Aerosol Science and Engineering (2022) 6:391–399
https://doi.org/10.1007/s41810-022-00152-7

ORIGINAL PAPER

Low-Cost Air Purifier Prototype Using a Ventilating Fan and Pump Against Haze Pollution

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Received: 7 April 2022 / Revised: 1 June 2022 / Accepted: 11 July 2022 / Published online: 20 August 2022

Abstract
This study aimed to focus on the design and development of low-cost do-it-yourself (DIY) air purifiers, using a ventilating fan, air pump, water pump, and an ultrasonic generator that can be used during the haze pollution. Six types of household air purifiers were fabricated. The amount of particulate matter (PM) and carbon dioxide (CO_2) levels were recorded at 0, 10, 20, 30, and 60 min (min), then, repeated 3 times. After 10 min of the 3rd experiment of each study, the last measurement of air pollution would be recorded. The results showed at 60 min, the high-efficiency particulate air (HEPA) filter and electrostatic fiber was the best technique regarding reduction of PM and CO_2 levels. The highest PM reduction rate had occurred at 30 min using an air pump procedure (99.330 to 100%). The CO_2 levels of all experiments had fluctuated at different times. After 10 min of a closed machine, PM levels of all air purifier systems were decreased, except HEPA filter and electrostatic fiber types. In conclusion, the best method for reducing particulate matter and cost without taking humidity into account is an air pump technique, whereas the HEPA filter and electrostatic fiber method is the best choice for lowering PM levels without increasing humidity and vapor production.

Keywords Air filtration · Air purifier · Haze · HEPA filter · Particulate matter

1 Introduction

Air pollution has become one of the global health hazards in the twenty-first century. From the report of the World Health Organization, 4.2 million premature deaths globally every year have been linked to outdoor air pollution. The major causes of death included 43% chronic obstructive pulmonary disease, 29% lung cancer, 25% ischemic heart disease, 24% stroke, and 17% acute lower respiratory infection, respectively. One of the main causes of ambient air pollution is particulate matter, especially that which is less than 2.5 μm as well as particles of 10 μm in diameter (PM2.5 and PM10). PM can penetrate the lung and enter the bloodstream, eventually destroying many respiratory, cardiovascular, and cerebrovascular functions (World Health Organization 2020). Over the period 1960 to 2009, the mean population-weighted PM, measuring 2.5 μm, concentrations were found to have increased by 38%, mainly noted in China and India, which attributed to global death increase by 89 to 124%, while PM 2.5 μm concentration trends were reduced in Europe and the United States (Butt et al. 2017). Thailand's northern region, especially in Chiang Mai and Chiang Rai Provinces, which are the northern frontier of Thailand with Laos and Myanmar, has been facing increasing haze pollution over the past decade. Haze pollution usually occurs during the dry season, from January to May, peaking in March every year. This problem reached a crisis when in March 2019, for several days, the PM 2.5 μm and PM 10 μm levels were higher than the national standard of 25 μg m^{-3} and 50 μg m^{-3}. Even though the Thai government has introduced laws and attempted to manage haze and forest fires since 2006, air pollution has been a persisting problem (Pardthaisong et al. 2018; Phetpradap 2020).

The composition of air pollution varies according to the origin, emission rate, and environment. The main components of particulate matter include nitrates, sulfates, endotoxins, polycyclic aromatic hydrocarbons, iron, nickel, copper, zinc, etc. Coarse particles (PM 10 μm) derive from both industrial and natural sources that cannot permeate beyond the upper bronchus, while fine (PM 2.5 μm) as well as ultrafine (PM 0.1 μm) particles, which are generated from

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the combustion of fuels, may affect the lower part of the airway. Therefore, both acute and chronic PM exposures can be expected to promote cardiovascular hazards, including, heart failure, ischemic stroke, and also ischemic heart disease (Hamanaka and Mutlu 2018). To reduce the levels of PM, the use of low-sulfur diesel fuel and biofuel to replace oil-based fuel, increased management of sources of combustion and industrial activity, and the creation of pollution control legislation, are applicable (Crinnion 2017). However, the implementation of public policymaking of haze management is problematic. When considering the COVID-19 pandemic, coughing and sneezing can generate respiratory droplets, which are usually larger than 5 μm, and are the most respiratory infection transmission, while particles, measuring 5 μm in diameter or smaller, can remain airborne. Data revealed that viruses SARS-CoV-2 can be transmitted by both small and large aerosols and it has been detected in the air within many hospitals. Therefore, haze problems cannot separate from COVID-19 spreading absolutely (Fennelly 2020).

