounted on the bottom of the frame.

F. Bearings

Two ball bearings are used for the free rotation of driven and driver pulley. The bearing is mounted inside the rollers which enables the frictionless free rotation of both the rollers.

IV. MATERIAL SELECTION

Rotary Blades – Stainless Steel
Rotary Shaft – Teflon
Conveyor – leather (or) Rubber
Base Frame – Mild Steel
Collection Tank – Mild Steel

Design of guider shaft,

ASME code for design of shaftFs max = 0.18 × UTS (N/m²) Fs max = 0.30 × YS (N/m²)

Material used : TEFLONFs max = 0.18 × UTS
= 0.18 × 39.89
= 7.135 N/mm²

Fs max = 0.30 × YS
= 0.30 ×25.02
= 7.5096 N/mm²
For safe operation minimum shear stress is selected then, the allowable Shear Stress is = 7.135 N/mm².

Shaft Power,
P= 2πNT/60
P = 2 π×200×2.863×10³P = 60.908W

Diameter of Shaft,

T= $\frac{\pi}{16}$ × Fs × D³

Where,

T – torque of the shaft (Nm)Fs –maximum shear stress D – diameter of shaft (mm)

T= $\frac{\pi}{16}$ × Fs × D³

= $\frac{\pi}{16}$ × 7.5096 × D³ D= 12.63 mm

Now, considering the standard diameterof shaft as 15 mm and check from torsional failure,
D= 15mm

T= × Fs × D³ $\frac{\pi}{16}$

Fs = T × $\frac{16}{\pi \times D^3}$

Fsact = 4.399 N/mm²

Fsact < Fsallowable Therefore, the shaft is safe undertorsional load

Conveyor Belt,

Maximum suitable belt inclination (α)

α = $\tan^{-1}$ $H/_{lh}$
= $\tan^{-1}$ (320/560)
α = 29°

Flow Ability Factor K=2.20 × 10^{-4}

Mass capacity of conveyor (M),

= $\rho K(0.9B - 0.05)^2 V$

where,
–density of phyacinth (kg/m³)K – flowability factor
B – belt width
V – velocity of belt (m/s) Diameter of pulley = K1× K2× Zp

Where,

K1 - Material factor of plies
K2 - Belt tension and arc of contactfactor
Zp - Number of piles

Diameter of pulley = 1.24 × 41 × 2
= 101 mm

Velocity of belt = $\frac{\pi DN}{60}$

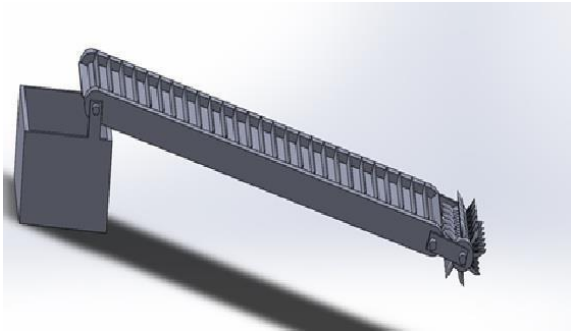
= $\frac{\pi \times 0.101 \times 200}{60}$

= 1.0397m/s

Therefore,

M = $\rho K(0.9B - 0.05)^2 \times V$
= 670×2.20 10^{-4}(0.9×0.24-0.05)²× 1.0397
= 4.2267 ×10^{-3} kg/s
= 16.901 kg/hr

VI. 3D MODELLING



at

Total capacity of storage tank = 100Kg

Rotary shaft diameter = 150mm

Conveyor belt length = 1300mm

Conveyor belt width = 250mm

Number of blades = 48

VII. BIODIESEL PRODUCTION

Transesterification – lab level

It is the reaction of an ester with an alcohol.These reactions are catalyzed by acid or base catalyst. Plant oils and animal fats are highly composed of triglyceride compounds which containing free fatty acids, trihydric alcohol and glycerol.

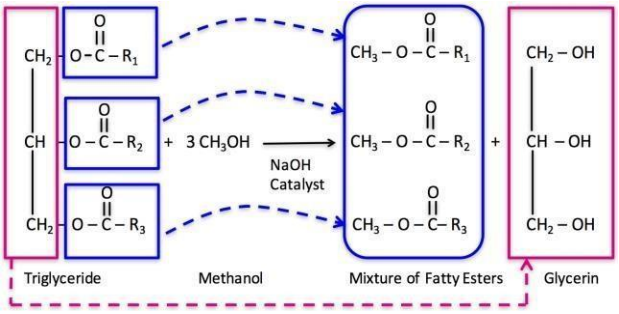


Fig 3. Transesterification process

VIII. TESTED SAMPLES

The crystallization occurs at the surface of biodiesel shown in fig.6 it is due to the improper bonding of alkali groups. Triglyceride and Monoglyceride atoms presenting in the reactants such as ester and alcohols are not reacted properly with base catalyst. To overcome this catalyst such as saccharomyces cerevisiae, candida shehatae, pichia stipites are used. It will enhance the bonding between reactants and helps to produce proper biodiesel.

