Modeling of solar assisted air purifier for room air conditioning

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Abstract*: *The main aim of the paper is to purify ambient air in the month of January and May in Guwahati city for an office room of 40 m^3 with 6 persons and 5 LED(light emitting diode) bulbs of 9W each throughout the day. In January ambient air is purified and brought to reference state of 40% relative humidity, 24^oC by using an air purifier, air blower, and vapour compression refrigeration system using 134a as refrigerant. Similarly in May ambient air is purified and brought to reference state of 50% relative humidity, 18^oC by using an air purifier, air blower, and vapour compression refrigeration system using 134a as refrigerant. The power required for operating the blower, 5 LED bulbs and vapour compression refrigeration compressor are obtained from 9 solar photovoltaic modules in parallel, 2 in series of model SW 280 assisted by 219.536 Ah capacity rechargeable battery.

***Keywords*: Ambient air, air purifier, blower, LED (light emitting diode) bulbs, vapour compression refrigeration, solar photovoltaic, rechargeable battery..**

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I. INTRODUCTION

An air cleaner plays an important role in maintaining clean air coming from the environment or mechanical, electrical, chemical equipment. Many researchers have worked on the functioning of the air purifier for various purposes. In [1], the authors built an economical solar air purifier that could be installed in every home and outdoors to take care of indoor air quality and contribute to cleaning the air in the surrounding environment. The air purifier was able to provide air filtration with sterilization powered by solar energy and available at an affordable price. In [2], the authors demonstrated a self-powered air purifier for the removal of indoor organic pollutants based on a triboelectric nanogenerator (TENG), combining non-thermal plasma (NTP) with photocatalytic oxidation (PCO). In [3], the authors created a solar outdoor air purifier that was energy independent and built for outdoor filtration powered by solar panels using a layer of pre-filters, HEPA (High-Efficiency Particulate Absorbing) filters, carbon filters and ultraviolet (UV) radiation for removing gases and pollutants (Particulate Matter) PM 10 and PM 2.5. In [4], authors designed and manufactured a solar powered air purifier system and tested the effectiveness of the system to reduce air pollution. In [5], researchers reviewed the idea of designing and manufacturing an air purification system that runs on renewable energy (i.e., solar energy) and also uses the reuse of laptop batteries to store energy produced from a solar panel.

The present paper deals with air purification of an office room of 40 m^3 with 6 persons and 5 LED(light emitting diode) bulbs of 9W each throughout the day in January and May.

II. SYSTEM LAYOUT

Fig. 1 shows a refrigeration plant where the enthalpy of air at the ambient temperature of Guwahati city leaving the blower and air purifier at *h1a* absorbs the heat dissipated by the refrigerant 134a in the condenser from 1 to 2 leaves at the enthalpy of air at 24 ^oC , *h1a* into the 40m^3 office room with 6 people. The relative air humidity considered at the inlet of the condenser is 79% [1'] and at the outlet of the condenser is 40%[2']. The temperature of the evaporator (T_E) is maintained at 15^oC, the temperature of the condenser (T_C) at 22^oC. The operation of the VCR is already known and is therefore not explained here.

Fig. 2 shows a refrigeration plant where Guwahati's ambient air enthalpy leaving blower and air purifier at *h1a* rejects heat to refrigerant 134a in evaporator from 3 to 4 exits at 18^oC air enthalpy *h1b* to 40m^3 office room with 6 people. The relative air humidity considered at the evaporator inlet is 75% [1'] and at the evaporator outlet is 50%[2']. The temperature of the evaporator (T_E) is maintained at 15^oC, the temperature of the condenser (T_C) at 30^oC.

Fig. 3 shows the distribution where the solar radiation hitting the solar photovoltaic modules (SPVs) during the solar hours generates the current I_{PV}. Through the charge controller, the current required by the compressor, blower and 5 LED bulbs (I_c +I_b+I_e) goes to the compressor, blower and bulbs after passing through the inverter and the extra current (I_{PV}- (I_c +I_b+I_e) goes to the rechargeable battery for storage for use in night time.

During the night, the current required by the compressor, blower and 5 LED bulbs (I_c +I_b+I_e-I_{PV}) comes from the rechargeable battery and is used by the compressor, blower and 5 LED bulbs shown in fig. 4.