The key attribute of any indoor air filtration system is a balance of adequate ventilation, filtration efficacy, and reasonable cost-effective maintenance, without adverse airflow and efficiency effects. A multi-layer air filtration system, composed of a pre-filter, carbon filter, antibacterial filter, and also a high-efficiency particulate air (HEPA) filter, has been the usual solution (Vijayan et al. 2015). However, this technique consists of many components, which are not amenable to simple construction methods. In commercial portable HEPA filter air cleaners, the filtration efficacy is highly effective against diesel combustion, which creates many sizes of small particles (Peck et al. 2016). Therefore, a compact air cleaner can be amalgamated with a ventilating fan without great difficulty. A solution that has commonly been applied for household smog eradication is based on a commercial household vacuum cleaner, which has a water-based cleaning system, and which significantly reduced both PM concentrations (PM 1 μm, PM 2.5 μm, and PM 10 μm) and particle numbers. However, the main drawback of a traditional household vacuum cleaner is that dust can reduce the airflow rate or even damage the filter (Fermo et al. 2019). To enhance the household air filter performance, ionizer-assisted air filtration can be applied. All submicron, ultrafine particles, fine particles, as well as coarse particles are then removed from the environment. Therefore, ionization should be used with an air filter to improve the filtration efficiency. A byproduct of the ionizer air purifier, which can lead to damage of the respiratory system, is ozone. To solve this problem, carbon fiber ionizers were added for ozone reduction (Shi and Ekberg 2015). That means this total system cannot be fabricated without mechanical expertise.

In the setting of low- and middle-income countries, there is a lack of novel technologies as well as experts to provide a high-performance household air purifier, these same areas are those most affected by the ongoing haze crisis and also COVID-19 spreading. An alternative strategy, that can provide low-cost health hazard protection, is to develop a common do-it-yourself (DIY) air purifier prototype and sharing the design. However, a suitable DIY air purifier model is still open to question. Therefore, this study attempted to focus on the design and fabrication of a low-cost DIY air purifier, using a ventilating fan, air pump, water pump, and also an ultrasonic generator and then to evaluate the filtration efficacy and also cost-effectiveness, to create a prototype of a low-cost DIY air purifier, easily constructed using simple methods.

2 Materials and Methods

Six types of household air purifiers, which were set at a similar initial cost, were fabricated and tested. To promote a cost–benefit analysis, all inventories and labor costs were limited to not exceed than 1,700 Thai baht (THB) for each prototype. Some techniques and testing procedures are shown below.

2.1 Machinery Design

The essential functions of the HEPA filter rely on 3 parts, first, outer filters, which work like sieves, that can prevent coarse particles entering to damage the filtration system. Second, a mat of dense fibers that are designed to trap either fine or ultrafine particles. Finally, the inner part of the filter that can catch air particles, using direct contact, when clouds of dust flow at high speeds, while at the same time some particles tend to attach the filter randomly at lower airspeeds according to Brownian movement (Sandle 2013). Therefore, two air purifier prototypes were made using a HEPA filter and a ventilating fan. An ultra-dense H11-grade 360° cylindrical triple-filter including, a primary filter, HEPA filter, an activated carbon filter, was amalgamated with a ventilating fan 0.04 A 8 W 220 V 50 Hz, output 0.480 $m^3\ min^{-1}\ W^{-1}$ to ensure that the airflow rate could produce contact between the particles and the HEPA filter. This dual device was positioned to be the main component of the air purifier. One technique that has been used as a component of air filtration processes is an electret polypropylene (PP) filter, which is combined with charge enhancers, such as magnesium stearate (MgSt), titanium dioxide (TiO_2), lithium niobate ($LiNbO_3$), silicon dioxide (SiO_2), nanoscale graphite platelets, barium titanate ($BaTiO_3$), etc. (Lou et al. 2020; Zhang et al. 2018). Therefore, another air cleaner model, using a HEPA filter with a ventilating fan was linked to an electrostatic air conditioner filter, made of PP fiber, in a separate enclosure. The HEPA filter with an electrostatic fiber prototype is shown in Fig. 1.

