JournalPublicationofInternationalResearchforEngineeringandManagement(JOIREM)
Volume:01 Issue:05 |may-2023

Solar air purifier

SharvariShelar[1],JanhaviKhaladkar[2],GauriBhavsar[3] ,&

Prof.U.L.Mohite[5]

[1]DepartmentofElectricalEngineeringofMET'S InstitudeBhujbal knowledge city nashik

---

Abstract-Thisresearchpaperisaboutdesigningandfabricating an air purifier system which is powered by solarenergyandtestingtheeffectivenessofthesystemtocurbtheairpollution. The focus is on extracting the suspended particulatematter from the air which are the major contributors in thepollutionofairinmanyurbancities.Itworksonanon-conventional method and intents to achieve best possible airpurificationresultsusingeco-friendlyandeconomicalmethod.Itworksonthebasicprincipleofadhesionofthesuspended particlesintheairwiththeliquidandsettlesdownduetobeingheavier than air and gets separated from the air helping us toachieve better air quality index. The fans and the pump in systemare operated with the help of solar energy, produced by solarpanels,whichconvertsthesolarradiations intoelectricity.

Key Words: Air Quality index, particulate matter, Atomization,precipitation, moisture content.

Introduction:

Asweknowthatairpollutionlevelincitiesisveryhigh.Mostofpollutioncomesasby-uctfromvehicleandconstruction of buildings, these are in form of particulatematterwhicharelikemethane,carbondioxide,dustparticulate etc. roblemlikerespiratoryillness,decreasedlungfunctions,developmentofdiseaseslikeasthmaetc.Largerdustparticle saremajorparticulateamongtheseandifitsairqualityvaluearedowntominimumthenairhasveryimprovedqualityinw hichalltpeoflivingthingscan breatheeasily.

Althoughtherearemanytypesofairpurifierthatareavailableinmarketbutnoneofthemaresufficientenoughtodeliverits workingefficiencyinpublicplaceslikebusstand,nearhospitals,trafficsignalsetc.Manyinstitutesarealsonotabletoaffo rdthesebecauseofhighcostandinstallationcost.Governmentorganizationshaveverylowbudgetforairpurifier like extra expenditure. So, it is advisable to developsuchairpurifierwhichcancostlessandarehighlyefficient.

So, we are making solar powered air purifier, which runs onsolar energy without use of filters and also works for longerduration than others. It uses component like solar panel, fan,converter, pump,etc

[1] NationalAirQualityIndex

[2] LiteratureSurvey

[3] Awareness of daily levels of air pollution is important to thecitizens,especiallyforthosewhosufferfromillnessescausedby exposure to air pollution. Further, success of a nation toimproveairqualitydependsonthesupportofitscitizenswhoarewell-informedaboutlocalandnationalairpollutionproblemsandabouttheprogressofmitigationefforts.Thus,asimple yeteffectivecommunicationofairqualityisimportant.The concept of an air quality index (AQI) that transformsweightedvaluesofindividualairpollutionrelatedparameters(e.g. SO2, CO, visibility, etc.) into a single number or set ofnumbers is widely used for air quality communication anddecisionmakinginmanycountries.

[1] IdentificationandCharacterizationofParticulateMatterConcentrations atConstructionJobsites:

The identification and characterization of particulate matter(PM) concentrations from construction site activities posemajor challenges due to the diverse characteristics related todifferentaspects,suchasconcentration,particlesizeandparticlecomposition.Moreover,thecharacterizationofparticulatematterisinfluencedbymeteorologicalconditions,includingtemperature,humidity,rainfallandwindspeed.Thispaperispartofabroaderinvestigationthataimstodevelopa methodologyforassessingtheenvironmentalimpactscausedby the PM emissions that arise from construction activities.The objective of this paper is to identify and characterize thePMemissionsonaconstructionsitewithdifferentaerodynamicdiameters(PM2.5,PM10,totalsuspendedparticulates(TSP)),basedonanexploratorystudy.Initially,aprotocol was developed to standardize the construction siteselectioncriteria,laboratoryprocedures,fieldsamplecollectionandlaboratoryanalysis.

Atomizationconceptandtheory:

Atomization refers to the process of breaking up bulk liquidsinto droplets. Common home atomizers you may be familiarwithincludeshowerheads,perfumesprays,gardenhoses,anddeodorantorhairsprays.Asprayisacollectionof moving droplets that usually are the result of atomization; they aremovinginacontrolledfashion.Naturallyoccurringspraysarerain and ocean sprays. A droplet is a small particle of liquidhaving a more or less spherical shape. Droplets are also knownasparticles.

The reason particles are round is due to the liquid's surfacetension. Recall that surface tension is the property of a liquidthat causes droplets and soap bubbles to pull together in asphericalformandresistspreadingout.Thispropertycausessheets or thin ligaments of liquid to be unstable; that is, theybreakupintodroplets, or atomize.