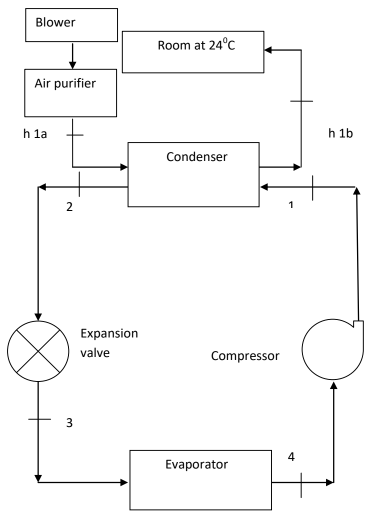

Fig. 1. VCR schematic with R134a as refrigerant for office room to be maintained at 24^{0}C for January

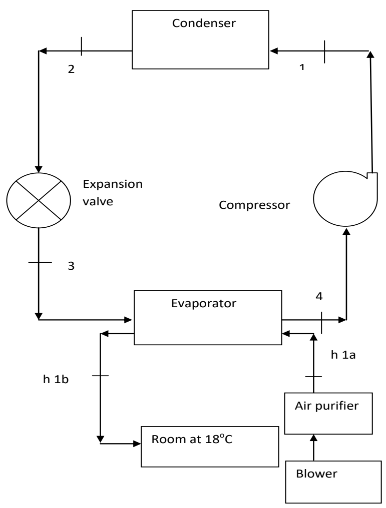

Fig. 2. VCR schematic with R134a as refrigerant for an office room to be maintained at 18^{0}C for May

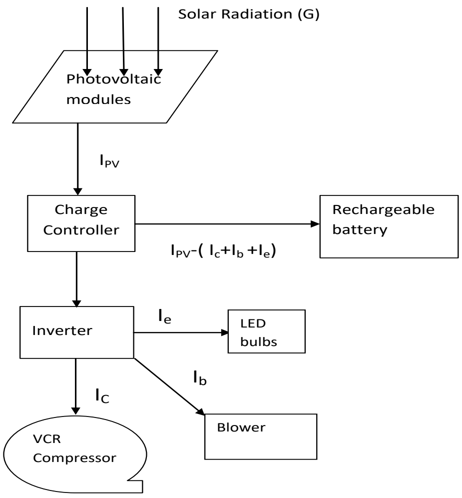

Fig.3. Schematic view of solar photovoltaic modules with charge controller, rechargeable battery and inverter for powering compressor, blower and LED bulbs during day time.

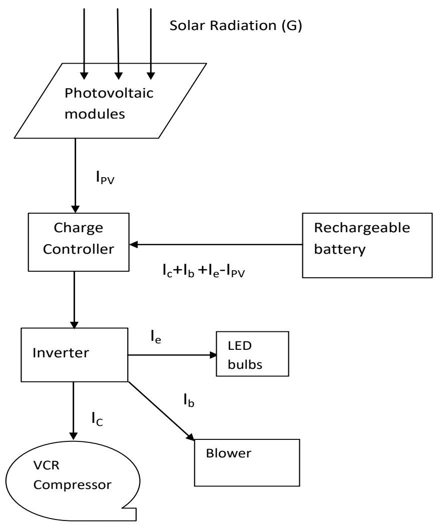

Fig.4. Schematic view of solar photovoltaic modules with charge controller, rechargeable battery and inverter for powering compressor, blower and LED bulbs during night time

III. MODELING OF COMBINED SYSTEM

The air cleaner is used to clean the air coming from the environment and discharged to the vapor compression refrigeration system with refrigerant R134a to maintain the desired condition of the office room. The volume of the room is considered to be 40 m^3 with the number of air changes per 24 hours being 15.29[6]. The number of air changes per second is therefore 0.00707 m^3/s for 6 people with a ventilation need of 0.0071 m^3/s for each person [6]. The total air circulation is therefore 0.0496 m^3/s.

Fig.5. Schematic layout of air filter.[3']

The pore sizes of the pre-filter, carbon filter and HEPA filter are assumed to be 10 microns[4'], 0.5 microns[5'] and 0.3 microns[6']. For effective filtration, an air speed of 1.462 m/s is considered [7']. The surface area of the filter is therefore calculated to be 0.184 m x 0.184 m.