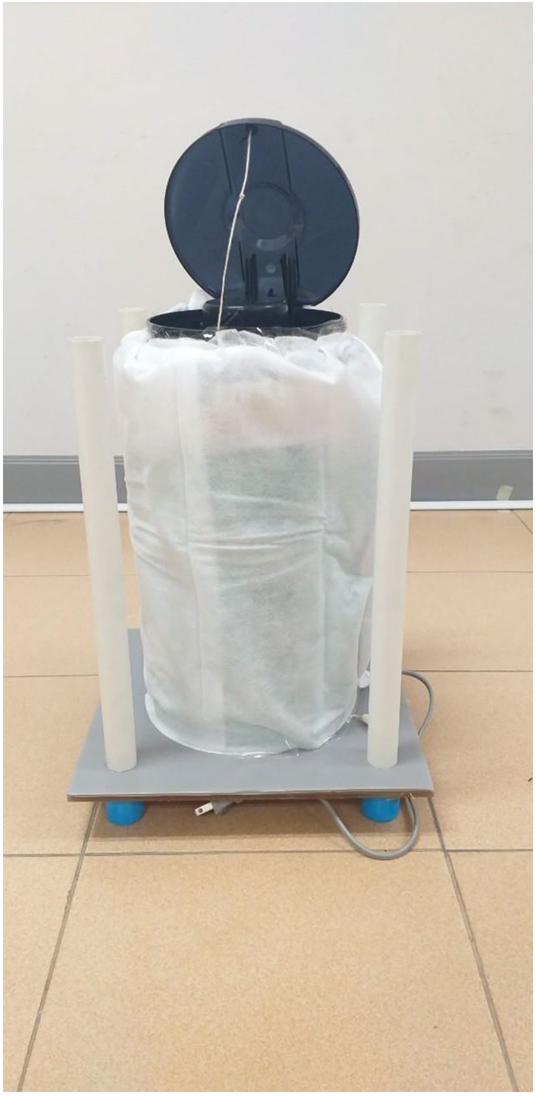

Fig. 1 HEPA filter amalgamated with a ventilating fan and an electrostatic filter prototype

The other four air purifier prototypes were designed to work without the use of a HEPA filter. An aquarium air pump 220 V 50 Hz 25 W, maximum output 55 L min^{-1} was mounted with a glass chamber (L × W × H = 0.35 m × 0.17 m × 0.21 m = 0.0125 m^3) and filled with 9 L freshwater. Dirty air is forced through the water, producing air bubbles in the water. The bubble dynamics, including bubble size, shape, and velocity, are influenced by buoyancy, viscosity, and surface tension (Nadooshan and Shirani 2008; Pradeep et al. 2019). Ideally, the contaminants should be contained within the water, returning only fresh air to the environment. However, large bubbles usually bring the contaminants to the surface of the water and back into the ambient air again. One technique, which can reduce the size of bubble formation, is the use of emulsions containing hydrophobic particles, also called "antifoams". Some additional ingredients may be used as antifoams, for example, linseed oil, phenyl ether, milk, polyamides, kerosene, amyl alcohol, trimethylcyclohexanol, etc. (Karakashev and Grozdanova 2012). However, after the air passes through the water, it should return to the environment without being filtered again. This means that chemicals should not be added to the water, to ensure that an air purifier returns only fresh air back to the environment. Therefore, as an alternative, the surface of the water was covered with only a polyurethane sponge to prevent larger air bubbles returning to the environment.

To compare the filtrate efficiency between an air pump and a water pump, an aquarium submersible pump AC 220 V 50 Hz 25 W, maximum pump head 1.5 m, maximum flow rate 1,500 L hr^{-1}, was used for this purpose. This uses the Venturi effect to make a water vacuum pump, which is the result of Bernoulli's principle in fluid dynamics. When the speed of fluid is increased as it passes through a pipe, which is suddenly reduced in diameter, the accelerated energy also creates a vacuum effect that can be used for the air suction (Ganas 2017). Other filtration components, except a water pump, were set as the air pump technique.

The last two methods, which were based on an air compressor as well as a water vacuum pump, were incorporated with an ultrasonic wave generator. The acoustic agglomeration technique, which is generated by sound waves, showed a high efficiency of PM 2.5 μm removal (Zhou et al. 2015). In general, ultrasonic mist maker testing has usually been carried out on simulated fog and fire suppression systems (Jian-yong et al. 2011). However, the study of the correlation of ultrasonic waves and water-based air purifier systems is minimal. Therefore, an aquarium mist maker 220 V 50 Hz 25 W was used for these experiments. It was positioned beneath a polyurethane sponge to prevent mist formation as well as pseudo-hazing. The test of the water pump technique compared with the water pump with the ultrasonic wave technique is shown in Fig. 2.

2.2 Air Pollution Tests

Closed air within the PVC box (L × W × H = 0.45 m × 0.45 m × 0.50 m = 0.10125 m^3) was used to simulate room air pollution. The amount of haze at 0, 10, 20, 30, and 60 min was recorded during air purifier prototype testing. The average percentage of haze was calculated 3 times for each experiment. After the 3rd experiment of each study, and the air purifier had been switched off 10 min, then, the last measurement of air pollution within the box was conducted.

