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Solar Powered Air Purifier with Air Quality Monitor

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Abstract:- As we know, the world has been shaken by rising pollution levels due to air pollution. We need to control the pollution levels under safe and standard levels. Using air purifiers is the most effective method of reducing air pollution. Here we design an outdoor purifier powered by a solar panel, it does not require any other supply, so it is energy independent. Air purifier's concept is known for years but not fully explored, so here we are designing an An air purifier that removes PM10 and PM 2.5 pollutants as well as harmful gases uses a exhuast fan to draw air from the base duct of the purifier through a layer of HEPA and Carbon filters. The purifier employs three stage purification, with the first layer being HEPA second being an Active Carbon filter and third is UV filter. The combination of these two filters results in dual filtration by sucking large amounts of air and purifying it of dust particles using centrifugal air force.

Keyword:- *Air Purifier , Solar Panel, HEPA ,Activated Carbon, UV Filter, Exhaust Fan , Particulate Matter, Air Pollutants.*

I. INTRODUCTION

As we know, air pollution levels in cities are very high. Most of the pollution comes as by-product from vehicles, produced waste gases from industries and dust from construction sites, these are in the form of particulate matter which are like methane, carbon dioxide, dust etc. These create a lot of health issues like asthma, decreased lung functions, pregnancy failing etc.

A.P.Singh et al., described forms of air of air pollution i.e, first is in gaseous form (ozone,carbon monoxide,methane,benzene and ammonia) and second are particulate matter like smoke,dust,fly ash and dust mist.**[1]**

Sharon, Frederic, et al., described that in our environment the gases are consist in the form which are nitrogen is in 78 percent, oxygen is in 21 percent and less than 1 percent is argon as well as varying amount of water vapor when by the different causes the harmful gasses are increases in the air the air became polluted**[2]**.

Indoor air quality (IAQ) is the air quality inside and outside of buildings and structures. IAQ has been shown to have an impact on the health, comfort, and well-being of building occupants. Government agencies use an air quality index (AQI) to communicate to the public how polluted the air is now or how polluted it is expected to become. As the AQI rises, so do the risks to public health. Each country has its own air quality index, which corresponds to different national air quality standards.**[3]**

 # Particles in air are present in different sizes due to different ways just like smoke ,dust ,Mist ,Fumes etc. On the basis of particles size there are two types of size categories that are given below:

- **Inhalable coarse particles**: The diameter of the particle range from 2.5 to 10 micrometers (PM10 – 2.5).
- **Fine Particles**:Typically found in haze and smoke, with sizes ranging up to 2.5 micrometres (PM).

- *We have an updated air quality index of new delhi and NCR of PM 2.5 and PM 10 monthly concentration oct 23 to nov 18.*