Fig. 1 shows the layout of a compression refrigeration system in January with R-134a refrigerant. The analysis of the compression refrigeration system is already known and will be limited to the condenser, since in January the system works as a heat pump. In the condenser, the superheated R134a leaving the compressor at 1 leaves the condenser at 2. The enthalpy of the heat removed *(h_1-h_2)* kJ/kg is used by the enthalpy of the heat arriving at *h1b* (kJ/kg) and the leaving heat enthalpy at *h1a* (kJ/kg) to the room which is supplied by the blower.

$$h_{1b} = (1.006 \times 24 + x_{24}(2501 + 1.84 \times 24)) \times m_{24} \quad (1)$$

$$h_{1a} = (1.006 \times T_{Jan} + x_{Jan}(2501 + 1.84 \times T_{Jan})) \times m_{Jan} \quad (2)$$

Where, 1.006-specefic heat of air(kJ/kg^{o}C), 2501-latent heat of vaporization of water(kJ/kg), 1.84-specefic heat of water vapour(kJ/kg^{o}C), T_{Jan}-ambient temperature in January(^{o}C), x_{24} is absolute humidity at 24^{o}C and x_{Jan} is absolute humidity at ambient temperature of Guwahati city for January, m_{24}-mass flow rate of air at 24^{o}C(kg/s), m_{Jan}-mass flow rate of air at ambient temperature in January.

$$x_{24} = \frac{0.622 \times 0.4 \times \rho_{w,24}}{\rho_{a,24} - \rho_{w,24}} \quad (3)$$

Where, 0.622- ratio of molar mass of water vapour and molar mass of dry air, 0.4 is the relative humidity of room considered at 24^{o}C, $\rho_{w,34}$ -density of water vapour at 24^{o}C(kg/m^3), $\rho_{a,24}$-density of dry air at 24^{o}C(kg/m^3).

$$x_{Jan} = \frac{0.622 \times 0.79 \times \rho_{wJan}}{\rho_{a,Jan} - \rho_{w,Jan}} \quad (4)$$

Where, 0.622- ratio of molar mass of water vapour and molar mass of dry air, 0.79-relative humidity of ambient air's temperature in January, $\rho_{w,Jan}$ -density of water vapour of ambient air's temperature in January(kg/m^3), $\rho_{a,Jan}$ -density of dry air at ambient air's temperature in January(kg/m^3).

It is to be noted that ρ_w (density of water vapour)(kg/m^3) at any temperature(*T*)in ^{o}C is obtained from equation 5,

$$\rho_w = \frac{0.0022 \times P_w \times 1000}{T + 273.15} \quad (5)$$

Where, 0.0022- reciprocal of individual gas constant of water vapour, P_w- pressure of water vapour at *T* in ^{o}C in kPa and ρ_a (density of dry air) at any temperature(*T*)in ^{o}C is obtained from [8'].

Power requirement of blower for pumping air at enthalpy of h_{1b} to enthalpy of h_{1a} is given by :

$$W_b = \frac{(h_{1b} - h_{1a})}{0.68} \quad (6)$$

Where, 0.68- peak efficiency of centrifugal blower [9'].

The condenser load(in W) is found by equation 6,

$$Q_h = (h_{1b} - h_{1a}) \times 0.0496 \times \rho_{a,Jan} \quad (7)$$

Where, 0.0496-number of air changes(m^3/s) for 40 m^3 room and 6 persons, $\rho_{a,Jan}$ -density of ambient air in January(kg/m^3), *(h_{1b}-h_{1a})* is in kJ/kg.

The ideal *COP*(coefficient of performance) of heat pump of figure 1 is :

$$COP_{HP} = \frac{T_C}{T_C - T_E} \quad (8)$$

Where,T_C-condenser temperature, T_E- evaporator temperature.

Cooling load(Q_E)(in W) of figure 1 is :

$$Q_E = Q_h - \frac{Q_h}{COP_{HP}} \quad (9)$$

Ideal compressor load (W_{c1}) (in W)of figure 1 is :

$$W_{c1} = \frac{Q_E}{COP_{HP} - 1} \quad (10)$$

Or,

$$W_{c1} = m_r \times (h_1 - h_4) \quad (11)$$

Where, m_r- mass flow rate of refrigerant 134-a(kg/s), h_1-enthalpy of refrigerant 134-a in superheated state at saturation pressure corresponding to condenser temperature and at exit from compressor(kJ/kg), h_4- enthalpy of refrigerant 134-a at saturation vapour state corresponding to evaporator temperature(kJ/kg).

