IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 66-69

Development of Alternate fuel system for drone technology to make it Hydrogen adaptive.

K. A. Mahajan, V. R. Joshi, S. T. Banerjee, M. J. Deo
(Department of Mechanical Engineering, Modern Education Society's College of Engineering, Pune, India)

Abstract: *This paper focuses on the details of a Drone system which utilizes the electricity produced from Hydrogen Fuel Cells ; the system also relies on the buoyant force obtained from the Hydrogen storage tank which gives a major thrust and drastically reduces the Lift required for hovering of the Aerial System. The paper also highlights the applications in which the above said system can be made operational. Presently, drones are quint essential for the ease of security systems especially in the field of surveillance and attack. But, the major drawback encountered in the conventional drone systems is that they lack hovering capability and also rely heavily on the power obtained from heavy battery packs. Hence, the authors have tried to device a major change and introduce a system such that the storage of the fuel itself assists the Hovering capability of the drone as well as provide it with ample amount of power so that it can traverse rapidly in the commanded directions. Much focus has also been made towards the production of Hydrogen Gas, which is the main driving force behind all this concept.*

Keywords: *Aerial, Battery, Buoyant Force, Drone, Fuel Cells, Hovering, Lift, Surveillance, Hydrogen gas*

I. Introduction

The authors intend to design a drone system which will be very versatile in nature. It draws power from hydrogen gas energy after that is converted to electricity with the use of fuel cells. In the modern times, applications of drones are increasing rapidly. Different models are coming with unique design; in the same manner, we have conceptualized a drone system as known as 'IndoHydroDrone' which will use Archimedes principle to give a lift force about that required for it to hover without the external power requirement. By doing so, the drone system will sustain longer duration of flight times and can be used extensively in the field of surveillance and attack, in a compromised situation / location where there is alarmingly high proximity of threat levels. The design of the drone system will be such that it displaces maximum amount of air in which it is scheduled to travel, and at the same time, it maintains optimum aerodynamic forces so that it can traverse in any desired directions as commanded by the operator. By displacing maximum amount of air, its density is apparently reduced drastically, and hence a larger buoyant force is experienced by the drone so that it can hover easily. For having safe descent, the shape of the drone can be changed so that it will displace minimum amount of air and hence the buoyant force reduces drastically, the density of the drone system increases rapidly and hence it descends down due to its self weight, and also because of the gravitational field.The rate of descent and ascent can be controlled by the operator as the situation demands. It can be done with the help of sophisticated controllers and sensors which are deployed in the 'IndoHydroDrone'. The 'IndoHydroDrone' can be used in heavily crowded market areas after having installed a Closed Circuit Television Camera (C.C.T.V), and also, it is used in industrial processes where constant monitoring is required and physical inspection of the process is not possible. The 'IndoHydroDrone' can also be equipped with an automated pistol gun, which can be automatically controlled by the operator from a remote location; the gun be activated and the bullets can be shot at the target for total or surround shots if the threat perception is extremely high.

II. Different processes of producing Hydrogen for re-fuelling the IndoHydroDrone system

2.1 Steam Reforming: [1]

Steam Reforming of Natural Gas is currently the most common method for industrial-scale hydrogen production. While this technique produces significant carbon-dioxide emissions, it can be combined with CO_2 capture, concentration and storage (CCS) to become a carbon-neutral process. In addition, methane can be obtained by fermentation of biomass rather from natural gas[1]. But, this technique will be difficult to adopt to fill the IndoHydroDrone, since it requires a considerably large area and cannot be done in a stealth way, if the situation demands so.

2.2 Catalytic Steam Reforming: [2]

Steam reforming is a method for producing hydrogen, carbon monoxide, or other useful products from hydrocarbon fuels, such as natural gas. This is achieved in a processing device called a reformer, which reacts a hydrocarbon with steam at high temperature. Currently the steam methane reformer is widely used in industry to make hydrogen. [2] This method cannot be adopted either, owing to its huge area requirements and production of effluents which are quite visible and hinders the surveillance operations if they are meant to be carried out in a secretive manner.

2.3 Alkaline Water Electrolysis : [3]

One of the most popular way to split water electrochemically is to use an alkaline water electrolyser (AWE). This technique has been used in the chemical industry for many years and the state of development of AWEs for high amount of hydrogen production, largely due to the simplicity of this technique. This method can be easily adopted and utilised for filling the IndoHydroDrone system. Efforts have been made to make a unique Hydrogen-Gas Electrolyser to fill the IndoHydroDrone system. The electrolyte is typically an alkaline solution of $KOH_{(aq)}$ or $NaOH_{(aq).}$ The oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) occur at the anode and cathode, respectively :

Anode : $2OH^- \Longrightarrow H_2O_{(l)} + (1/2)\ O_{2\ (g)} + 2e^-$

Cathode : $2H_2O_{(l)} + 2e^- \Longrightarrow H_{2(g)} + 2OH^-$

The overall reaction is as follows -

$H_2O \Longrightarrow H_{2(g)} + (1/2)O_{2(g)}$

Oxygen gas is produced at the anode, because OH^- is more easily oxidised compared with H_2O. At the cathode, H^+ is reduced to form hydrogen gas, since H_2O is more easily reduced than K^+ or Na^+.