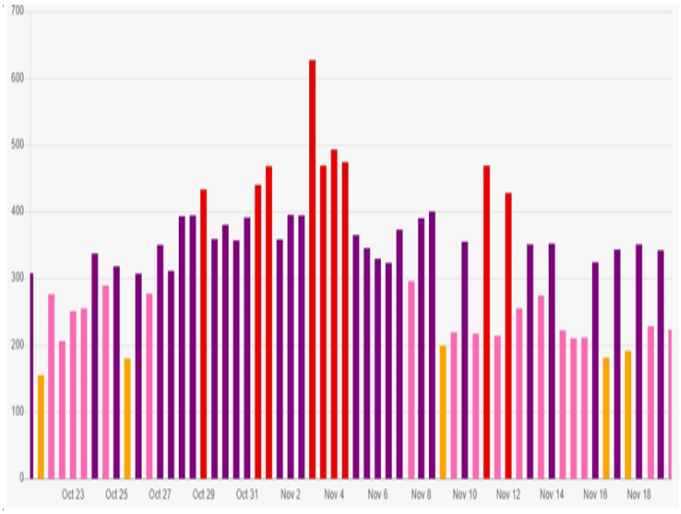

Fig.[1] concentration graph of PM 2.5

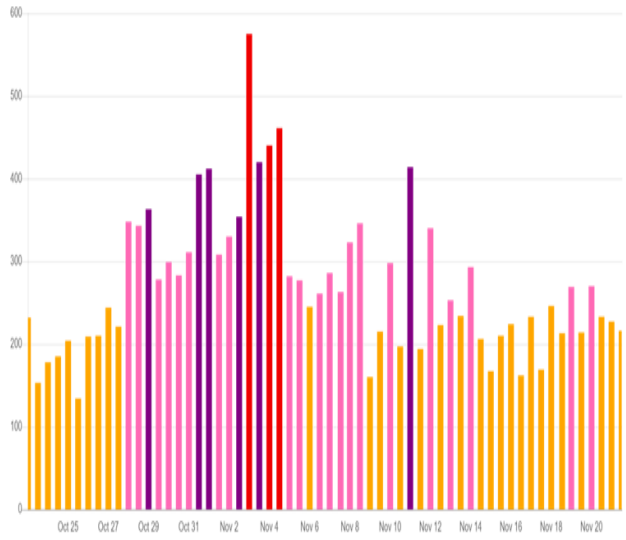

Fig.[2] concentration graph of PM 10

According to a WHO survey report, 2.8 billion people use solid fuels such as wood, dung, crop wastes, charcoal, and so on, while 1.2 billion people use kerosene lamps, which are the major cause of air pollution, affecting people in colleges, offices, and homes. As we know that for balance and long-life high-quality air is very necessary[1].

Although there are many types of air purifier available in the market, none of them are able to deliver its full working efficiency in public places like Metro Stations, Bus Stands, Hospitals etc. Many institutes are unable to afford these because of high cost and installation cost. So, it is advisable to develop such air purifiers that are economical and highly efficient.

Filters that are used in SPAP : The first is a HEPA (High Efficiency Particulate Air) filter, which can remove 99.97% of dust, pollen, mould, bacteria, and other airborne particles as small as 0.3 microns. The Carbon Active filter removes silicon oxide, and the second filter is carbon activated. An air quality sensor and display are also included in the system to show the current air quality. A solar panel is used to supply power to the system.

Because this machine is small and portable, it can be easily transported to schools, play areas, residential areas, and public places for effective and immediate pollution control.

An electrical inverter is also used to convert the solar panel's DC voltage into AC voltage, which is then used to charge the battery.

Our solar air purifier has a suction fan that draws air from the bottom of the purifier through a layer of HEPA and Carbon filters to remove PM10, PM2.5, and gases. A battery that is also used for purifier night uses in daylight will be charged by solar panel voltage. As a result, we intend to create a solar-powered purifier that uses biodegradable filters and runs on solar energy. Our goal is to create low-cost, high-efficiency air.

As we know that air pollution occurs due to many reasons just like burning of solid fuels, crop waste, charcoal and building demonstrates so to prevent this polluted air many types of air filter are designed but none of them did not succeed. Some have efficiency problems, some have backup power problems and whereas some have desirable filtration problems.

Perumal d, et al **[4]** Whenever Government organizations have very low budgets for air purifiers like extra expenditure. So, it is advisable to develop such air purifiers which can cost less and are highly efficient.

Author came to the conclusion that he created a solar powered air purifier that runs on solar energy. He created an indoor air purifier for purification as well as air monitoring systems, so it is energy dependent on an AC power supply. His purifier consists of a fan that pulls air from the bottom of the purifier through a layer of filters for elimination of pollutants and gases in the air.

Kim et al **[5]** Micro dust removal is proposed using Li+ batteries and a Super cap parallel connection. A solar controller part is also required to control the charging of the Li+ batteries, and the Super cap parallel connection provides power when no sunlight is available.

He completed the process of Li+ battery along with a parallel super capacitor for power supply at night when there is no sunlight. Solar panels are also used to charge batteries.

Marinov et al **[6]** proposed that Portable Air Purifier with Air Quality Monitoring Sensor, In which they uses three layer of air filters ,where first one was 'prefilter' it is used to absorb the largest air contaminants such as dust, hairs and other matter visible to the naked eye.

The active carbon filter is the second filter. It absorbs offensive odours, smoke, and volatile organic compounds. The final filter is the HEPA filter, which removes the majority of particles with a diameter greater than or equal to 0.3 micron.