Mass flow rate of refrigerant (m_r) (in kg/s) is:

$$m_r = \frac{Q_E}{(h_4 - h_3)} \quad (12)$$

Where, h_4-enthalpy of refrigerant 134-a at saturated vapour corresponding to evaporator temperature(kJ/kg), h_3-enthalpy of refrigerant 134-a at exit from expansion valve(kJ/kg).

Actual compressor load(W_c) (in W)of figure 1 is:

$$W_c = \frac{W_{c1}}{0.85} \quad (13)$$

Where, 0.85- isentropic efficiency of centrifugal compressor[10'].

Power required by electrical appliances is given by :

$$W_e = P_{LEDbulbs} \times 5 \quad (14)$$

Where, $P_{LEDbulbs}$-power of a LED bulb being 9 W.

Actual COP(coefficient of performance) of heat pump of figure 1 is :

$$COP_{a,HP} = \frac{Q_h}{W_c} \quad (15)$$

Fig. 2 shows the layout of a compression refrigeration system in May with R-134a refrigerant. The analysis of the compression refrigeration system is already known and will be limited to the evaporator, since in May the system works as a refrigerator. The enthalpy of heat absorbed by R134a (h_1-h_4) kJ/kg is used by removing the enthalpy of heat arriving in *h1a* and leaving with the enthalpy of heat in *h1b* to the room, which is supplied by the blower.

$$h_{1a} = (1.006 \times T_{May} + x_{May}(2501 + 1.84 \times T_{May})) \times m_{May} \quad (16)$$

$$h_{1b} = (1.006 \times 18 + x_{18}(2501 + 1.84 \times 18)) \times m_{18} \quad (17)$$

Where T_{May}-ambient temperature in May, x_{18} is absolute humidity at 18^{o}C and x_{May} is absolute humidity at ambient temperature of Guwahati city for January, m_{May}-mass flow rate of air at ambient temperature at May(kg/s), m_{18}-mass flow rate of air at 18^{o}C.

$$x_{18} = \frac{0.622 \times 0.5 \times \rho_{w,18}}{\rho_{a,18} - \rho_{w,18}} \quad (18)$$

Where, 0.622- ratio of molar mass of water vapour and molar mass of dry air, 0.5 is the relative humidity of room considered at 18^{o}C, $\rho_{w,18}$ -density of water vapour at 18^{o}C, $\rho_{a,18}$ -density of dry air at 18^{o}C.

$$x_{May} = \frac{0.622 \times 0.75 \times \rho_{w,May}}{\rho_{a,May} - \rho_{w,May}} \quad (19)$$

Where, 0.75 is the relative humidity considered at ambient temperature in January, $\rho_{w,,May}$ -density of water vapour at ambient temperature in May, $\rho_{a,May}$ -density of dry air at ambient temperature in May.

Power requirement of blower for pumping air at enthalpy of h_1 to enthalpy of h_2 is given by:

$$W_b = \frac{(h_{1a} - h_{1b})}{0.68} \quad (20)$$

Where, 0.68- peak efficiency of centrifugal blower [9'].

The evaporator load(in W) is found by equation 21,

$$Q_e = (h_{1a} - h_{1b}) \times 0.0496 \times \rho_{a,May} \quad (21)$$

Where, (h_{1a}-h_{1b}) is in kJ/kg.

The COP of refrigerator of figure 2 is :

$$COP_R = \frac{T_E}{T_C - T_E} \quad (22)$$

Compressor load (W_{c2}) of figure 2 is :

$$W_{c2} = \frac{Q_e}{COP_R} \quad (23)$$

Or, $$W_{c2} = m_r \times (h_1 - h_4) \quad (24)$$

Where, m_r- mass flow rate of refrigerant 134-a(kg/s), h_1- enthalpy of refrigerant 134-a in superheated state at saturation pressure corresponding to condenser temperature and at exit from compressor(kJ/kg), h_4- enthalpy of refrigerant 134-a at saturation vapour state corresponding to evaporator temperature(kJ/kg).

Mass flow rate of refrigerant (m_r) (in kg/s) is:

$$m_r = \frac{Q_e}{(h_4 - h_3)} \quad (25)$$

Where, h_4-enthalpy of refrigerant 134-a at saturated vapour corresponding to evaporator temperature(kJ/kg), h_3-enthalpy of refrigerant 134-a at exit from expansion valve(kJ/kg).

