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DESIGN & DEVELOPMENT OF FILTERLESS AIR PURIFIER AND HUMIDIFIER

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Abstract - *Population density increased by the social development in cities, contributing to extreme air contamination in the inside. As a result of these developments, greater attention has been paid to the problem of safe and balanced indoor environments. To enhance the indoor air quality, various air purifying techniques were adopted. Air filtration technique can eliminate air contaminants and effectively reduce worsening air quality indoors the system makes use of blower which sucks the air. When air is passed through a water tank situated at the bottom of the purifier. The air passed through water gets purified as water traps dust, fungi, bacteria etc... In the water. The resulting air rising through the water is a purified air. Also added essential oils to the system allow for humidifying the area/room with essential oils which helps humans to relax. This project finds its application in various places like in IT industries, colleges and schools, clinics and medicals, Bakery factory, high population cities Where air is polluted due to large number of vehicle travels and industries The people living in metro cities may get effects on their skin, age and their organs. By using our water-based air purifier the affects may get decrease to some extent.*

***Key Words*: Contaminates, Humidifying, Medicals, water, Rising.**

1. INTRODUCTION

Air cleaners and filters can help reduce airborne contaminants including viruses in a building or small space. The peoples living in an apartment, it is highly likely that they are exposed to higher concentration of pollutants due to smaller living space. Also, people in apartments cannot control the behaviour of neighbours who might be smokers, using firewood in winters, not cleaning homes regularly and thus, exposing to odour and smoke. By development of air purifier which does not use expensive filters but rather uses water. Also it acts as an air humidifier and can be used as oil diffuser too which helps to relax and also kills certain bacteria and viruses present in the air.

Air purifiers use blower to suck the outside air. Then air is passed through water. A water-based air purifier or water-based air revitalisers cleans indoor air to remove dust, pollen, spore, pet hair, smoke, and even bad smells from room. However, it does not use any types of filters or ionizers to purify air. Instead, it uses a water filtration to trap in all the allergens inside room. Most water-based air purifiers use a rotating motor to create water swirls. Here, allergens are trapped, and the water continuously cycles inside the water reservoir. As a result, the machine can also function as a versatile humidifier and a scent diffuser.

Despite this, water-based air purifiers are preferred for their multifunctional use at a reasonable price. Although they cannot clean air at a microscopic well, they are excellent for purifying air from most allergens.

Hyeon-Ju Oh et al. [6] investigated the indoor air quality and efficiency of air purifier in childcare centers and found enhanced efficiency of air purifier. Shiue et al. [7] reported the particles removal by negative ionic air purifier in cleanroom. This study investigated the effect of particles at various locations like heights and distances with reference to the source of negative ions. The results of experiments around the negative ionic purifier showed better performance compared to the rest of the cleanroom. With reference to height, it was observed that at 60 cm, highest removal efficiency was recorded. This height was measured from floor. It was also observed that this efficiency reduced substantially with increase in height. Hye-Kyung Park et al. [8] reported air purifier and its effectiveness on health outcomes of children with allergic diseases and indoor particles. The living rooms and bedrooms were installed with an air purifier amongst the active group for the test period of 12 weeks. For the week 0, 6 and 12, asthma control test, peak flow rate and nasal symptom scores were evaluated. An improvement trend in asthma control test and peak flow rate was observed in the active group compared to control group. On the other hand, the control group showed deterioration. Yoshiko Yoda et al. [9] investigated air purifier and its effects on indoor environment and respiratory system of healthy human beings. The results revelled that enhanced air purification in ordinary homes but it did not show any improvement in the health.

2. MATERIALS AND METHODS

The water-based air purifier as shown in fig.1 was designed and developed to filter the air in a room, without the use of filters. The use of water was made in the place of multiple filters used in commercial air purifier. To design this air purifier, the basic assumption is the size of the space. It was calculated for a bedroom of size 12' x 10'. Based on this space consideration, the blower was selected. It is brushless dc motor with locked rotor protection working with 4500 rpm. It can be operated in temperature between 10°C to 60°C. It is rated 12V DC with air flow of 38 CFM. Power consumption is 18-32W. To control the speed of the device, the controller was used which allows three speed variation.