II. METHODOLOGY

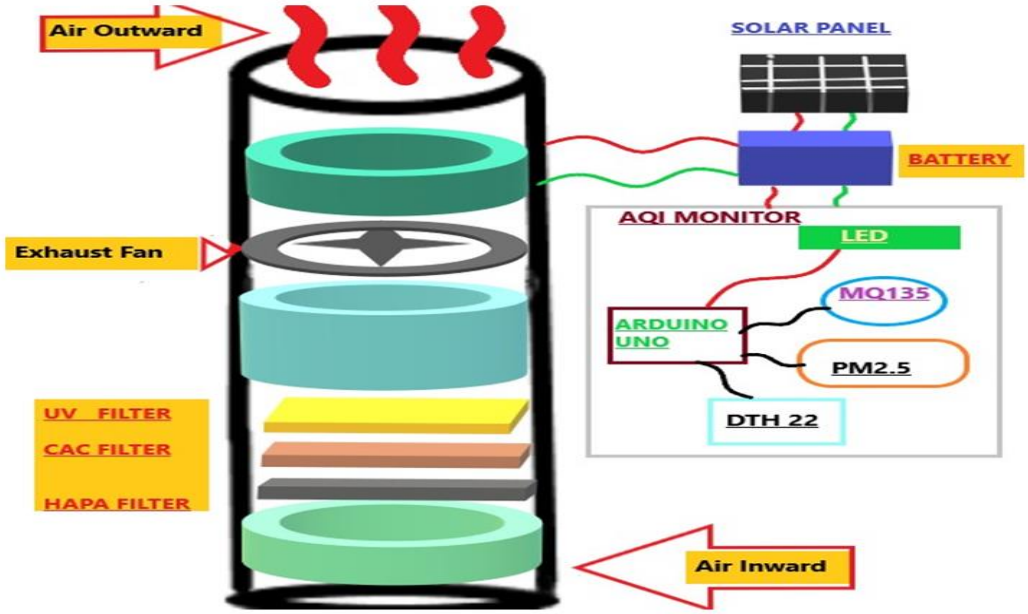

Fig 1 :- Methodology

Table 1 Break points for comparing AQI ,India **[3]**

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5 –1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

#COMPONENETS

 # SENSORS

1. MQ 135

This is gas sensor which is used to detect or send harmful gases and smoke such as anomia, sulphide, benzene, alcohol, NOx, CO, CO2.

2. DTH 22

DTH 22 sensor is used to measure humidity and temperature of the surrounding air and records its values for further use.

***3.* PM 2.5**

PM 2.5 sensor is used for measurement of dust particle of diameter less than or equals to 2.5 microns.

4. ARDIUNO UNO

Microprocessor is used in the hardware design is the3.3V 8MHz version of the ARDIUNO Uno and OLED display is used to display data.

 # FILTERS

1. HEPA FILTER

HEPA FILTER: HEPA filter is a high efficiency particulate air filter.

HEPA filter are mainly use for bacteria removal as well as dust collection also.[7]

AJAY N Bhagwat ***[8]*** .,HEPA filter can capture minimum particle size 0.3micro meter and HEPA filter provide efficiency up to 99.97% for cleaning minor particles.

2. CARBON ACTIVATED FILTER

ACTIVATED CORBON FILTER :Activated carbon filters absorb household chemicals, carbon dioxide, smoke, and other pollutants. It is composed of small granular carbon particles and is highly porous in nature.

S.B divate et al.,**[9]** proposed in the reasarch that activated carbon having more absorbing capacity than other absorbants.

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N.R. Adila et al.,**[10]** , estimated activated carbon as adsorbant for CO2.

3. UV FILTER

UV FILTER: This filter removes biological pollutants such as bacteria and viruses that can cause common diseases.

III. CALCULATION

The important factor in the air purifier is determining the size of the room for the selection of the components. The size of the is determined according to the value of cfm (cubic feet per minute) and then fan for air purifier is selected from same value of cfm of room. The cfm of fan is determined from rpm of fan. Equation (1) and (2) are given by

CFM= (L x W x H x Q)/60 min (referring [9])
L=Length of room (sq ft)
W=Width of room (sq ft)
H=height of room (sq ft)
Q=Air Flow Rate(sq ft)
CFM-3.1416(PI)X(0.5-S) x R x A
S=Square feet radius of fan (sq ft)
R=Area of Fan

The Calculations of the Air Purifier In The Project Are As Follows:-

1)

L= Length of room (sq ft) W= Width of room (sq ft) H= Height of room (sq ft) Q = Air Flow rate

CFM = 3.1416(PI) X (0.5- S) X R X A ..(2)
S = Square feet radius of fan (sq ft)R = Rpm of fan (rad/s)
A = Area of fan

The Calculations Of The Air Purifier In The Project Are As Follows:-

1) *The Measurements Of Room Is Given In Order To Determine CFM*

L = 20 SQ FT, W = 20 SQ FT, H= 20 SQ FT, Q = 2
CFM= (L X W X H X Q)/60 MINCFM = (20 X 20 X 20 X 2)/60 CFM = 16000/60
CFM = 266.6

THE CFM OF SELECTED ROOM IS 266.6

The values of cfm for room and fan which are obtained for the project are

a) The CFM of Selected ROOM IS 266.6
b) The CFM of Fan IS 300

The given values are considered per the equations and any changes in it maybe consider the change in the selectivity of the given components.

IV. CONCLUSION

Now we have seen that how efficient is **SOLAR POWERED AIR PURIFIER** than other type of device available in market. It also very economical and do not have to replace any component quickly. It reduces particulate PM10, PM 2.5 and small particles of smokes etc and purifies air to make safe breathable air.

A pure and clean air is right for a human being and all other living creature on this earth and this project is a small effort from our side to give the all their right.

Also, In future modification can be made to improve working efficiency without Effecting system.

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