Electricity Generated By Acetylene Using Waste Water Purifier System

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Abstract— This paper leads to the idea of using the waste water and utilize the water efficiently and effectively so that the water is reacted with chemicals to produce acetylene. Hence this acetylene is used in the internal combustion engine and electricity is produced such that it reduces the demand of the petroleum products that is going to be extinct in near future. It includes about the emissions of harmful gases that can be reduced by the use of acetylene instead of petroleum products. Various fuels have been tested on IC engines for their suitability as alternate fuels. Except few alcohols, CNG and LPG, not many fuels have been found to be matched with IC Engines requirements .Thus this project is an attempt for the use of an alternative resource such that it can prove to be useful for the peoples in near future. Hence to produce the acetylene the waste water is utilized and hence producing less pollutants and better waste water management and air pollution control solutions for greener future.

Index Terms—calcium carbide, acetylene, water filtration, gas, internal combustion engine,

1 Introduction

One of the biggest concerns for our water-basedresources in the future is the sustainability of the current and even future water resource allocation. As water becomes scarcer the importance of how it is managed grows vastly. Finding a balance between what is needed by humans and what is needed in the environment is an important step in the sustainability of water resources. Attempts to create sustainable freshwater systems have been seen on a national level in countries such as Australia, and such commitment to the environment could set a model for the rest of the world. Here we are utilizing the water with calcium carbide to produce acetylene to run the engine and to generate electricity the usevof fossil fuel is increasing drastically due to its consumption in all consumer activities. The high utility of fossil fuel depleted its existence, degraded the environment and led to reduction in underground carbon resources. Hence the search for alternative fuels is paying attention for making, sustainable development, energy conservation, efficiency and environmental preservation, has become highly pronounced now a days the world wide reduction of underground carbine resources can be substituted by the bio-fuels. The SI and CI engines are the major contributors of the GHG. The main researchers around the world are finding the alternate fuel that should have the least impact on the environmental degradation. Rudolf Diesel patented an engine design for used dual fuel system. The present fuel system involves the adaptation of Rudolf with diesel as a single fuel. The emission of COX is unavoidable in fuel combustion systems. An attempt has been made to develop a tri fuel system without additives in conventional C.I engines to achieve bio-fuel and to reduce emission of pollutants. The results are presented and discussed. [1]

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2. About Acetylene

Various industrial environments, acetylene generation are initiated in acetylene generators. These equipment are sold in various capacities from 8 m3 to over 200 m3 per hour. Calcium carbide is introduced from the top of the generator shell into the water. The chemical formula of this reaction can be expressed as:

$CAC2 + 2\ H2O \rightarrow C2H2 + CA\ (OH)2$

This reaction should only be conducted under controlled conditions. The process unit should be equipped with pressure and temperature sensors, as well as non-return valves for safety purposes. [1]

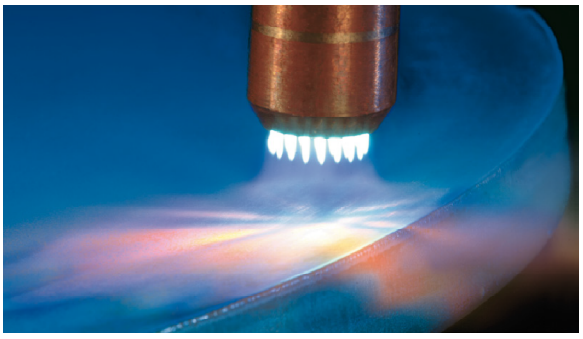

Fig.1. Industrial use of acetylene

Acetylene is the colorless gas with garlic smell produced from the calcium carbide, which is obtained from calcium

carbonate. Further the calcium carbonate is heated in lime kiln at about 825 degree Celsius which forms calcium oxides (lime) liberating. Calcium oxide is then heated in electric furnace with coke to produce calcium carbide finally calcium carbide is hydrolysed producing acetylene.
As acetylene is highly combustible with high flame speed and fast energy release, it can be used as alternative fuel in IC engines. It has a very wide flammability range and minimum ignition energy required for ignition. Furthermore comparing with various other fuel properties, acetylene proved good to be used in internal combustion engines. [2]

