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Solar powered Air purifier used in Solar Helmets

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Abstract: Traffic jams and air pollution in India are very common and are so intense that it will take hours to travel for miles and the quality of air is bad which makes the rider feel discomfort. The section 129 of the motor vehicles act, 1988 makes mandatory for a person driving two wheelers to wear a helmet, but due to the average temperature inside the helmet, people refuse to wear it. So I have fused the technology and a basic helmet in which printable solar cells are embedded and the air filter is powered by it. The air filter used here is electrostatic precipitator. To prevent the deterioration of solar cells from rain, it is provided with IC 555 which is powered by the secondary battery which acts as a back-up. This paper describes the principle of the printable solar cells,purification of air in electrostatic precipitator and the working of IC 555 rain sensor, secondary battery. It also gives the information of the air pollution in major cities in India and the way to escape from harmful side effects of it. With this idea, the use of solar helmets will be enhanced to the maximum extent.

Keywords: printable solar cells, electrostatic precipitator, secondary battery, back-up, purification.

I. INTRODUCTION

Safety and security is one of the most talked of topics in almost every aspect. Previously the most compulsion is to wear the helmet for the bike rider's safety. For the inconvenience caused many of them refused to wear the helmet which caused the death of those people. Keeping in view of the inconvenience caused in the helmet, I have implemented air purifier which will enhance the user to lower the average temperature inside the helmet, get pure air to breathe. These are the two main aspects that led me to devise such equipment. Moreover, wearing helmet is important and good both for the rider and the co-rider. To get the Electrical energy source we have taken printable solar cells as source which is embedded in a normal helmet. The solar cells can normally produce 5V to 12V depending upon their cell size, quality and type of material used. The secondary battery is charged using the energy obtained from the printable solar cell and it powers the air purifier. The air purifier used in my project is electrostatic precipitator. The secondary battery acts as an back- up power to the air purifier. During the cloudy and rainy days, they provide power to the air purifier. And it is also connected to the rain sensor to guard the printable solar cell from rain. The storage quantity and the amount of energy stored depends completely on the type of secondary battery used.I have used IC 555 for rain sensor as it is more economical and easy to implement. It is used to cover the printable solar cells during rain. It is powered by secondary battery. The air purifier used is electrostatic precipitator which consists of two electrodes namely collection electrode and discharge electrode. I have selected electrostatic precipitator as the air purifier because the maintenance is easier and the electrostatic precipitator can be cleaned with water.

II. HARDWARE IMPLEMENTATION IN HELMET

A. Printable Solar Cells

Printable solar cells are nowadays made by inkjet printer to put down the semiconductor material and electrodes onto a solar substrate in order to make it more flexible and installed easily. Both organic and inorganic solar cells can be made using the inkjet method. Inkjet printed inorganic solar cells are mainly Copper Indium Gallium Selenide (CIGS) solar cells. First, the ink is prepared which consists of CIGS in the organic case and Fullerene blend in case of organic. These are the materials which provide electric power from sunlight. To enhance the efficiency of the solar cells other materials are also deposited. The entire process is done in atmospheric pressure and a temperature of 500 °C. The basic principle of printable solar cells is same as that of photovoltaic cells. When the solar energy falls on it, the light energy is converted into electrical energy which is known as the photovoltaic effect. The efficiency of the printable solar cells are comparatively high as compared to solar photovoltaic cells. The important factors for the efficiency of inkjet printed organic solar cells are the inkjet latency time, the inkjet printing table temperature, and the effect of the chemical properties of the polymer donor.Due to the efficiency and the advantages listed above, I have used printable solar cells instead of solar photovoltaic cells. The printable solar cells are pasted or embedded over the surface of the helmet to enhance the absorption of sunlight. Then it is directly connected to the secondary battery which acts as a source for the air purifier. It also acts as the back-up for the rain sensor. A polythene sheet is used to cover the printable solar cells from rain.