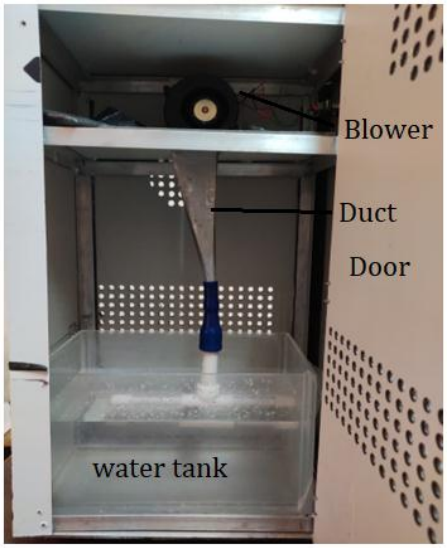

Fig-1. Working model of air purifier

Standard Cubic Feet per Minute. It is the CFM at standard density, defined as .075 lb/cubic foot. ACFM stands for Actual Cubic Feet per Minute. It is the CFM at an identified density other than .075 lb /ft3. It is also the required mass flow rate divided by the density of the gas being handled. Since fans and blowers handle the same volume of air regardless of density, the ACFM value (and corresponding density) is the preferred value to use when selecting a fan or blower. Note that ACFM and SCFM are not interchangeable except at .075 lb/ft3 density.

Airflow is rated in cubic feet per minute (CFM) or the metric equivalent, cubic meters per hour (M3/Hr).

$$1 \text{ CFM} = 1.6990 \text{ m}^3/\text{Hr}$$

Keeping home at a comfortable temperature is an extremely important consideration for most homeowners. The term "CFM" is an acronym that stands for "cubic feet per minute," a term used to describe a fan's efficiency in terms of airflow. Determining the CFM of a room is a mathematical process of figuring the room's cubic area as well as the rate at which air to circulate throughout the room. Calculating the CFM of a room helps when choosing a fan.

When power is switched on then, motor rotates to drive the impeller to rotate; the air between the blades in the impeller rotates along with it, and throws out under the action of centrifugal force. It sucks air from it's one side blowing it out through its exhaust port which has rectangular outlet then air is passed through duct which has rectangular inlet and circular outlet. While flowing through the duct and pipe there will be pressure drops as wells as friction losses due to which velocity is affected.

Then air is passed through flexible PVC reducer. This reducer is connected to T-section which is immersed in water tank and pipe has holes on it. When air passed through pipe which has holes air comes out from pipe and goes upward. Then air gets purified as water traps dust, odor, bacteria etc. in the water and humidity level is also increase in small amount. Then air moves upward and passes through the holes which are on the exterior panel thus air is purified and humidified.

Table -1: Temperature and Humidity

Speed (RPM)	Time (mins)	Temperature (°C)	Humidity (%)
LOW	0	32	46
	5	32	46
	10	32	49
	15	33	49
MEDIUM	0	32	46
	5	32	51
	10	33	51
	15	32	55
HIGH	0	32	46
	5	32	69
	10	31	74
	15	32	86

During the test of this device, three sets of experiment was carried out. Temperature and Humidity was recorded for three different speeds using DHT11 sensor which senses both humidity and temperature at the same time. Sensor is connected with Arduino board to convert unreadable signals from sensors to readable form and compiling through program

3. RESULTS AND DISCUSSION

3.1 Temperature and Humidity results

The trial of the device was carried to record the humidity and temperature at different time with varying speed of the blower and is shown in the table-1. At low speed, the below figure says, at low speed of blower temperature of room remains constant at the same time humidity of room increases as time passes by, initially the normal conditions of rooms are, temperature 32°C and 46% of humidity. Readings are taken in time slots like 0, 5, 10, 15 minutes. At medium speed, the below figure says, at medium speed of blower, the temperature of room slightly increases to 33 °C at the same time humidity of room increases to 55% and it increases as time passes by. At high speed, the above figure says, at high speed of the blower, the temperature of the room slightly decreases to 31 °C at the same time, the humidity of the room increases to 86 %.

3.2 Particulate Matter of Incense Stick

Two Experiments were performed to measure particulate matter suspended in the room air. In the first trial incense sticks were used to fill the room full of smoke as per measuring capacity of the dust sensor. In the second trial camphor was used. In this experiment Arduino board and Dust Sensor were used and connected to the laptop for readable readings by using standard programs.