2.1. Total Emissions Of Acetylene

The molecular weight of acetylene is 26 with two carbon atoms (C2H2) gas density = 0.068 lb/ft3 typically the Material and Safety Data sheet will provide this detail of information) while the molecular weight of CO2 is 44 with one carbon atom. Given that each mole of acetylene, under complete combustion, will create two moles of CO2 (i.e., each pound of acetylene combusted will produce 3.38 pounds of CO2 (2x44/26)). Use the following conversion calculations to derive an emission factor for acetylene:

$$\frac{0.068\ lb}{1\ cubic\ feet\ of\ C2H2} \text{ x } \frac{453.6g}{1\ lb} = \frac{30.854g}{1\ cubic\ feet\ of\ C2H2}$$

$$\frac{30.854g}{1\ cubic\ feet\ of\ C2H2}\ X\ \frac{1}{26.04/1\ mol\ C2H2} = \frac{1.185\ mol\ C2H2}{1\ cubic\ feet\ of\ C2H2}$$

$$\frac{1.185\ mol\ C2H2}{1\ cubic\ feet\ of\ C2H2}\ X\ \frac{2\ mol\ CO2}{1\ mol\ C2H2} = \frac{2.370\ mol\ CO2}{1\ cubic\ feet\ of\ C2H2}$$

$$\frac{2.370\ mol\ CO2}{1\ cubic\ feet\ of\ C2H2}\ X\ \frac{44.01}{1\ mol\ CO2} = \frac{104.304\ g\ CO2}{1\ cubic\ feet\ of\ C2H2}$$

$$\frac{104.304\ g\ CO2}{1\ cubic\ feet\ of\ C2H2} X\ \frac{1\ metric\ ton}{10^6} = \frac{104.304\ X\ 10^{-4} m.ton\ CO2}{1\ cubic\ feet\ of\ C2H2}$$

Acetylene consumed (cubic feet) X Acetylene emission factor ($\frac{104.304 \text{ X } 10^{-4} \text{metric ton CO2}}{1 \text{ cubic feet of C2H2}}$) = Total emissions (metric tons)

The result obtained from this calculation illustrates that the amount of CO2 emitted is fairly minimum and other emissions like NOx, SOx are highly negligible compared to CO2. Also the CO emission is less comparing to gasoline. This indicates that acetylene can be relatively more environmental friendly than gasoline.[3]

3. METHODOLOGY

There are multiple stages of energy conversion. In the first stage waste water is purified and stored. In the second stage the water used with proper proportion with calcium-carbide to produce acetylene and proper storage of acetylene is done. In the third stage this acetylene is used as fuel for internal combustion engine hence controlling the engine for regulated torque and speed output. This rotational output of IC engine is fed to alternator to produce electrical output. Hence this method of energy harvesting is cheaper and has lesser pollutants thus we can utilize water from STP plant for energy supply. This is a decentralized and simple method of electrical power generation and hence this method can be employed in domestic purpose for a standby power supply.[4]

4. OVERVIEW OF PROJECT

4.1. Step 1:

Water is passed through many portion of purification elements like char coal, filter papers, sand and gravels such that all the impurities are blocked and hence we can obtain cleaner and fresh water at the other end and collect it for the reaction purposes [5]

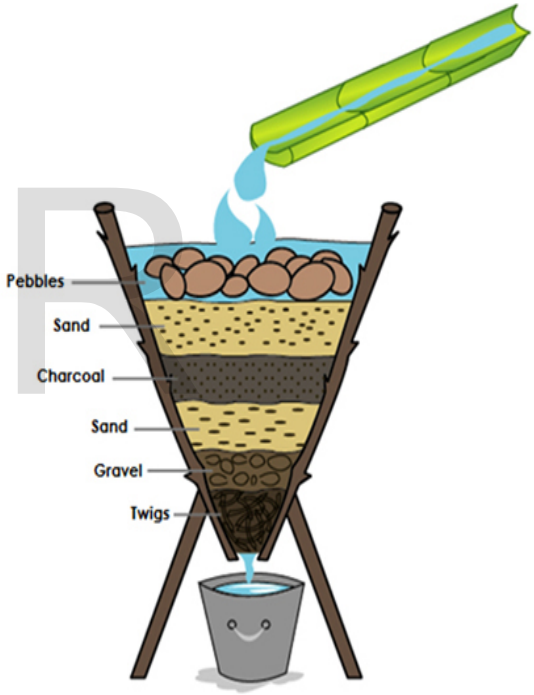

Fig.2. water filtration unit

4.2. Step 2:

The second step involves the production of acetylene gas through the Calcium Carbide reacting with water in the reaction tank.[6]
CaC2+2H2O C2H2+Ca (OH)2

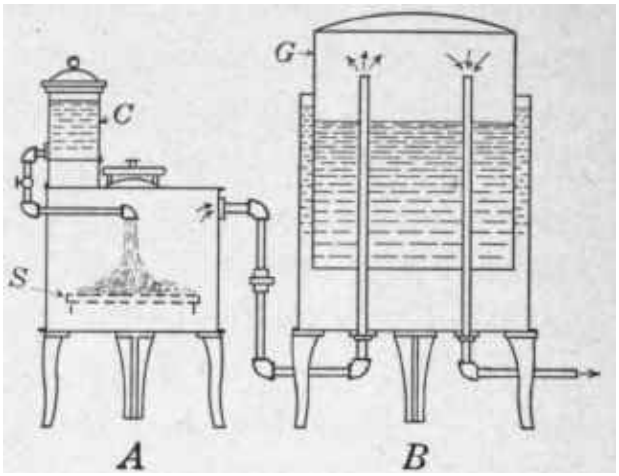

Fig.3. calcium carbide reaction chamber

The reaction tank constitutes two chambers:

- In first (upper) chamber the water is kept.
- In second (lower) chamber the calcium carbide is kept.

The water from the first chamber is released in such away to proceed the reaction spontaneously. The water is passed through the control valve. In the second chamber the calcium carbide is kept in desirable amount to react with water. Through second chamber a valve is connected to the storage tank where the gas produced during reaction is stored.[6]

4.3 Step 3

In this step the acetylene gas is stored in the storage tank and the pressure is measured by the pressure gauge. In this step the produced gas is stored and is passed through the pipes. Here the gas is stored to avoid moisture and the gas stored in storage tank is provided pressure through pressure gauge so the gas is of high concentration.[7]

4.4 Step 4

The gas in passed in the pipes in a very Sophisticated manner and then pipe is joined in the carburetor fitted with the filter, this then filters the air and acetylene then the mixture is passed in the engine and combustion is made [8]


Fig.4. air and gas intake

4.5 Stage 5

The engine is coupled to the electric generator such a way that it runs in a speed of 1500 rpm and hence we can generate electrical output of 1.5KW. [9]


Fig.5. engine connected to alternator

TABLE 1
COMPARISON OF EXHAUST GAS

Gasoline($C_8H_{14.96}$)		Acetylene(C_2H_2)	
CO_2	0.0695	CO_2	0.0804
H_2O	0.1239	H_2O	0.720
CO	0.0642	CO	0.058
H_2	0.00124	H_2	0.00836
N_2	0.7410	N_2	0.7586

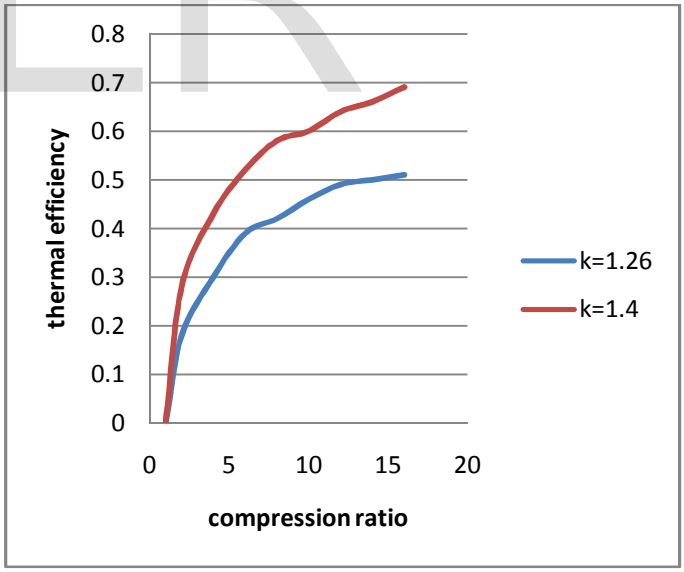

Fig 6: thermal efficiency v/s compression ratio

TABLE 2
COMPARISON WITH OTHER FUEL GRAPH SHOWS THE THERMAL EFFICIENCY OF AIR AND ACETYLENE UNDER DIFFERENT COMPRESSION RATIO

Physical and combustion properties of fuels	acetylene	Hydrogen	Diesel
Fuel	C_2H_2	H_2	C_8-C_{20}
Density kg/m^3(at 1 atm& 20^{o}C)	1.092	0.08	840
Auto ignition temp (^{o}C)	305	572	257
Stoichiometric air fuel ratio, (kg/kg)	13.2	34.3	14.5
Flammability limits (vol %)	2.5-81	4-74.5	0.6-5.5
Flammability limits (equivalent ratio)	0.3-9.6	0.1-6.9	
Lower calorific value (kJ/kg)	48,225	1,20,000	42,500
Lower calorific value (kJ/m^3)	50,636	9600	
Max deflagration speed (m/sec)	1.5	3.5	0.3
Ignition energy (MJ)	0.019	0.02	
Lower heating value of stoichiometric mixture (kJ/kg)	3396	3399	2930

5 Ozone Layer Depletion (Photochemical Ozone Creation Potential (POCP))

Despite playing a protective role in the stratosphere, at

Photochemical ozone production in the troposphere, also known as summer smog, is suspected to vegetation and material. High concentrations of ozone are toxic to humans. Radiation from the sun and the presence of nitrogen oxides and hydrocarbons incur complex chemical reactions, producing aggressive reaction products, one of which is ozone. Nitrogen oxides alone do not cause high ozone concentration levels. Here are some of the comparisons of POPC between several compound.[10]

TABLE 3
POPC Compression Of Different Compound

VOC	POCP
Ethane,C_2H_6	8.8
Propane,C_3H_8	18.3
n-Buthane,n-C_4H_{10}	36.3
n-pentane,n-C_5H_{12}	36.6
2,2-Dimethyylpropane,$C(CH_3)4$	20.3
n-Hexane,$CH_3(CH_2)_4CH_3$	45.6
n-Octane,$CH_3(CH_2)_6CH_3$	40.1
Ethylene,CH_2-CH_2	100
Propane, CH_3CH-CH_2	105.4
Trans-2-butane,$CH_3CH=CHCH_3$	110.7
Acetylene CH=CH	**9.9**
Formaldehyde, HCHO	47.1
Acetaldehyde, CH_3CHO	55
Acetone, CH_3COCH_3	7.5
Butanone,$C_2H_5COCH_3$	35.3
Methanol, CH_3OH	16.5
Ethanol, C_2H_5OH	39.7
Benzene, C_6H_6	20.3
Toliene, $C_6H_5CH_3$	51
1,3,5-Trimethylbenzene, $C_6H_3(CH_3)_3$	108.2

TABLE 4
Calorific Values Of Different Fuel Gas In Comparison With Acetylene

Fuel Gas	(*kcal/kg*)	
	Gross Heating Values	Net Heating Values
Hydrogen	33889	28555
Methane	13284	11946
Ethane	12400	11350
Ethylene	12020	11270
Natural Gas - approximately	12000	11000
Propane	12030	11080
Propylene	11700	10940
n-Butane	11830	10930

Fuel Gas	(*kcal/kg*)	
	Gross Heating Values	Net Heating Values
Iso-Butane	11810	10900
Butylene-1	11580	10830
Acetylene	11932	11514
LPG (average)	11920	10997

6APPLICATIONS:

- A good replacement for gasoline and petrol.
- It can be used in place of LPG directly with minor manipulation in engine.
- As it emits CO2, so it is more eco-friendly thus its use can be beneficial in countries like India where in year 2050 fossil fuel will get depleted (shown by studies).[11]

7ADVANTAGES:

- Emission is non-polluting as only carbon dioxide and water vapours are emitted.
- Homogenous mixture is formed due to which complete combustion.
- Better efficiency.
- It is very cheap and available in abundance.
- It uses same handling system which is used in CNG and LPG cylinders.
- It has very low Photochemical Ozone creation Potential (POCP).
- An engine operated on such a fuel can be interchangeably utilized for indoor and outdoor
- Operations without environmental concerns
- The need for a three-way catalytic converter or other EGR device is eliminated
- Due to reduced operating temperatures, there are fewer tendencies for viscosity
- Breakdown of engine lubricants and less component wear
- Due to cleanliness of the combustion process, build-up of carbon- and sulphur
- Compounds are eliminated thereby substantially extending the time intervals between routine maintenance.[12]

8RESULT:

- Complete combustion of acetylene occurs when oxygen gas in the surrounding air mixes completely and is present in the stoichiometric mole ratio to react completely with the amount of hydrocarbon. For acetylene, the mole ratio is five moles of oxygen per two moles of acetylene 2:5
- 1 kg of calcium carbide produces 0.41 kg of acetylene and hence one gram of acetylene produces 48.2KJ of energy and 1.92KG of calcium carbide is used to produce 1.5 KW/hr energy in our setup in the presence of atmospheric air.
- In the presence of pure oxygen , 1.52KG of calcium carbide is used to produce same amount of electrical energy, here carbon monoxide percentage is also reduced when oxygen and acetylene is used in the proportion of 2:5 ratio also it is observed that the vibration and knocking is also reduced in a significant quantity.

9 CONCLUSION:

- The main focus of this paper is on the waste water utilization in a appropriate way to generate the electricity and control the air pollution by reducing the emission of flue gasses.
- This paper includes the fact that acetylene can be a good fuel for the country where calcium carbonates are abundant in nature as it is very cheap.

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