2.4 EXPERIMENTAL SETUP

The setup consists of a container which contains the electrolyte. It is inserted with nickel plated copper plates which act as electrodes (both cathode as well as anode). The electrolyte used is Potassium Hydroxide Solution ($KOH_{(aq.)}$ 25% Wt. / Vol.) and the container is made of acrylic sheets. The Electrodes are attached to the power source (D.C) by copper wires as shown in Fig. 1. The H_2 gas is collected at the negative electrode and it travels up through a narrow cavity which is provided by the inverted syringe. From there H_2 gas travels through narrow tubes of silicon material up to the delivery point.

Fig.1: Electrolysis Setup

We tested the electrolysis setup using a Switched Mode Power Supply (SMPS) as shown in Fig 2. We observed the following :-

At 12 Volts and 10 Amperes (D.C Power Supply) using $KOH_{(aq.)}$ Solution (25% Wt./Vol.) bubble formation occurred and gas was collected at the surface of electrolytic solution, but unfortunately the gas could not escape the surface of the solution. This is probably due to inappropriate rectification of AC to DC current by SMPS due to its inherent characteristics. If battery is used instead of the SMPS then this problem will not occur.

Fig. 2: Switched Mode Power Supply

To calculate the actual flow of H_2 Gas, a mass flow meter of H_2 Gas is required. It will give the exact amount of gas ejected from the electrolysis setup. The setup of a gas flow meter consists of an inlet, an Outlet and a display unit.

Fig. 3: Gas Flow Meter with Digital Display [4]

Fig. 3 shows a gas flow meter with Digital Display. These Digital Mass Flow Meters are very accurate.

III. Buoyant Forces Acting On the Indohydrodrone System.

3.1 Weight Considerations of IndoHydroDrone system.

A total weight of the complete system is assumed to be 10 kilograms (kgs).
it can be splitted into three major parts i.e. :-
a) Weight of the Fuel Cell = 2.5 kgs
b) Weight of the IndoHydroDrone = 3 kgs
c) Weight of any external carrier = 4.5 kgs
The external carrier's weight depends on its nature, orientation and density. It can vary from situation to situation.
Density of fluid displaced (air) = $\rho = 1.225\ kg/m^3$
Buoyant force of Hydrogen gas can be given as :-
$F_{Buoyant} = \rho \times g \times V$
ρ = Air Density = $1.225\ kg/m^3$

g = Acceleration due to gravity = 9.81 m/s^2
V = Volume of the tank of IndoHydroDrone system = 0.05 m^3
$F_{Buoyant}$ = 1.225 x 9.81 x 0.05 = 0.60086 N (Newton)
Total Weight of the IndoHydroDrone system = 10 kg = $F_{TotalWt}$ = 981 N
Therefore,
Thrust force needed to be powered by the Hydrogen Fuel Cell system :-
$F_{Thrust} = F_{TotalWt} - F_{Buoyant}$
F_{Thrust} = 981 - 0.60086 = 980.399 N

IV. Conclusions and Future Scope

1) Efficient method of Hydrogen production, for filling into the Tank of the IndoHydroDrone system is found out to be Alkaline Water Electrolysis.
2) The force requirements by the propeller blades have been reduced.
3) The lifting time for the Drone has been cut down to a large extent.
4) This IndoHydroDrone can be used in various fields such as Surveillance, inspection and attack purposes.

Conflict of interest The authors declare that there is no conflict of interests regarding the publication of this paper.

References

[1]. Y. Shiratori, Q.-T Tran, M. Tajima, T. Ogura, O. Higashi, S.M. Lyth, Springer, Japan 2016, *Hydrogen energy Engineering, Green Energy and Technology.*
[2]. Y. Shiratori, Q.-T Tran, M. Tajima, T. Ogura, O. Higashi, S.M. Lyth, Springer, Japan 2016, Hydrogen energy Engineering, Green Energy and Technology.
[3]. K. Ito, Hua Li, Yan Ming Hao, Springer, Japan 2016, *Hydrogen energy Engineering, Green Energy and Technology.*
[4]. Gas Flow Meter with Digital Display, http://www.aalborg.com