Two instruments were used for this study, first, the Portable Particle Counter Model 9310 TSI AeroTrak® for cleanroom measurement, was used for calculating the number of particle sizes of 0.3, 0.5, 1.0, 3.0, 5.0, and 10 μm (particle m^{-3}), respectively. Second, Q-Trak™ Indoor Air Quality Monitor Model 7575, was used for CO_2 detection (ppm).

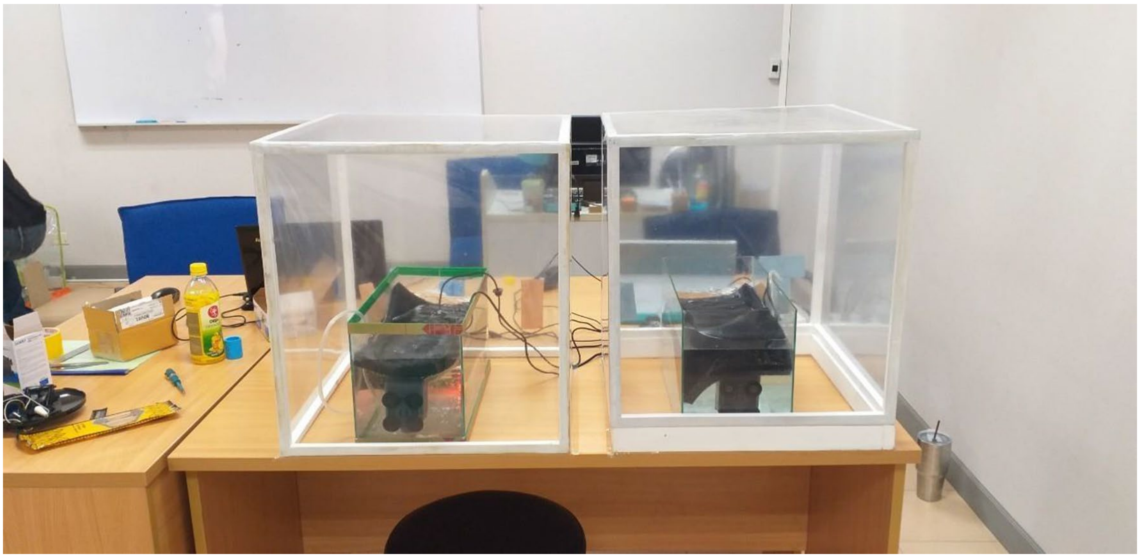

Fig. 2 Test of the water pump with the ultrasonic wave technique, which showed a red light from the mist maker (left), and the water pump technique (right) within PVC boxes

3 Results

Over 18 experiments, each air purifier prototype was tested 3 times. The results of filtration efficacy and cost-effectiveness among each air purifier prototype are shown as follows.

3.1 Particulate Matter and CO_2 Levels

In Table 1, at 60 min air treatment, an air purifier using a HEPA filter amalgamated with electrostatic fiber showed the best performance in reducing any type of particulate matter (92.727 to 95.411%) as well as a 4.335% reduction in CO_2 levels. In the group of air purifiers using water-based air treatment, an added air pump technique had the highest efficiency in decreasing particulate matter. However, the trend of PM levels, as shown in Fig. 3, revealed that the levels of particulate matter, which were treated only by an air pump technique, also significantly dropped during 10 to 30 min of treatment. In Table 2, three types of air purifiers, with the best reduction of the levels of particulate matter, included an air pump technique (99.330 to 100%) at 30 min air treatment, HEPA filter and electrostatic fiber (92.727 to 95.411%) at 60 min air treatment, and HEPA filter (0 to 91.003%) at 30 min air treatment, respectively. After 30 min air treatment using all water-based purifier systems, a great amount of vapor had appeared, contrasting with both HEPA filter-based techniques, which did not produce vapor. Figure 4 shows the CO_2 levels, in the range

Table 1 Percentage difference of particulate matter (particle m^{-3}) and CO_2 (ppm) among 6 types of air purifiers when compared between 0 and 60 min air treatment. The symbol "+" represents an increasing percentage of PM at 60 min when compared to 0 min, whereas the symbol "–" represents the opposite

Prototype	Percentage difference of air pollution at 60 min						
	PM0.3	PM0.5	PM1.0	PM3.0	PM5.0	PM10	CO_2
HEPA filter	– 80.966	– 81.808	– 76.701	– 78.218	– 78.788	– 100[a]	+ 8.458
HEPA and electrostatic fiber	– 94.095	– 94.720	– 95.096	– 95.411	– 92.727	–[b]	– 4.335
Air pump	– 51.785	– 56.917	– 44.293	+ 62.150	+ 39.256	0[c]	+ 6.978
Air pump and ultrasonic wave	+ 54.173	+ 193.833	+ 256.894	+ 247.060	+ 154.656	– 50	+ 2.083
Water pump	+ 58.410	+ 119.310	+ 158.278	+ 199.132	+ 181.949	– 100[a]	– 3.815
Water pump and ultrasonic wave	+ 32.127	+ 48.140	+ 140.074	+ 175.293	+ 152.691	– 66.667	– 3.410

[a] After 60 min, PM10 was completely cleared

[b] PM10 could not be detected during the experiment

[c] PM10 levels were the same between 0 and 60 min

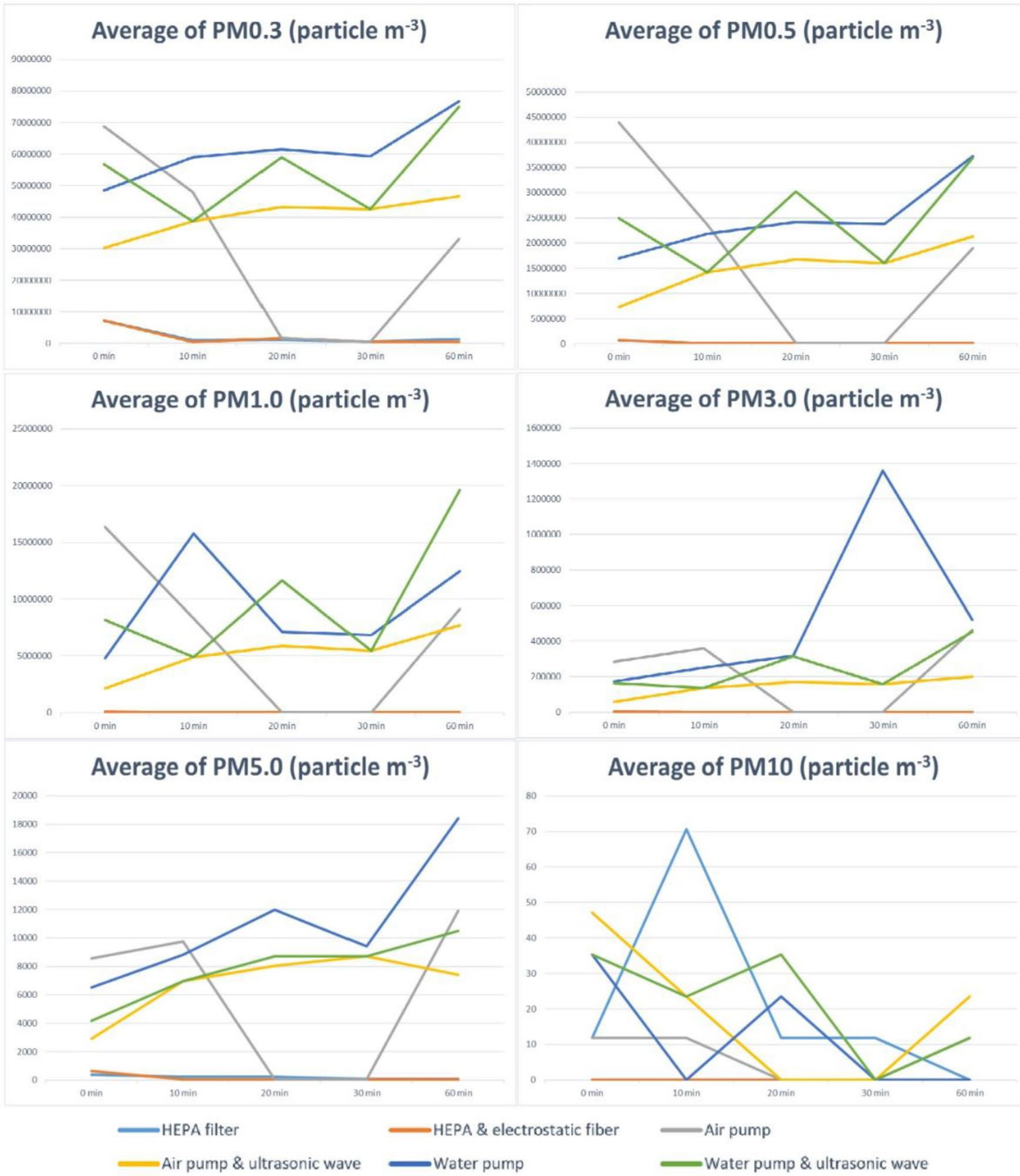

Fig. 3 Average number of particle sizes of 0.3, 0.5, 1.0, 3.0, 5.0, and 10 μm (particle m^{-3}) at different times

of 416 to 531.667 ppm, which fluctuated at different times during all the tests.

At the 3rd experiment of each air purifier prototype, the differences in air pollution comparing between 60 min air treatment and 10 min after the process finished is shown in Table 3. HEPA filter with electrostatic fiber method revealed the highest rate of PM elevation, from 1,461.180 to 4,800% in PM 0.3, PM 0.5, PM 1.0, and PM 3.0 μm levels, followed by the HEPA filter procedure, while all water-based purifier systems showed a decrease of particulate matter levels. Regarding the HEPA filter technique, even though PM 10 μm was completely eliminated after 60 min of air treatment, it returned after 10 min of process completion, just like PM 5.0 μm and PM 10 μm in the HEPA filter and electrostatic fiber system. The CO_2 levels during all experiments did not vary by more than 4%.

Table 2 Percentage difference of particulate matter (particle m^{-3}) among the best 3 prototypes of air purifiers at the best air pollution-reducing times. The symbol "+" represents an increasing percentage of PM at any time when compared to 0 min, whereas the symbol "–" represents the opposite

Prototype	Percentage difference of the best performance of air purifiers					
	PM0.3	PM0.5	PM1.0	PM3.0	PM5.0	PM10
30 min HEPA filter	– 91.003	– 90.936	– 86.499	– 81.683	– 81.818	0[a]
60 min HEPA and electrostatic fiber	– 94.095	– 94.720	– 95.096	– 95.411	– 92.727	–[b]
30 min Air pump	– 99.330	– 99.899	– 99.957	– 99.901	– 99.449	– 100[c]

[a]PM10 levels were the same between 0 and 30 min

[b]PM10 could not be detected during all HEPA filter and electrostatic fiber experiments

[c]After 30 min, PM10 was completely cleared

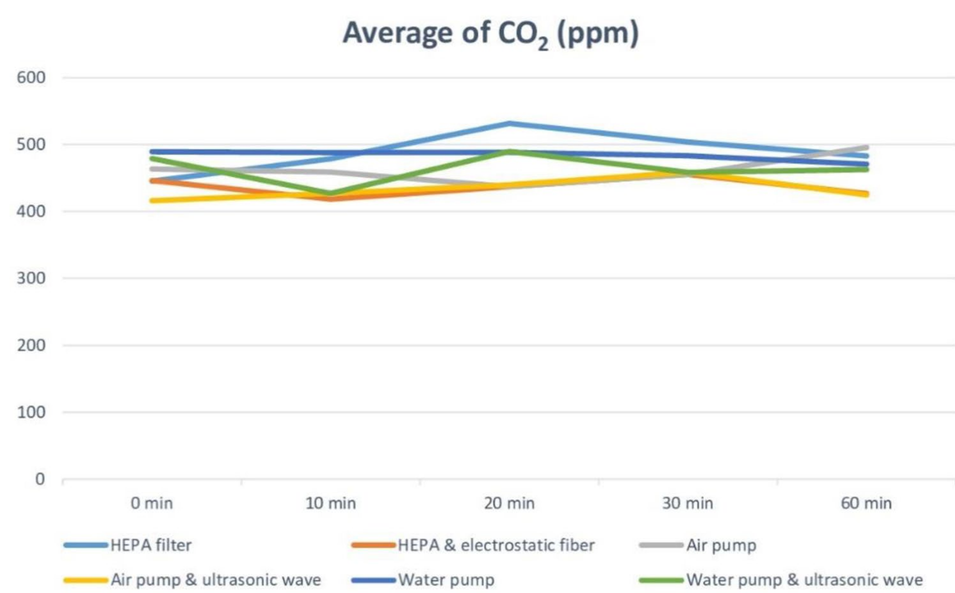

Fig. 4 Average CO_2 levels (ppm) at different times

Table 3 Percentage difference in particulate matter (particle m^{-3}) and CO_2 (ppm) between 60 min of air treatment and 10 min after process completion in the 3rd experiment. The symbol "+" represents an increasing percentage of PM after 10 min process finishing when compared to 60 min of air treatment, whereas the symbol "–" represents the opposite

Prototype	Percentage difference of air pollution after 10 min process finishing						
	PM0.3	PM0.5	PM1.0	PM3.0	PM5.0	PM10	CO_2
HEPA filter	+ 134.162	+ 126.973	+ 109.695	+ 125.000	+ 200	+ 35.336[a]	+ 0.633
HEPA and electrostatic fiber	+ 1461.180	+ 1607.347	+ 2158.696	+ 4800.000	+ 494.699[a]	+ 35.336[a]	– 2.247
Air pump	– 21.339	– 31.982	– 36.464	– 58.130	– 80.882	– 100[b]	+ 0.221
Air pump and ultrasonic wave	– 20.537	– 42.334	– 49.051	– 54.799	– 60.145	0[c]	+ 1.370
Water pump	– 8.675	– 21.801	– 40.577	– 63.479	– 66.733	0[c]	– 3.862
Water pump and ultrasonic wave	– 9.180	– 21.265	– 36.681	– 53.316	– 74.522	0[c]	– 2.614

[a]PM values were undetectable after 60 min of air treatment, but appeared after 10 min of process completion (particles m^{-3})

[b]After 10 min of process completion, PM10 was completely cleared

[c]PM10 levels were the same between after 60 min of air treatment and after 10 min of process completion

3.2 Cost-Effective Analysis

The cost of inventories, which were calculated in THB, are shown in Table 4. A product's service life for each prototype was set at 3 years. Initial cost consisted of the standard wages 200 THB and equipment costs, including, a ventilating fan with its accessories 1,000 THB, an air pump with its accessories 1,120 THB, a water pump with its accessories 460 THB, and an aquarium mist maker 300 THB, respectively.

Maintenance expenses per month for each prototype also included the wages 10 THB and the replacement parts as follows; HEPA filter 1,000 THB and electrostatic fiber 400 THB (if any) for HEPA filter methods, and water 10 THB per 500 L with a polyurethane sponge 40 THB (annual replacement) for each water-based air purifier system, respectively.

The electricity charge was analyzed at the rate of 2.3488 THB for 1 kilowatt-hour when all prototypes worked 8 h per day and for 30 days per month, respectively. Being part of the electrical devices, the costs of an 8 W ventilating fan, 25 W air pump, 25 W submersible pump, and also a 25 W mist maker, were calculated.

The results showed HEPA filter and electrostatic fiber technique needed the highest maintenance rate, followed by the HEPA filter method, and water-based purifier systems, which correlated with the total cost in 3 years. A water pump procedure was the cheapest air cleaner method, working for over 3 years, followed by an air pump method. When compared to commercial smart home air purifiers that use a HEPA filter technique, the variable cost per year is the same as a DIY HEPA filter system, but the initial cost varies depending on the level of Internet of Things (IoT) connectivity.

4 Discussion

A HEPA filter and electrostatic fiber prototype is the best way to reduce the levels of particulate matter, nonetheless, this method also released a heavy amount of returned dust. This phenomenon may occur according to the filtrate materials, which were made of PP fiber, having good properties to prevent dust entry at the end of the airway, but also poor dust absorption properties. That is why, after 10 min of the 3rd experiment's process completion, the HEPA filter and electrostatic fiber methods revealed the highest rate of PM elevation, exceeding 1,000 folds, when compared to 60 min of air treatment. To promote filtration efficiency, a low-cost DIY air purifier using a ventilating fan should be incorporated with an air reserve at the entrance of the airway prior to the dust passing through either an electrostatic fiber or HEPA filter. When switching off the air purifier, the user must close the air entry immediately to prevent backflow of dust particles. The fabrication of the HEPA filter-based air cleaner without an air reservoir at the entry part is, therefore, not recommended. Comparison of dust prevention, as well as cost-effectiveness, between the HEPA filter method and HEPA filter and electrostatic fiber method, is similar. To maintain an air purifier efficiency of more than 90%, the HEPA filter and electrostatic fiber technique is minimally better than HEPA filter on its own. However, the maintenance cost of these products will be an issue.