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Fig. 1 Printable Solar Cell

B. *Electrostatic Precipitator*

1) *Description:* The principal components of electrostatic precipitators are two sets of electrodes. The first is composed of rows of electrically grounded vertically parallel plates, called the collection electrodes, between which the gas to be filtered flows. The second set of electrodes are wires, called the discharge electrodes, that are centrally located between each pair of parallel plates. The wires carry a unidirectional, negatively charged, low voltage, low current from an external source. The applied low voltage generates a unidirectional, non-uniform electric field whose magnitude is greatest near the discharge electrodes. When that voltage is high enough, a blue luminous glow, called corona, is produced around them. A theoretical model, based on the assumption of particle Stokes flow, which is applicable for a Reynolds number below 1, and on the absence of turbulent diffusion and other restrictions, results in the following relationship for the migration velocity of a particle of diameter *d*

$$Vm = \frac{2.95 \cdot 10^{-12} p \left(\frac{E}{s}\right)^2 d}{\mu} \qquad (1)$$

Where Vm = migration velocity in m/s,

p = a function of the particle dielectric constant that varies between 1.50 and 2.40 for many types of dust, with an average of 2.0

E = applied Voltage, V

s = distance between charging electrode and collecting electrode, m

d =particle diameter, m

μ = gas velocity, kg/(m . s)

C. *Particle Removal*

When dust builds up on the plates, it deposits in a layer of increasing thickness with possible re-entry into the gas stream unless it is periodically removed. This removal is done by rapping the plates to cause shock vibrations that shake the dust into hoppers at the bottom of the precipitator. Properly controlled and timed removal is critical for precipitator performance. It contains a vertical plunger that strikes the collection electrode support system to deliver the necessary shock wave and then returns back to its top position to prepare for the next strike. In one design the downward impact motion is effected by an electromagnetic coil and then return by a spring. In another the plunger is lighter, the impact is by gravity, and the return is by an electromagnet.The length of the precipitator passage in the direction of gas flow that is necessary to remove a given particle size is obtained by seeing to it that the time required for the particle to migrate to the collection electrode has to be less than the time it takes it to pass through the precipitator at the same velocity as the gas. Neglecting the charging time, the required length would be given by

$$\frac{s}{Vm} <= \frac{L}{Vg} \qquad (2)$$

$$L >= s * \frac{Vg}{Vm} \qquad (3)$$

where L = length of passage, m

V_g = gas velocity, m/s

D. *Collection Efficiencies*

The overall efficiency ,$\eta_o$is given by

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$$\eta_o = \frac{\text{mass or concentration of all particles retained by the collector}}{\text{mass or concentration of all parcticles entering the collector}} \quad (4)$$

lthough the relationship in eqs. (1)-(3) are based on highly idealized models, the trends they predict are applicable to the real case. Thus the migration velocity $V_m$is greater for large particles, the length of the passage necessary to remove them is smaller. In other words, it is easier to collect large particles than smaller particles. There is, therefore, a fractional collection efficiency which is also called as η_d that is given by

$$\eta_d = \frac{\text{mass or concentration of particles of a given size retained the collector}}{\text{mass or concentration of particles of a same size entering collector}} \quad (5)$$

From Eq. (5) it can be expected that $\eta_d$increases with size of diameter *d*. $\eta_d$is also expected to increase with electrode area and decrease with the flue-gas volume flow rate. Several relationships have been proposed for η_d. A well known one is the Deutsch expression, which is derived from physical or probability considerations

$$\eta_d = 1 - e^{-\left(\frac{AVm}{Q}\right)}$$

where A = area of collector electrodes, m^2

V_m = migration velocity, m/s

Q = flue-gas volume flow rate for each plate, m^3/s

E. Rain Sensor Using Ic 555

The sensor for sensing the rain is called rain sensor. I have used rain sensor using IC 555 because the IC inexpensive and it works on low power. It was introduced in 1972 by Signetics, the 555 is still in widespread use due to its low price, ease of use, and stability. It is now made by many companies in the original bipolar and in low-power Complementary metal-oxide-semiconductor(CMOS). As of 2003, it was estimated that 1 billion units were manufactured every year. The IC 555 is the most popular integrated circuit ever manufactured.

The IC 555 consists of 8 pins. Each of them is numbered from 1 to 8. It operates in three modes namely astable, monostable and bistable. The schematic circuit diagram for the rain sensor is given below as follows :-

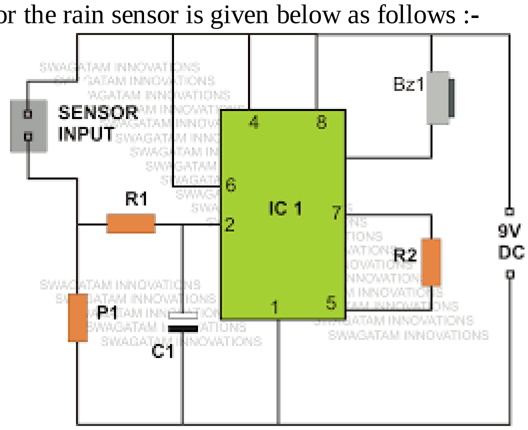


Fig. 2.Rain sensor using IC 555

F. Secondary Battery

Battery is a device which stores energy. There are two types of battery namely primary battery and secondary battery. Secondary batteries can be recharged but the primary batteries cannot be charged. Secondary batteries are widely used in almost all applications and all over the world. In this project I have used a 12 V secondary battery which acts as the stores the energy and supplies the power to the air purifier.When it is raining, the secondary battery acts as an back-up source for the air purifier to work. And it makes the rain sensor to cover the printable solar cells. Even though the power required for the rain sensor to cover the printable solar cells is less, the exceeding power is stored for further use in air purifier. So, the efficiency of the solar helmet increases.

III. ENVIRONMENTAL ASPECTS

A. Air Pollution

Air pollution is one of the major problem in large cities all over the world. The air pollution has adverse effects on health and nature. The air pollutants can be categorized into Suspended particulate matter and flue gas. They are generally estimated in parts

per million(ppm) and mg/m^3. For simplicity, I consider Indian cities and the significance of my project. It deals with the preventive measure taken by using an air filter powered by solar energy.
The following table shows the air pollution in major cities in India which is measured in mg/m^3

Table 1 Air pollution of major Industrial Cities in India

Pollutant / City	Mean Value of SO_2(mg/m^3)	Suspended Particulate Matter(mg/m^3)
Mumbai	48.1	240.8
New Delhi	44.4	601.1
Kolkata	39.9	340.7
Kanpur	16.9	543.5
Ahemadabad	12.7	306.6
Chennai	9.3	106.9
Nagour	8.7	261.6
Hyderabad	6.1	140.2
Jaipur	5.2	146.1

If we see the above table it is quite difficult to travel in the road due to the air pollution in these cities. There are other pollution which accounts for environmental hazard. So to have a combined solution of the pure air and to obey the section 128 of the motor vehicle act, 1984, the solar helmet is devised. It comes as an gift for both the purpose.

IV. IMPLEMENTATION OF THE CIRCUIT

A. Construction

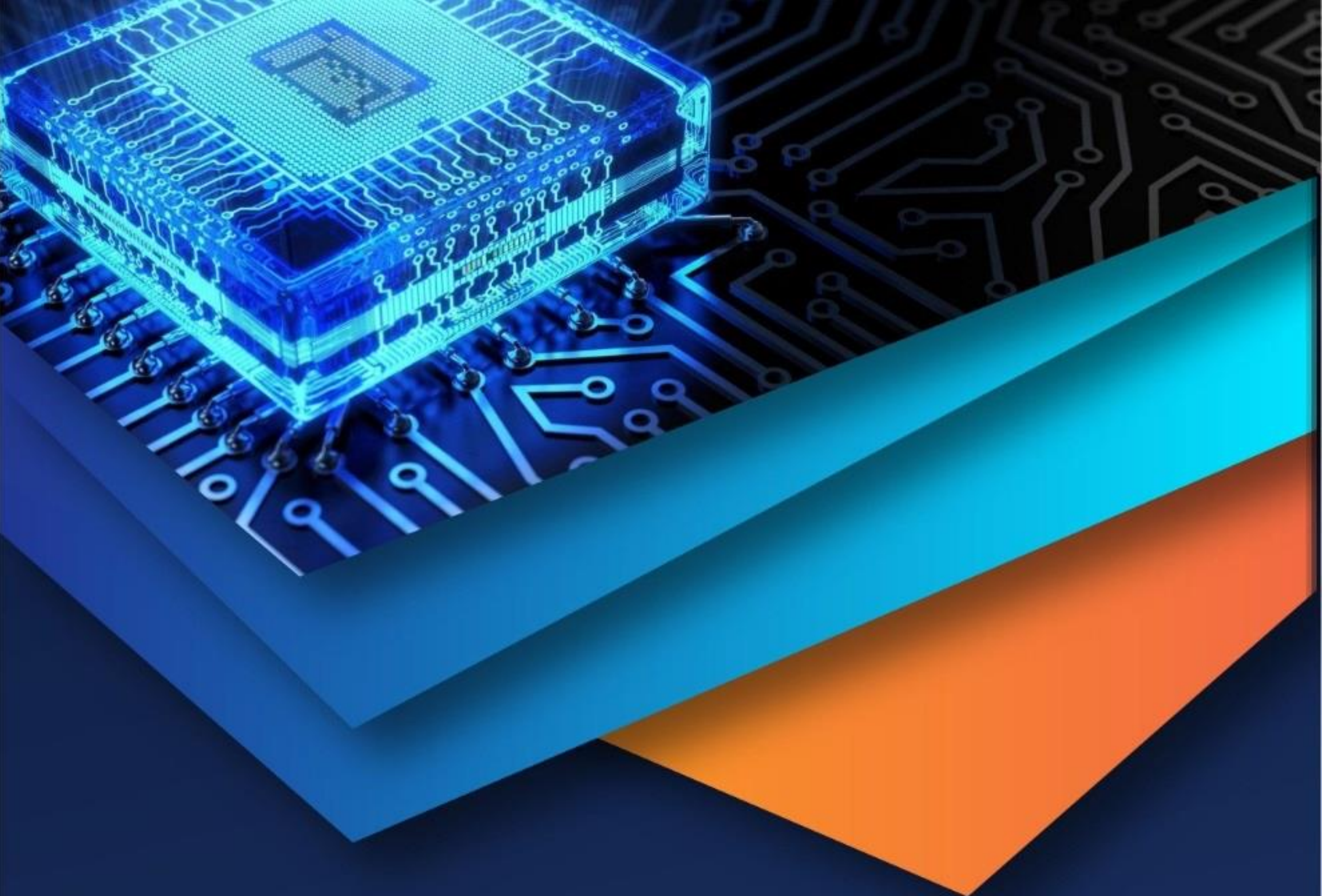
In a basic helmet, the printable solar cells are pasted or embedded over the surface of the helmet. I have chosen printable solar cells because it is easily available, inexpensive compared to the conventional photovoltaic solar cells. The solar cells give the power to the secondary battery which is connected to the air purifier and rain sensor. The secondary battery acts as the back-up when sunlight is not available to the air purifier and rain sensor.

B. Operation

The operation of the printable solar cells is same as that of the conventional photovoltaic solar cell. It also converts the solar energy into electrical energy known as photovoltaic effect. A secondary battery is used to store the energy from the printable solar cells. The secondary battery acts as a source to the air purifier and the rain sensor. The air purifier used here is electrostatic precipitator. There are two sets of electrodes in an electrostatic precipitator. The first set consists of vertically grounded electrodes and the second set consists of wires. The air that has to be purified passes through the first set of electrodes, corona effect takes place. While the air enters the second set of electrodes, the air is purified and it lowers the average temperature in the helmet. When it is raining, the rain sensor senses it and covers the photovoltaic with polythene sheet.

IV. RESULTS AND DISCUSSION

In this project I have discussed about the use of solar helmet in the purification of air in large cities. The papers which were earlier published consisted of using the solar energy by charging the cell phones and for other purposes like drunk identification and the accident spot identification. With a small change in the purpose of use of using the solar energy I have made the solar helmet easily wearable and the cost of the design is quite high but its applications are high.It will pave way to new innovations in the helmet industry making it so easier and wearable that people will be passionate about what the helmets they wear.



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