Actual compressor load(W_c) (in W)of figure 2 is:

$$W_c = \frac{W_{c2}}{0.85} \quad (26)$$

Where, 0.85- isentropic efficiency of centrifugal compressor[10'].

Power required by electrical appliances is given by :

$$W_e = P_{LEDbulbs} \times 5 \quad (27)$$

Where, $P_{LEDbulbs}$-power of a LED bulb being 9 W.

The detailed calculations for solar photovoltaic modules and specifications are available in [7] and [11'] respectively. The solar radiation and wind speed data are obtained from [12'] and [13'].

Number of photovoltaic modules needed in series(N_s) is given by:

$$N_s = \frac{48}{V_{mod}} \quad (28)$$

Where 48 is the system voltage and V_{mod}-maximum voltage of the module.[14']

Amount of current required from photovoltaic modules(I_{spv}) is given by:

$$I_{spv} = \frac{(W_b + W_c + W_e) \times 1.25}{48 \times 0.85 \times 0.85 \times 7 \times 0.85} \quad (29)$$

Where, W_c-total compressor work(in W) in a day, 1.25-derating factor[15'], 48-system voltage, 0.85-power factor, 0.85-inverter efficiency,7-average sunshine hours in Guwahati[16'], 0.85-charge controller efficiency.

The number of photovoltaic modules in parallel (N_p) is given by:

$$N_p = \frac{I_{spv}}{I_{mod}} \quad (30)$$

Where, I_{mod}- maximum current of the module[21]

IV. RESULTS AND DISCUSSIONS

Table I shows the variation of enthalpies at the outlet of the blower passing through the air filter and the entrance to a 40 m^3 office room with 6 people. The variation of blower work (W_b) along with vapor compression compressor work (W_c) is shown. It can be seen that h_{1a} increases with T_{Jan} with increase in x_{Jan}. However, h_{1b} remains constant because the temperature at the outlet of the condenser remains constant, i.e. 24 °C and also x_{24}. At 5:30 AM, 8:30AM and 11:30AM, (h_{1b}-h_{1a}) it is negative which means that the heat is absorbed by the condenser. It also means that the blower and compressor are being worked on. It can be seen that as the (h_{1b}-h_{1a}) term increases, the blower work increases. Also, the actual work of the compressor increases if the blower work increases due to the increase in Q_h according to equation 7, which results in an increase in the mass flow rate of the refrigerant 134a.

TABLE I. TEMPERATURES, ENTHALPIES, BLOWER POWER, COMPRESSOR PUMPING POWER FOR JANUARY

Time in hours	$T_{amb,Jan}$ (°C)[17']	h_{1a} (k W)	h_{1b} (k W)	(h_{1b}-h_{1a}) kW	W_b (kW)	W_c (kW)
12:30 AM	13.33	1.549	2.128	0.579	0.85	0.0128
3:30 AM	16.111	1.849	2.128	0.279	0.409	0.0065
5:30 AM	20	2.303	2.128	-0.175	-0.258	-0.0028
8:30 AM	21.111	2.441	2.128	-0.313	-0.460	-0.0056
11:30 AM	18.888	2.168	2.128	-0.04	-0.059	-0.00007
2:30 PM	17.777	2.038	2.128	0.09	0.131	0.0026
5:30 PM	15.556	1.787	2.128	0.341	0.5003	0.0078
8:30 PM	15	1.727	2.128	0.401	0.588	0.0091

TABLE II. ELECTRIC ENERGY DISCHARGING AND CHARGING IN JANUARY

Time in hours	Discharged current from battery(Ah)	Charged current to battery(Ah)
12:30 AM	6.475	0
3:30 AM	3.286	0
5:30 AM	0	1.001
8:30AM	0	22.284
11:30AM	0	28.366
2:30PM	0	27.608
5:30PM	3.121	0
8:30PM	4.582	0

Table II shows the changes in battery discharge and charge. It can be seen that the discharge current decreases from 12:30AM to 3:30AM as the blower and compressor work decreases. And the discharge current at 12:30AM is maximum because the work of blower and compressor is maximum. Sunshine is considered to be the time from 6:00 AM. to 6:00 PM. It can be seen that the battery charge increases at 11:30 AM from 8:30 AM and decreases at 2:30 PM from 11:30 AM as the solar radiation increases from 6:00 AM to 12:00 PM and decreases again at 6:00 PM.