Regarding the water-based air cleaner systems, an air pump technique provides the best high-efficiency system that can reduce air pollution at a low cost. However, humidity became a significant factor that could interfere with the experiments. The accumulation of vapor within the PVC boxes of all water-based air purifier experiments was strikingly increased but did not appear at the boxes of HEPA filter-based prototypes. After 30 min of air treatment, the presence of high humidity interfered with the measurement

Table 4 Comparison of costs among any air purifier prototypes

Prototype	Cost (Thai baht, THB)				
	Initial cost	Variable cost per year			Total cost in 3 years
		Maintenance expenses	Electricity charge	Total	
HEPA filter	1,200.00	12,120.00	54.00	13,374.00	37,722.00
HEPA and electrostatic fiber	1,200.00	16,920.00	54.00	18,174.00	52,122.00
Air pump	1,320.00	280.00	169.08	1,769.08	2,667.24
Air pump and ultrasonic wave	1,620.00	280.00	338.28	2,238.28	3,474.84
Water pump	660.00	280.00	169.08	1,109.08	2,007.24
Water pump and ultrasonic wave	960.00	280.00	338.28	1,538.28	2,774.84
Commercial air purifiers using HEPA filter	1,500.00–7,000.00	12,120.00	54.00	13,674.00–19,174.00	38,022.00–43,522.00

of air pollution. To reduce the interference of humidity, the addition of a ventilating fan after an air treatment is an appropriate choice, but also this solution is not necessary if we need to return the humidity to the environment. To ensure that the false positive readings of particulate matter levels were a result of vapor present within the system, humidity measurement should be prioritized in the next investigation. Other water-based air purifiers, including, a water pump, air pump and ultrasonic wave, also a water pump and ultrasonic wave, revealed fluctuation of particulate matter levels. Even though the author put an ultrasonic generator beneath a polyurethane sponge to prevent a false positive measurement of PM linked to the emergence of the mist, the results were not positive. Therefore, such an ultrasonic wave technique should not be amalgamated with similar water-based air purifier systems. This phenomenon hypothesized that evaporating water had attached to the inner side of the PVC box, where there was a temperature gradient between the inner and outer box, and then it condensed and became visible water. Therefore, the pulsatile graph of particulate matter coincided with the rhythm of condensation (LeiLei and XueZhi 2018; Lindblom and Nordell 2006). Regarding CO_2 levels, all DIY air cleaner prototypes from this study are not suitable for the reduction of CO_2.

Other important points to note are that the HEPA filter and the HEPA filter and electrostatic fiber techniques could eliminate almost all dusts in 10 min, whereas the air pump method required 20 min. As a result, HEPA filters are also appropriate for living rooms that require dust removal quickly. However, for large spaces (e.g., conference rooms, atriums, platforms), where users are not concerned about the dust elimination rate, the air pump technique may be appropriate, particularly in low- and middle-income countries, when the total cost over 3 years is considered.

5 Conclusions

In this research paper, the author has focused on alternative ways to protect people in low- and middle-income countries from the air pollution crisis. Six low-cost DIY air purifier prototypes were fabricated and tested. At 60 min of air treatment, the results showed that a HEPA filter amalgamated with an electrostatic fiber prototype had the highest PM reducing efficiency, followed by HEPA filter on its own, and then an air pump technique, respectively. However, the best performance measured occurred at 30 min of air treatment using an air pump technique. Both air purifiers using a ventilating fan released dust when switched off following an air treatment process. All experiments showed fluctuation of CO_2 levels with the result that all the DIY techniques used in this study are not useful for CO_2 management.

In summary, the most appropriate air cleaner prototype depends on usability. The optimum method, which can reduce both particulate matter and cost, without the consideration of humidity, is an air pump technique. The HEPA filter and electrostatic fiber method is the best choice to decrease PM levels without an increase in humidity and production of vapor, but also it needs an enclosed structure at the air inlet to prevent dust coming back into the room. Of relevance is the reality that the filtration efficiency of filter and electrostatic fiber procedures, is likely unaffordable for the target population. The author hopes that knowledge from this research can be implemented to help people to make a low-cost air purifier on an individual basis to protect us away from the haze crisis and also the spread of COVID-19. In the future, when the prototype is stable, the internet of things (IoT) technology and a smartphone should be applied for the next products.

Acknowledgements The author would like to thank Dr. Roger Timothy Callaghan MB. ChB. a lecturer at the School of Medicine for grammatical approval, Sitang Kongkratoke, a lecturer at the School of Health Science, Watchara Jamnuch, an electrical engineer, for technical support, and also Pitchayapa Jumlongkul, my beloved wife, for her cheerfulness. The declaration of conflict of interest is none.

Author Contributions Arnon Jumlongkul created all experiments, analyzed, and drafted the manuscript solely.

Funding This work was supported by the Haze-free Thailand Fund, Mae Fah Luang University, Memorandum No. 7742(1)/0646, the fiscal year 2020.

Data Availability Data sharing not applicable to this article as no data sets were generated or analysed during the current study.

Declaration

Conflict of Interest The author has no conflict of interest to declare.

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