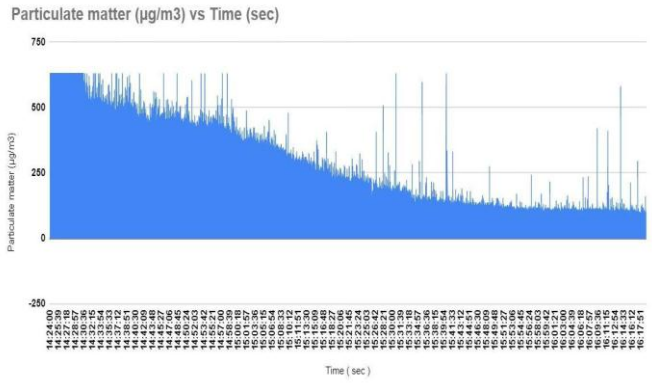

Chart-1: Particulate Matter Vs Time

In case of incense sticks, it was observed that using incense sticks, the impurity in air measured was 631µg/m^3. After running the device for an hour, it was measured at 86 µg/m^3. It was observed that air impurities reduced by 86%. In case of camphor, it was observed that, the impurity in air measured was 631 µg/m^3. After running the device for an hour, it was measured at 97 µg/m^3. It was observed that air impurities reduced by 84.60%.

3. CONCLUSIONS

As per the standards available for the indoor air quality, the ideal indoor humidity in a house should be between 30% to 50% relative humidity. From the results, it was observed that the air purifier satisfies this requirement for slow and medium operating speeds. This device when operated at high speed the humidity requirement cannot be satisfied.

The purpose of any air purifier is to remove the suspended particulates of air by filtration. This device found to be more effective in removing the suspended dust particles of air. From the results it was observed that 85% of the suspended dust particles were filtered within one hour using this device. The use of water filter instead of filter proved to be one of the ways of air purifier.

REFERENCES

[1] Shiue,A.,Hu, S.C. And Tu, M.L., 2011, "Particles Removal by Negative Ionic Air Purifier in Cleanroom"; Aerosol and Air Quality Research; 11(2); Pp.179-186.

[2] Park, H.K., Cheng, K.C., Tetteh, A.O., Hildemann, L.M. And Nadeau, K.C., 2017, "Effectiveness of Air Purifier on Health Outcomes and Indoor Particles in Homes of Children with Allergic Diseases in Fresno"; California: A Pilot Study. Journal Of Asthma; 54(4), Pp.341-346

[3] Hashimoto, K. And Kawakami, Y., 2018, "Effectiveness of Airborne Fungi Removal by Using A Hepa Air Purifier Fan In Houses"; Biocontrol Science; 23(4), Pp.215-221

[4] Xiao, R., Mo, J., Zhang, Y. And Gao, D., 2018, "An In-Situ Thermally Regenerated Air Purifier for Indoor Formaldehyde Removal"; Indoor Air; 28(2), Pp.266-275.

[5] Kim, J.S., Jeong, U.C., Kim, D.W., Han, S.Y. And Oh, J.E., 2015, "Optimization Of Sirocco Fan Blade To Reduce Noise Of Air Purifier Using A Metamodel And Evolutionary Algorithm"; Applied Acoustics; 89, Pp.254-266.

[6] Hyeon-Ju Oh, In-Sick Nam, Hyunjun Yun, Jinman Kim, Jinho Yang, Jong-Ryeul Sohn, 2014, "Characterization of indoor air quality and efficiency of air purifier in childcare centers, Korea", Building and Environment, Volume 82, Pages 203-214.

[7] Angus Shiue, Shih-Cheng Hu, Mao-Lin Tu, 2011, "Particles Removal by Negative ionic Air Purifier in Cleanroom", Aerosol and Air Quality Research, 179–186

[8] Hye-Kyung Park, Kai-Chung Cheng, Afua O. Tetteh, Lynn M. Hildemann, Kari C. Nadeau, 2017, "Effectiveness of air purifier on health outcomes and indoor particles in homes of children with allergic diseases in Fresno,

California: A pilot study" Journal of Asthama, Vol 54, Issue 4, pp 341-346.

[9] Yoshiko Yoda, Kenji Tamura, Sho Adachi, Naruhito Otani, Shoji F. Nakayama and Masayuki Shima, 2020 "Effects of the Use of Air Purifier on Indoor Environment and Respiratory System among Healthy Adults" Int. J. Environ. Res. Public Health, 17, 3687, pp1-11.

[10] Ezzat Khalifa., Branson, Yee, 2005, "Effect of Nonuniform Uv Irradiation on Photocatalytic Air Purifier Performance", Discussion, Ashrae Transactions, pp.535-542.

[11] Tang, Tan, Chen, Li, Shuai, 2020, "Design and Implementation of Temperature and Humidity Monitoring System for Small Cold Storage of Fruit and Vegetable Based on Arduino"; In Journal of Physics: Conference Series, Vol. 1601, No. 6, P. 062010.

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