TABLE III. TEMPERATURES, ENTHALPIES, BLOWER POWER, COMPRESSOR PUMPING POWER FOR MAY

Time in hours	$T_{amb,Jan}$(°C)[17']	h_{1a} (kW)	h_{1b} (kW)	(h_{1a}-h_{1b}) kW	W_b (kW)	W_c (kW)
12:30 AM	23.888	2.733	1.985	0.748	1.1	0.048
3:30 AM	25	2.883	1.985	0.898	1.321	0.057
5:30 AM	26.667	3.115	1.985	1.13	1.661	0.072
8:30AM	27.777	3.276	1.985	1.291	1.898	0.082
11:30AM	27.222	3.195	1.985	1.21	1.779	0.077
2:30PM	25.555	2.959	1.985	0.974	1.433	0.062
5:30PM	25.555	2.959	1.985	0.974	1.433	0.062
8:30PM	26.111	3.036	1.985	1.051	1.545	0.067

Table III shows the variation of enthalpies at the outlet of the blower through the air filter and at the entrance to a 40 m^3 office room with 6 people. The change in blower work (W_b), compressor work (W_c) is also shown. It can be seen that h_{1a} increases with increasing T_{May} and increasing x_{May}. However, h_{1b} remains constant because the evaporator outlet temperature remains constant, i.e. 18°C and also x_{18}. It can be seen that the blower work is more for May, as x_{May} is more for May than January. As (h_{la}-h_{1b}) increases, W_b increases and W_c also increases as Q_e increases according to Equation 21, resulting in an increase in mass flow rate of refrigerant 134a.

TABLE IV. ELECTRIC ENERGY DISCHARGING AND CHARGING IN MAY

Time in hours	Discharged current from battery(Ah)	Charged current to battery(Ah)
12:30 AM	8.511	0
3:30 AM	10.148	0
5:30 AM	12.681	0
8:30AM	0	16.507
11:30AM	0	38.567
2:30PM	0	29.096
5:30PM	0	0.104
8:30PM	11.818	0

Table IV shows the changes in battery discharge and charge. It can be seen that the discharge current increases from 12:30AM to 5:30AM with increasing work of blower (W_b), compressor (W_c). It can be seen that the battery charge increases at 11:30 from 8:30 and decreases at 2:30PM from 11:30AM due to the fact that solar radiation increases from 6:00AM to 12:00PM and decreases again until 6:00PM.

Based on blower work, compressor work, and LED power, 9 modules of solar PV modules in parallel (Eq. 30) and 2 modules in series (Eq. 28) of SW280 module are needed to power the entire system.

The amount of charge stored and discharged by the rechargeable battery in January and May are 88.117Ah, 17.076Ah and 85.516Ah, 41.499Ah with a battery capacity of 219.536Ah. Stored current is less than January and discharge is more than January for May due to more work of blower and compressor.

V. CONCLUSIONS

Based on the parameters given in the text, a system with 9 modules of solar PV modules in parallel (Eq. 30) and 2 modules in series (Eq. 28) of the SW280 module is sufficient to operate a 40 m^3 office room with 6 people and 5 LED bulbs at room temperature 24^{o}C (RH-40%) and 18^{o}C (RH-50%) in January and May respectively in Guwahati city with an infiltration load of 0.0496 m^3/s. The study is done in January and May because January and May have the minimum solar radiation, temperature and maximum solar radiation and temperature respectively, so if the system works well in the minimum and maximum conditions, the system will work well throughout the year.

REFERENCES

[1] A. Arora, K. Bhardwaj, N. Esmail, and P. D. Dubey, “Design, Fabrication, and Testing of a Solar Powered Air Purifier with UV Sterilization Capability,” Advances in Manufacturing Technology and Management. In: Proceedings of 6th International Conference on Advanced Production and Industrial Engineering (ICAPIE)—2021, pp 261-272, 2023.

[2] Q. Zheng, T. Sun, L. Fang, L. Zheng, and H. Li, “Self-powered air purifier with coupling of non-thermal plasma and photocatalytic oxidation for formaldehyde degradation based on triboelectric nanogenerator,” Nano Energy, vol. 102, pp.107706, 2022.

[3] P. K. Ganesh, R. Santosh, N. K. Srimannarayana, N. K. Sriramsrinivasan, and D. K. Manu, “Solar outdoor air purifier with air quality monitor,” i-Manager's Journal on Communication Engineering and Systems, vol. 11(1), pp. 6-12, 2022.

[4] R. Y. Powar, and V. D. Bavdhane, “Solar Powered Outdoor Air Purifier with Air Quality Monitor,” International Research Journal of Innovations in Engineering and Technology, vol. 6(4), pp. 68-70, 2022.

[5] D. Perumal, G. S. Kumar, S. Vignesh, S. Poovalingam, and S. P. Iyappan, “Solar indoor air-purifier with air quality monitor system,” International Journal of Electrical Engineering and Technology, vol.12(3), pp.49-54, 2021.

[6] S. S. Banwait, and S. C. Laroiya, Birla’s Properties of Refrigerant and Psychrometric, Tables and Charts in S.I.unit: Birla Publications and Private Limited, 2005.

[7] R. Chenni, M. Makhlouf, T. Kerbache, and A. Bouzid, “A detailed modeling method for photovoltaic cells,” Energy, vol. 32, pp. 1724-1730, 2007.

WEB LINKS

[1’] Relative Humidity in Guwahati, India, https://www.guwahati.climatemps.com/humidity.php. Accessed 12.11.2022

[2’] Ideal Humidity in Winter vs. Summer - One Hour Heating & Air. https://www.onehourheatandair.com/pittsburgh/aboutus/blog/2019/december/what-is-the-ideal-humidity-in-winter-vs-summer-/. Accessed 12.11.2022

[3’] 26128 Air Purifier Images, Stock Photos & Vectors, https://www.shutterstock.com/search/air-purifier.Accessed 14.11.2022.

[4’] Pre Filter 10 Micron, For Clean Room Application, Size, https://www.indiamart.com/proddetail/pre-filter-10-micron-20705001655.html. Accessed 15.11.2022.

[5’] Activated carbon for air purifier, https://www.ucicarbons.com/activated-carbon-for-air-purifier/. Accessed 20.11.2022.

[6’] Why do HEPA Filters have 0.3 Micron Pore Size?, https://www.pharmaguideline.com/2018/10/hepa-filters-pore-size.html. Accessed 20.11.2022.

[7’] FILTER SIZING, http://www.dnr.louisiana.gov/assets/TAD/education/ECEP/hvac/g/g.htm. Accessed 20.11.2022.

[8’] Air - Density, Specific Weight and Thermal Expansion, https://www.engineeringtoolbox.com/air-density-specific-weight-d_600.html. Accessed 22.11.2022.

[9’] FANS AND BLOWERS - Bureau of Energy Efficiency,https://beeindia.gov.in/sites/default/files/3Ch5.pdf. Accessed 25.11.2022.

[10’] Compressor Isentropic Efficiency: What, How, Several Types ...; https://lambdageeks.com/compressor-isentropic-efficiency/. Accessed 25.11.2022

[11’]How do I read the solar panel specifications?-altEStore https://www.altestore.com/blog/2016/04/how-do-i-read-specifications-of-my-solar-panel/#.YhOABOhBzIU. Accessed 29.11.2022.

[12’] Solar Irradiance - calculate the solar energy available on your ..., http://www.solarelectricityhandbook.com/solar-irradiance.html. Accessed 30.11.2022.

[13’] Solar Energy Assessment Report,For 100kWp at Guwahati, Assam,India by ezysolare, http:solar design ezysolare.com-1-638. Accessed 2.12.2022.

[14’] How Do I Read Solar Panel Specifications?, https://www.altestore.com/blog/2016/04/how-do-i-read-specifications-of-my-solar-panel/#.YTXxgp0zbIU. Accessed 3.12.2022.

[15’] Telecommunication Engineering Centre (TEC), New Delhi, Planning and maintenance guidelines for SPV power, http://www.tec.gov.in/guidelines.html. Accessed 11.12.2011.

[16’] Annual Sunshine in India - Current Results, http://www.currentresults.com/Weather/India/annual-sunshine.php. Accessed 10.12.2022.

[17’]Weather History & Data Archive | Weather Underground, https://www.wunderground.com/history. Accessed 10.12.2022.

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