Understandingdropsize:
Inordertoaccuratelyassessandunderstanddropsizedata,allof the key variables such as nozzle type, pressure, capacity,liquidpropertiesandsprayanglehavetobetakenintoconsideration. The drop size testing method should also befully understood. The measurement techniques, type of dropsizeanalyseranddataanalysisandreportingmethodsallhaveastronginfluence onthe results.

Differentcomponentsofproject:

1 CHAMBER:

The chamber is the main part of the air purifier. The pollutedair from the environment is sucked into the chamber using afan.Itisdesignedinrectangularcross-section.Inthechamberthe rack arrangement is close fitted containing the atomizersandthebafflearrangement.Itisdesignedtoprovideadequatespace for atomization by atomizers and efficient adhering ofparticleswithwaterdroplets.Theoutletsideofthechamberiselevatedfromthebasetoreducetheairflowspeedandamountofmoistureinthecleanair.Aclearanceisprovidedatthe bottom in the chamber for easy flow of water containingparticulatematter.

Solar panel

FAN:

A750RPMfanisinstalledattheventofthedevice.Thisfanhastwoimplicationsthataretosuckpollutedairfromtheinlet environmentintothechamberandalsotoflowawaytheclean airintothe outletenvironment.

,

.

1SOLARPANEL

There is an installation of a 100-watt solar panel. This panel isused to produce electricity from radiation of sunrays. Thepanelconsistsofagridofinterconnectedphotovoltaiccells.

1.

SOLAR PANEL

DC-DC CONVERTER

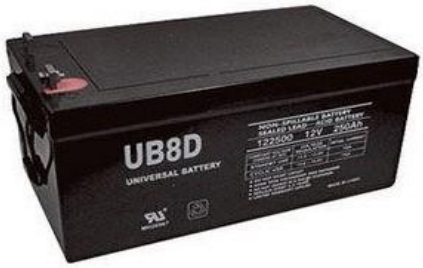
A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load).

A buck converter steps a voltage down, producing a voltage lower than the input voltage. A buck converter could be used to charge a lithium ion battery to 4.2 V, from a 5 V USB source. A boost converter steps a voltage up, producing a voltage higher than the input voltage.

ELECTRICAL CONVERTER

BATTERY:

A battery with a high capacity and a low power rating isinstalled which delivers a low amount of electricity (enough torunafanandpump)foralongtime.



STRAINER:
Astrainerisinstalledinthechamberwhichpreventsresiduemoisturefromentering thefan.Itismadeoffinefabric.

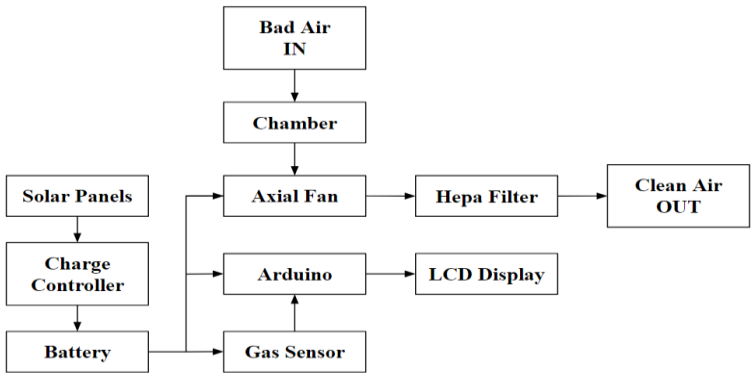
SPECIFICATION:

Item	Specifications
Pump	Open flow: 1.1 L/MinSEIFSuctionheight:2 mAmps:1.0A Max. Inlet pressure: 60psiMax.Outletpressure:140p si Voltage:12Vdc
Fan	Type: Axial fanVoltage: 12V
Chamber	Material:plywood,Size:18”X12”X12”

WORKING: Sunlight is incident on the Solar panel during the day time. The voltage output from the panel is measured with the help of a multimeter. Usually a voltage output from the solar panel varies throughout the day according to the sun position in the sky. However, a constant rated voltage and current is needed for charging the battery. This rated voltage is achieved with the help of a charge controller, which controls the voltage input to the battery. The battery is then used to store the power and operate the air purifier system as and when required. There is a chamber in which air is sucked in by the fan, while the air is entering it passes through the strainer.

Simultaneously water is pumped from the reservoir to the atomizer, which converts water into small water droplets and these droplets are suspended into the chamber along with air. These water droplets have an adhesive property due to which the particulate matter and dust particles get absorbed on them. This way air is cleaned and is flown out from the chamber by exhaust fan. The water with dust and particulate matter is collected in an evaporation tank, where water undergoes a natural evaporation process, leaving behind the dust and particulate matter; these are periodically cleaned and water is used again in the air cleaning process.

In this way, purified clean air is circulated in the atmosphere by filtering out the harmful contaminants in the air using solar power. Thus saving in electricity consumption cost.



SCHEMATIC DIGRAM:

CALCULATIONS:

There is 1 power generatingcomponent as the solar panel and2 power consuming component as the pump and fan in thesystem.

