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Solar Powered Ozone Generator Prototype Using Corona Effect

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Abstract : *This project aims to develop a sustainable solar powered ozone generator whose operating principle is based on the production of ozone by corona effect. Ozone gas is now-a-days used for treatment of drinking water, disinfection, and air-purification.Corona effect occurs when an intense electric field accelerates the existing electrons around a conductor. This effect generates ozone through a high voltage process that produces a strong enough electric field to break the dielectric strength of the air between the electrodes and breaks the oxygen molecules and form ozone(O3). This phenomenon occurs at or near a field strength of 2kv-10kv. Flyback converter which is excited by a high frequency Hartley oscillator and act as a high voltage-high frequency transformer to reach the expected voltage. The whole system is powered by the solar photovoltaic panels . This work is aimed to evaluate the efficiency of this solar powered ozone generator.*

Keywords - *Air purification, Corona Effect, Flyback converter, Hartley Oscillator, Ozone generator, Photovoltaic panels*

I. INTRODUCTION

Industries and manufacturing advance causes serious damages to environment, these impacts are mainly visibly due to pollution emitted as gases and effluents. However, most companies are looking for alternatives that are both fast and efficient in reducing environmental degradation and ozone seems to be the best disinfectant out there. Ozone is among the best disinfectants known in the world, which is 3125 times more powerful than chlorine and 100% environmentally friendly. Nowadays, ozone is widely used in industries for disinfecting and oxidizing in substitution of chlorine. With the help of the ozone generator using corona discharge method. Corona effect generates ozone through a high voltage process that produces a strong enough electric field to break the dielectric strength of the air between the conductors, where the free electrons reach high speeds, breaking the oxygen molecules and forming ozone gas. The electric discharge process, which consists in the application of an electrical potential difference between the reactor electrodes can be obtained from the use of a flyback converter, excited by a high frequency oscillator acting as a high voltage transformer. Among the all the circuits available for HV production, the Hartley oscillator stands out best among them because it meets the demand for high frequency and its use makes possible the utilization of higher current values than other oscillator type which implies in a higher power at the transformer output. This project aims to develop a sustainable solar powered ozone generator whose operating principle is based on the production of ozone by corona effect. The operational framework of ozone generator is divided in four main blocks, which consist of power supply unit, voltage regulator, high voltage generator and air ionization unit. By applying electronic concepts the system intends to construct a stable and sustainable system. [1]

II. METHODOLOGY

Among the many other producing gas methods, corona discharge method is preferred. The production by corona discharge, which produces ozone in significant amounts, being the most used method to obtain gas. The use of photovoltaic module as a power source would be an economically and environmentally viable alternative with potential on reducing costs while decreasing the impacts caused by consumer's high demand for electricity

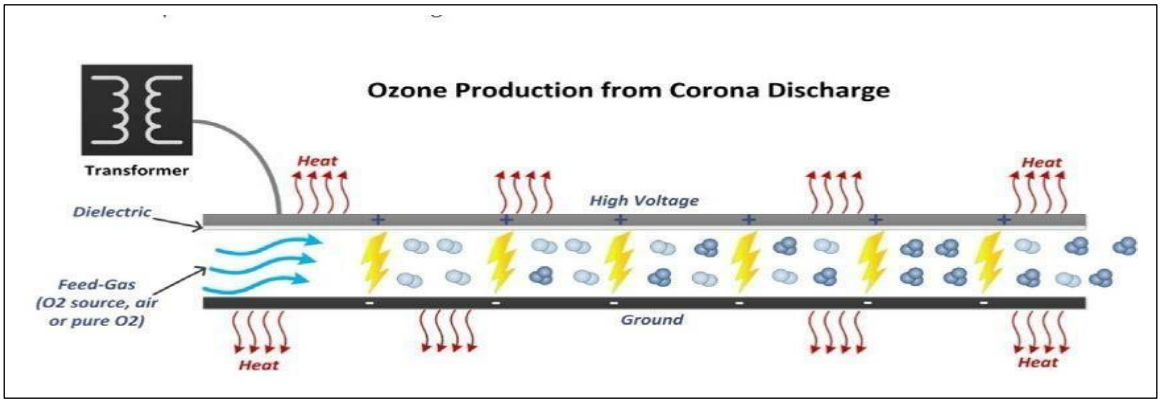

Figure 1: Corona discharge tube

2.1 Working Principle:

The basic method used here for the ozone generation is based on the corona discharge method using solar power as power supply source. The solar panel sends the power to the battery where in between charge controller is installed which regulates the voltage from the solar panel as it's transferred to the battery. The battery then supply the dc power to the voltage regulator which is used to prevent the voltage from dropping down or rising above a required value. Voltage regulator further powers the high voltage generator where flyback converter is used, excited by a high frequency oscillator which would act as a high voltage transformer. The high voltage supply generated from the flyback transformer is given to the ozone chamber in which two electrodes are placed co-axially with a dielectric medium created between them. This electrode contains outer pipe (-ve) glass dielectric and inner stainless foil (+ve).then oxygen gas is passed between two electrodes. Where high potential above 3kV is applied between these electrodes, the oxygen molecule will be converted into ozone

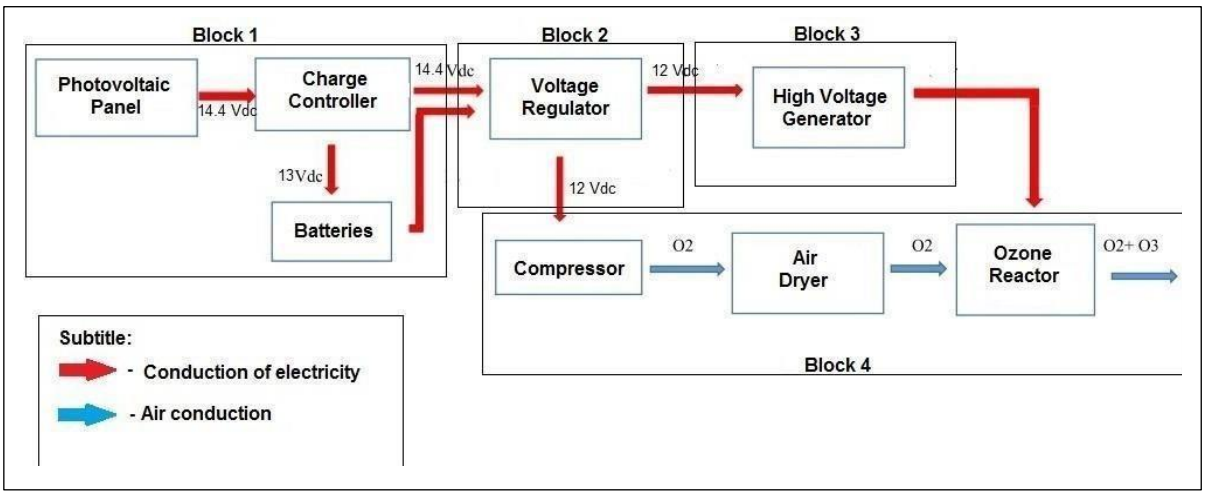

Figure 2: Block Diagram of Prototype

2.2 Mathematical Calculation for Components

Output Frequency of the Hartley Oscillator can be calculated by the formula: $(F) = 1/2\pi\sqrt{LtC}$ (1)
Where Lt = L1 + L2
Required L1, L2 and C for High voltage generation are:
L1 = 3169 to 507 nH, L2 = 3169 to 507 nH
C = 10uF
Power Calculation
Discharge power can be calculated by: P (t) = V(t)*i(t) (2)
Ozone Calculation

Ozone production**:** (gm/hr) = LPM * 0.001 * 60 *14.3*%O3 (3)
Where LPM is Flow rate of oxygen
Ozone efficiency**:** (g/kWh) = Produced Ozone (g/Nm3)/Discharge power(P) (4)

III. FIGURES AND TABLES

Table 1: Material Required

Components	**Specification**	
Solar panel	Material	Poly crystalline
	Rated power range	1-30W
	Watt	10 W
	Voltage at P max	17.3V
	Module voltage	12V
Charge controller	Charging voltage	11-17V
	Upper limit current	10A
	Type	Li-ion
Battery pack	Type	Li-ion Rechargeable type
	Rating	12V 20ah
	Max discharge current	3A
Voltage Regulator		
Zener diode	Range	3-100V
Transistor	Rating	30V,100ma
Resistor	Rating	10-10k ohm
Flyback converter	Voltage range	1Kv-10Kv
Dc Fan	Rating	12v, 0.13A
	Input power	1.6 watt
	rpm	2700
Electrodes		

IV. CONCLUSION

The prototype designed would be used to obtain ozone gas by corona discharge method will be used in water treatment, air purification, sanitization and demonstrate the technical feasibility regard to construction of a sustainable ozone reactor. The advantages of the proposed system are its high efficiency, smaller size and lower cost. Corona effect, responsible for obtaining ozone, was controlled and constant respecting the electrical parameters observed in the electronic construction of flybacks. The voltage step-up is achieved by use of flyback converter excited by hartley oscillator, which would acting as a high frequency-high voltage transformers and makes possible the utilization of higher current values. This high voltage supply easily attain the threshold limit of voltage for corona generation, which is 2.5kv. The use of solar energy as a power supply would be beneficial as it would provide continuous supply whenever needed because of the battery used in the system. The co-axial arrangements chosen of the electrodes will prove to be more beneficial as compared to the parallel plate configuration as it will provide additional capacitance to the electrodes which will help in more ozone yield.

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