



FABRICATION AND DESIGN OF SOLAR AIR CLEANING ROBOT TO IMPROVE AIR QUALITY INDEX

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Abstract : Pollution has become a major issue these days, majorly air pollution. Air Pollution exists in the external environment but still makes ensuring safety inside homes difficult. This Polluted air causes many serious health issues in cities. For people with breathing problems or lung diseases such as asthma, or sinusitis, air purifiers serve as a survival tool. Air purifiers reduce the chances of health problems caused by indoor pollutants that directly cause nervous system problems, respiratory infections or asthma symptoms. So, making an affordable solar air purifier using HEPA filters, activated carbon filters, solar panels, and other parts can be an inexpensive yet effective alternative to surviving these difficult times. This Air purifier goes through various processes, such as filtering out large dust particles in the primary pre-filter, then filtering out dust particles and smoke molecules in the HEPA filter, and filtering out fine particles using a carbon filter to create clean and purified air.

Module Type	40W
Max. Power	40W
Tolerance	+/- 3%
Open Ckt Voltage	22.22V
Short Ckt Current	2.38A
Max. Supply Voltage	18.25V
Max. Supply Current	2.2A
Efficiency	12.84%
Solar Panel Efficiency	17.3%
Operating Temperature	-40°C / 85°C

The results and analysis conclude that the Air Purifier can produce up to 96 % clean air and is capable of running for 14 hrs a day with a solar- powered system.

Index Terms - Air Quality Index, HEPA Filters, Activated Carbon Filters, Solar Panels, and Air Purifiers.

1. INTRODUCTION

An Air purifier is a device which is capable of making air contaminants free and is also used for enhancing the Air Quality Index. An air purifier can be made using HEPA filter, Activated Carbon Filter and some miscellaneous components that can be proved as an efficient alternative for such difficult times. An air purifier uses many processes like the first pre-filter filtering the heavy dust particles, then captures the dirt and smoke molecules at the HEPA-Filter, then uses carbon-filter for capturing micro-particles, and as a result produces clean purified air. After the Industrial Revolution, air pollution is counted as a serious problem and a major discuss in today's era. According to many reports from different organizations stated that air pollution caused 21 million

premature deaths in 2012. Therefore, we must deal with this serious crisis. Subramanian Sundar Rajana evaluated HEPA filters and activated carbon filters as effective in purifying the air from dust molecules in his research paper. Infact, HEPA filters have up to 99.97% efficiency in filtering out fine particles along with disinfecting microbes present in the air [3]. Activated charcoal can combine with sodium along with iron to purify sulfur and its constituents belonging to the sulfate and sulfite groups. Research papers also state that sodium and iron sulphite and sulfur can be absorbed by coal, but the adsorption efficiency may vary with time[4] It was the analysis of S.B. Diwat & S.R. Kadam et al that activated carbon has higher adsorption efficiency than other filters in the same category.

2. COMPONENTS

1. Solar Panel
2. Hepa filter
3. 12v 2.5ah battery
4. Arduino Uno ATmega328p development board
5. Brushless dc motor
6. Filter Type: Activated Carbon, Coverage Area:
7. Control Method: touch
8. Warranty Description: 3 month
9. Features: This filter is used to remove PM 2.5 as well as fine particles, ultrafine particles, allergens, bacteria, viruses and mold spores.
10. Features: Captures 99.97% of airborne allergens and pollutants.

SOLAR PANEL



Rice.1: Solar panel

ACTIVATED CARBON FILTER + HEPA



Rice.3 HEPA + Activated Carbon Filter

HEPA FILTER



Rice.2: Hepa filter

DC BRUSHLESS MOTOR



Rice.4 Brushless DC motor

2.1 Product Description

We are enlisted amongst leading supplier and trader of 12V 2.5AH SMF Motorcycle Battery. Our products are known for their high performances which bring less consumption of energy and it is easily manageable. These Batteries are durable and reliable which bring long operational life. One can avail these products from market in huge quantity.

2.2 Features:

- It is Manufactured from lead-calcium alloy using Absorbed Glass Mat Technology
- Requires no maintenance
- No leaks, spills or water to test
- The best, most powerful and highest output amplifier
- Longest life
- High cell compression and fiberglass spacers to extend battery life
- High level of vibration resistance in extreme road and engine conditions

Arduino Uno ATmega328P



Rice.5 Arduino Uno ATmega328p development board

2.3 OVERVIEW

Microcontroller board based on ATmega328 is used by the Arduino Uno Rev3 SMD. It consists of 14 digital in/out pins (where 6 pins are used for PWM outputs), 6 analog inputs, a 16MHz ceramic resonator (CSTCE16M0V53-R0), USB connector, Power connector, ICSP Header, and a RESET button. Everything it has is used to support a microcontroller. To start it we need to just simply connect it with a computer by a USB Cable or connect an AC/DC adapter or battery. The Arduino Uno is different from all the previous boards as they do not use the FTDI USB-to-serial driver chip.

R3 Additional Features:

- ATmega16U2 is used in place of 8U2 as USB-to-serial converter.
- PinOut 1.0: Added SDA and SCL pins for TWI communication next to AREF pin and added 2 new pins next to RESET pin. IOREF allows the shield to adapt to the voltage supplied by the board and the second pin is left non-connected. Some contacts are reserved for the future use.
- Powerful Reset Circuit.

2.4 Specifications:

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Battery Type	Nominal voltage	Capacity (10 Hr) Ah	CCA @ F(-18C) A	Dimensions- Millimetres (2 mm)			Assembly Figure (As Per Cover Polarity)	Terminal Type	Weight	Regular Charge Current		Kg	A
				L	W	H							
LT 2.5-3	12	2.5	25	80	70	105	3 1/B		23/4	41/8		1.14	0.3

3. RATIONALE:

Time required for charging 12.0 V / 7.0 Ah battery from 40W Solar panel :

Solar panel and Component Description:

- 12.0 V / 7.0 Ah battery
- 40W Solar panel
- Solar Charge Controller Battery

Estimating the maximum power of the charge controller in order :

40W / 12.0 V = 3.34 includes power dissipation (19.9%), and

Efficiency of the solar charge controller :

$$75\% \times 3.34\text{A} \times (1 - (19.9 / 100)) \times (75 / 100) = 1.503\text{A} (\sim 2\text{A})$$

Efficiency of Lead- Acid Battery:

$$84.9\% * 7.0 \text{ Ah} * (1 / (84.9 / 100)) = 5.93\text{Ah} (\sim 6 \text{ Ah})$$

Approximate time required for fully charged a battery, if charging at 2Ah/hr : + 2 hours = 5 hours

So it takes about 5 hours to fully charge a 12.0 V / 7.0 Ah battery.

Time required for 0.5A motor fan to discharge 12.0/7.0 Ah battery : $7.0\text{Ah}/0$ to calculate time for 0.5A motor to run on 7Ah battery when the battery is fully charged. $5 = 14$ hours

Therefore, a solar air purification system can operate for up to approximately 14 hours on a 7Ah battery when the battery is full charged.

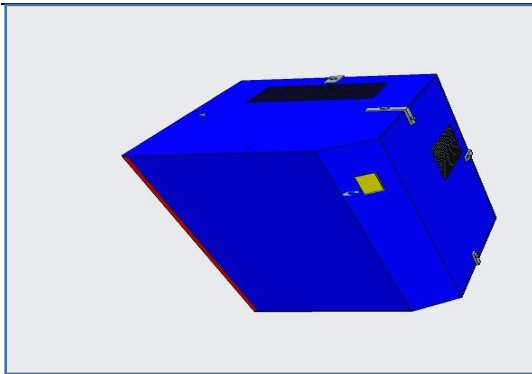
3.1 TECH SPECS

<u>ATmega328P</u>	Microcontroller
Operating voltage	5 Volt
I/p voltage (Recommended)	6.85-12.0V
I/p voltage (Limit)	5.9-20.0V
Digital In/Out pins	14 .0(6 provide PWM outputs)
Digital In/Out pins PWM	6.0
Analog i/p Pin	6.0
In/Out per pin DC current	20.0 mA
DC Current for pin 3.3V	50.0 mA
FLASH Memory	32 KB (ATmega328P), of which 0.5KB used by bootloader
SRAM	2KB (ATmega328P)
EEPROM	1KB (ATmega328P)
Clk Frequency	16.0 MHz
Led_BuiltIn	13
LENGTH	68.6mm
WIDTH	53 mm
WEIGHT	25g

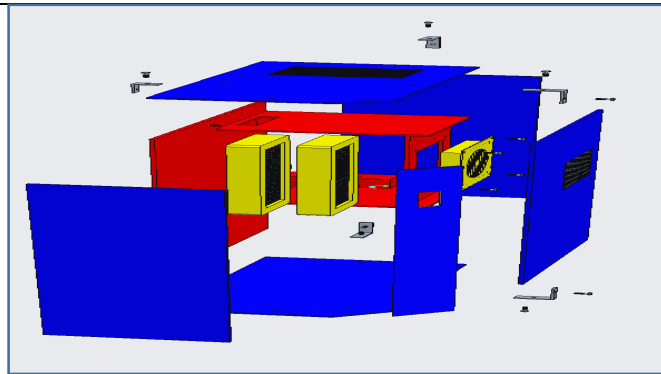
Table1: Technology Specifications

3.2 AIR QUALITY GRADE CALCULATION:

Under natural smog conditions , MQ135 Sensor will read 0 to 300 ppm (0 to 900 ppm for ammonia or benzenegas).
 Sensor Percentage = (Air Quality Reading * 100) / 300.



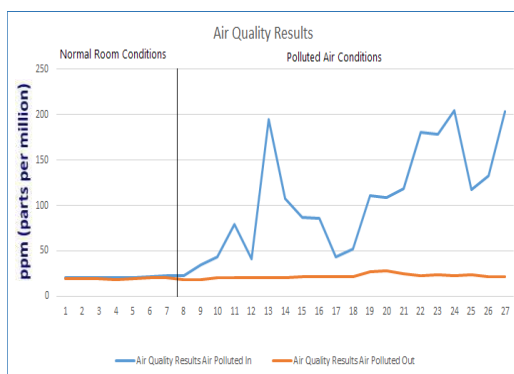
Rice.5 creo air purifier design



Rice.6 Disassembly of Air Purifier

The Solar Plates receives the sun rays, the Electrical Energy is converted to Solar Energy and after that sends the energy to Solar Charge Controller for handling the unsteady current. The Solar Charge Controller provides 12.0 V of balance current to the battery. Batteries store current according to their respective capacities. The speed of the controller supplies power to the 12V brushless DC motor, from the battery, to the 12V Electronic Speed Controller, and the Arduino board by the connected speed controller pins which are connected as shown. To manage the speed of DC motor, the speed controller is required to receive input readings from the Arduino board, in this case using a signal pin. To provide specific inputs to the speed controller, the Arduino board reads a potentiometer (with a 10kΩ resistor) and supplies the appropriate inputs to the speed controller to help in controlling the speed of the motor. Instead of an Arduino board, you can also use a servo tester and a speed controller using a potentiometer. The fan after that forces the affected air via the air filter, and vivid types of filters provide purification, remove the pure air. The MQ135 air quality sensors are used to detect the incoming affected air and outgoing clean air and it is connected in the front & rear side of the air purifier.

4. RESULTS AND DISCUSSION



Rice.7 Air quality of the manufactured air purifier



Rice.8 Front view of air purifier with 40W solar panel

The values shown in the table are the original air quality sensor observations (0-290 ppm) dust free room breathing air upto 10% or - 20 ppm of air quality sensor. This investigation is performed by artificially generated smog (approximately 195 ppm) at home. The above result is the value of MQ135 air quality sensor mounted behind the air purifier where polluted air enters the filter and the Sensor is arranged ahead to measure the quality of the purified air by air purifier. Vacuum cleaner comes forward.

Table 2: Air quality indicators for affected air entering and leaving the Filter.

Air Quality Observation (in ppm)	
Incoming Affected Air	Outgoing Affected Air
20.0	18.8
20.0	18.0
20.0	19.0
23.0	19.0
23.0	18.0
35.2	18.0
42.8	19.0
79.0	19.0
41.0	19.0
195.0	19.0
108.0	19.0
87.0	21.0
86.0	22.0
43.0	22.0
52.0	22.0
112.0	27.0
109.0	28.0
118.0	25.0
181.0	23.0
178.0	24.0
205.0	23.0
117.0	24.0
133.0	22.0
203.2	21.0

5. ACKNOWLEDGMENT

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6. CONCLUSION

Max. air index value = 205ppm corresponding to the Filter air index value (with ~6ppm defect due to Affected air) = 18ppm, air purification rate = $(205-16 / 205) \times 100 = 91.90\%$ to 92% air purifier, it is clean air but also taking into account that, people are highly concerned about unnecessarily more power utilization. The Purifier delivers 92% pure air and runs for approximately 14hrs on an average charge of 5 to 6 Hrs of Sunlight per day.

Also, solar air purifier is affordable and can be used without electricity. It can be converted into remote control portable air purifier also. Add temperature controlled refrigeration via the DTH11 and limited duration perfume dispenser via atomize and you have a unique, attractive and affordable product to market at a fraction of the price.

7. REFERENCES

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