Fig 4. Extracted Water Hyacinth Juice

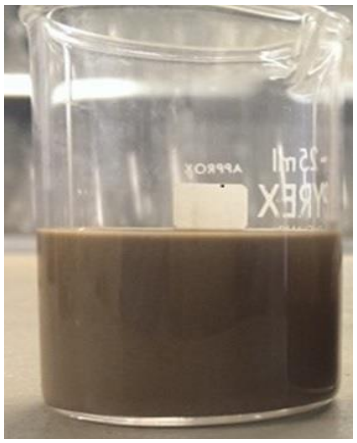


Fig 5. Biodiesel formed with impurities

Fig 6. Crystallization occurs on the surface

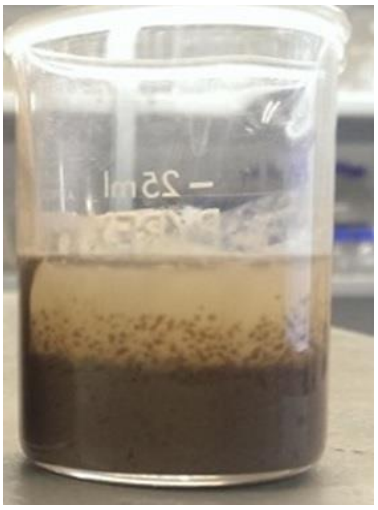


Fig 7. B30 – Biodiesel with 30% water hyacinth bio oil

IX. RESULTS

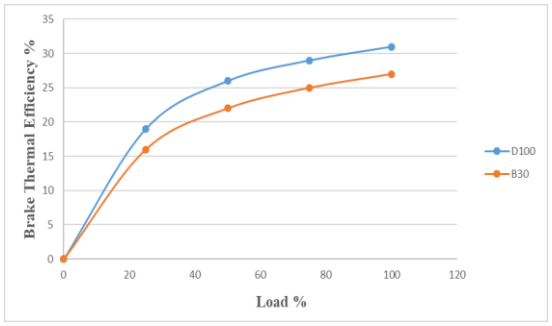


Fig 8. Comparison of brake thermal Efficiency vs load

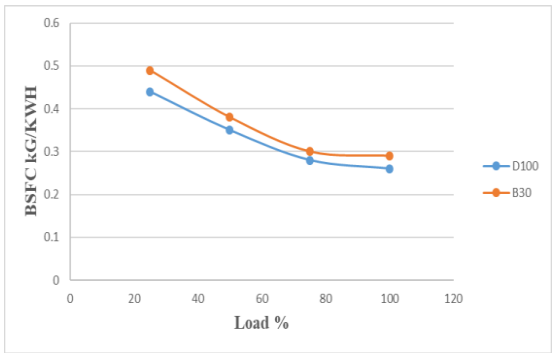


Fig 9. Comparison of Brake Specific fuel consumption vs Load

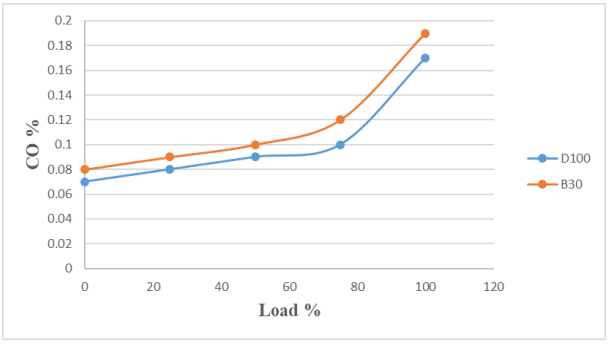


Fig 10. Comparison of carbon monoxide vs load

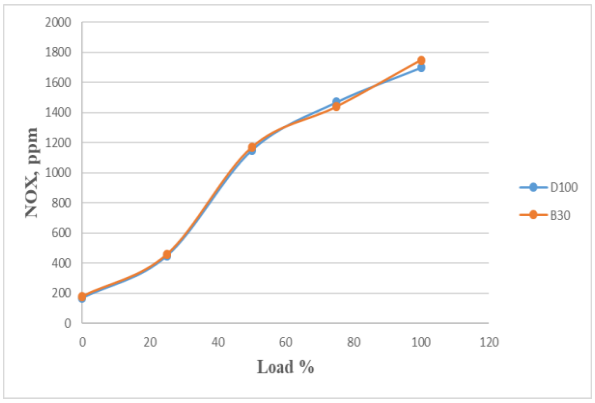


Fig 11. Comparison of Nitrogen Oxides vs Load

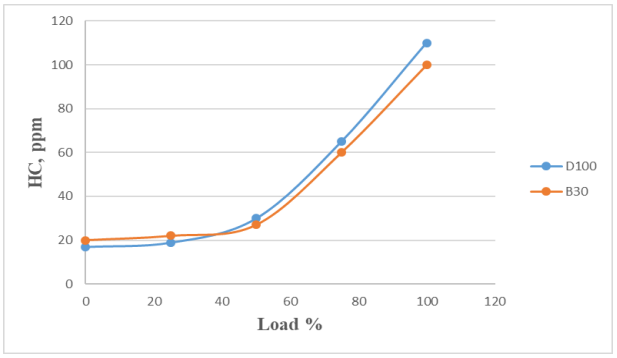


Fig 12. Comparison of Hydro carbons vs load

X. CONCLUSION

The proposed machine will clear 44.44m² which contain 20KG of biomass in one hour. Thus the experimental investigation on performance and emission test on diesel engine with blend of B30 biodiesel we can conclude that, Brake thermal efficiency of B30 is nearer to the D100. Emission characteristics such as CO is nearly close to the D100, NOx emission is slightly higher than D100, HC emission is lower than D100.

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