Thefollowinggivendataisconsideredforthecalculation:Diameteratinlet of nozzle, **d=0.0002 m**

5) Pump

Areaatinletofnozzle,**a=3.14*10^{-8}m^2**

Themainworkofthepumpistogetthelow-pressurewaterflowthrough thenozzlesothatthewatergetsatomized.

Diameterofpipe, **D=0.004m**

Area of pipe, **A = 50.24*10^{-6}m^2**Coefficientoffrictionofpipe,**f=0.006**Length ofthepipe,**L=1.5m**

Netheadofwateratinletofnozzle, **H=0.26m**

Fromtheformula,

$$v=\sqrt{[2gH/(1+(4fL/D)*(a/A)2)]}$$

Aftercalculation,

$$v=3.408ms^{-1}$$

Fromtheformula,**p=ρ*g*Hp=2548Ns^{-1}**

6) 2.Fan

Theairflowratewouldddeterminethepowerconsumptionofthefan.

Thefollowingdataisknowntous:

Thefanrpmoffan, **N=1750rpm**

Thediameterofduct,**D=0.1125m**

Theareaofduct,**A=9.93515625*10^{-3}m^2**

Thefollowingdatais tobecalculated:

Velocity of air flowing through fan, **V=?**Rateofdischargeofairthroughfan,**Q=?**Fromthe formula,

$$V=(2*\pi*N)/60*(D/2)V=3.281ms^{-1}$$

Fromtheformula,

$$Q=A*V$$

Q=0.0326m^{3}s^{-1}

3. Solar panel

Thetotalpowerrequired=poweroffan+powerofpump+extrapowerforstoragein battery

Totalpower=**20watt+24 watt+56watts**

Totalpower= **100watt**

So,weneedtoinstalla **100-watt**solarpanel.

4. Battery

For making our air purifier any time usable we can install abatteryof**500 watts.**

EXPERIMENTAL READINGSCONSIDERATIONS

Consideringthefollowingpoints:

- Thetestingisdoneinopen.
- TheAQIoftheincensestickis999+.

APPARATUS USED	PARTICULATE MATTER	MAXIMUM VALUE	MINIMUM VALUE	CONSTANT VALUE
AMBIENT ENVIRONMENT	PM2.5	71	55	62
	PM10	95	73	83
FAN	PM2.5	83	62	67
	PM10	111	83	89
FAN + PUMP	PM2.5	195	170	177
	PM10	260	226	236
FAN + INCENSE STICK	PM2.5	167	118	132
	PM10	222	157	176
FAN + PUMP + INCENSE STICK	PM2.5	257	205	222
	PM10	343	273	296

-

CalculationbasedonPM2.5reading

The deviated results of the above table is due to the measuringdevicelimitationofdetectingfinedropletsasparticulatematter and therefore the contribution due to water dropletsmustbe eliminated,whichcanbedoneby

Moisturecontent=(AQIoffan+pump+incensestick)–(AQIoffan +pump)

= 222-117= **105**

Amountofpurification=AQIofincensestick–Moisturecontent

=999-105=**894**

Purificationpercentage=[(reductionofAQI/AQIofincensestick)*100]= **89.4%**

Conclusion:

NowwehaveseenthathowefficientisSOLARPOWEREDAIRPURIFIERthanothertypeofdeviceavailableinmarket.It alsovery economical and do not have to replace any componentquickly. It reduces particulate level to satisfactory

positionwhereapersondoesnotneedtowor aboutpollutionrelatedproblems.

A pure and clean air is right of a human being and all otherliving creatures on this earth and this project is a small effortfrom our sideto givetheall theirright.

Also in future, modifications can be made to improve workingefficiency withouteffectingsetup.

REFERENCES

[1] National Air Quality Index by Central Pollution ControlBoard

http://www.indiaenvironmentportal.org.in/files/file/Air%20 Quality%20Index.pdf

[2] Identification and characterisation of particulate matterconcentration in construction jobsites by Ingrid P. S. Araújo,Dayana B. Costa and Rita J. B. de Moraes ISSN 2071-1050Sustainability2014,6,7666-7688;doi:10.3390/su6117666
www.mdpi.com/journal/sustainability

[3] UnderstandingDropSizebyRudolfJ.SchickSprayi
ngSystemsco.

http://www.spray.com/literature_pdfs/B459C_Understandi
ng_Drop_Size.pdf

NowwehaveseenthathowefficientisSOLARPOWEREDAIRPURIFIERthanothertypeofdeviceavailableinmarket.It alsovery economical and do not have to replace any componentquickly. It reduces particulate level to satisfactory positionwhereapersondoesnotneedtoworryaboutpollutionrelatedproblems.

A pure and clean air is right of a human being and all otherliving creatures on this earth and this project is a small effortfrom our sideto givetheall theirright.

Also in future, modifications can be made to improve workingefficiency withouteffectingsetup.

Calculation: