Advance Researches in Civil Engineering
ISSN: 2645-7229, Vol.1, No.3, pages: 28-35

Clear-cut, Easy and Safe Air Purifying Technique (Poyrazmatic)

Hadi Habibazarfard [1], Ahmed Cemal Saydan[2]*

[1] M.Sc. of Environmental Engineering, Department of Environmental Engineering, Hacettepe University Ankara, Turkey (hhabibazarfard@gmail.com)*

[2] Professor, Department of Environmental Engineering, Hacettepe University Ankara, Turkey

(Date of received: 15/11/2018, Date of accepted: 07/03/2019)

ABSTRACT

Indoor air quality is inevitably linked to ambient air quality. What controls ambient air quality also affects indoor air quality. The desert belts and their respective dust plumes on a global basis regulate ambient air quality. Each desert has its own exclusive extension zone and during the period of cyclonic depressions millions of tons of dust is injected into the atmosphere. These dust particles having 10- micron size or less can traverse long distances and are composed of clay minerals and embedded bacteria fungus and viruses. It has been shown that when inhaled it may adversely affect the respiratory system as well as triggering genes that are responsible from the production of specific proteins that results with migraine attacks. Basing on this work we have developed simple water based air purifier system that can effectively removes 90 % of particles in an hour and ultimate purification is reached within 120 minutes in one cubic meter experimental chamber. Of course, increase in air flux will inevitably shorten the time necessary for ultimate purification for a given environment. The air purifying system consists of an aquarium pump hose and air stone and simple 5 l water bottle. The basic principle behind the purification system based on the fact that during the rise of air bubble the air bubbles increases the surface area that is in contact with water and friction with water creates a vortex further assisting the transfer of any particles and bacteria fungus and virus to water phase. With this simple purification system the adverse effect of dust particles can effectively be removed from indoor environment. Renewing the water is the only thing required for the continuation of effective purification. The water is not wasted and can be used to irrigate the flowers lawns etc. Such systems also offer an ideal low cost pre-cleaning filtering that can be used to extent the operational life of expensive filtering systems.

Keywords:

Air quality, Bacteria, Dust, Water filtration.

Advance Researches in Civil Engineering
ISSN: 2645-7229, Vol.1, No.3, pages: 28-35

1. Introduction

Particulate matter (PM10 with an aerodynamic diameter of less than 10 micrometers) are important air pollutants and concern for human health because of their adverse effect on respiratory track. Air quality and especially the indoor air quality is directly linked to human health and work performance. It has been shown that increase in outdoor particulate matter (PM), can adversely affects human health and we are all exposed to PM of outdoor origin whether we are at outside or in office[1]. Due to this and numerous other reasons people use various high performance filter and air purification system for their health care [2]. There are many air purification system that are available on the market such as absorption, ionization, HEPA filtering, having various particulate matter removal capabilities but as the removal efficiency increase so their cost increase as well. [3]

In recent years along with other systems the technologies for cost-effective air purification system have been developed addressing low energy utilization as well as increased efficiency. Titanium dioxide – based photo catalysts can be given as one of the examples for such endeavours [4], [5].

Another technological area is in the use of ultra-light 3D nanofibre-nets binary structured nylon6-polycrylonitrile membranes for efficient filtration of fine particulate matter [2].Or using renewable photocatalyst in concrete [6] or using a non-thermal plasma reactor with multiple – wire-to-wire type electrodes and fiber air filters [7] or use photocatalytic materials and technologies for air purification [8]. All of this air purification methods have positive and negative sides and many people can't benefit from proper air purification system both at work and home but suffers from the adverse effects of bad air quality. The studies carried out in connection with the possible triggering of migraine attacks during the desert dust pulses have shown that those test animals kept under dust free conditions did not affected from the adverse effect of dust transport and the ones who are subjected to desert dust suffered from the symptoms of migraine attack. For those rats who has not affected from migraine attacks were those who are kept in dust free conditions that were provided by simple water based air filtration. Thus we have decided to test the removal efficiency of this water based system since it offers the best air purification system and nearly cost free compared to all other known techniques. For Turkey dust is transported from SW direction and locally named as "Lodos". Dust free air comes from NW direction since the air traverse either from vegetation and forest covered land during the summer months and frozen lands during the wither and both has to traverse Black Sea before reaching the Anatolia and known locally as "poyraz". Thus, basing on this local name, we have named our water based purification System as "poyrazmatic". Practically dust laden atmosphere or "lodos" enters the system and dust free air or "poyraz" comes out hence the system named as "poyrazmatic".

2. Experimental Setup

2.1. Poyrazmatic

This water-based air purification system composed of the following parts that can be purchased from any aquarium shops. Basic parts are composed of;

1. Low cost aquarium air pump;
2. Few meters of air hose;
3. At least two aquarium air stones for bubble generation;
4. Used drinking water plastic container of 5 or 10 liter size;

2.2. Sampling and Analysis

The efficiency of this low-cost air purification system tested in our laboratories following the setup of this basic system. Measurement process started on November 19, 2014 and lasted till February 10, 2015, on a daily basis from 2:00-5:00 pm. This time period has been selected intentionally since during the course of this sampling system its quite normal to experience few Saharan desert dust pulses as well as periods with strong northerly winds basing on the statistical averages of dominating meteorological weather patterns. In this study we have used 1 m3 all glass test chamber as shown in Figure 1.

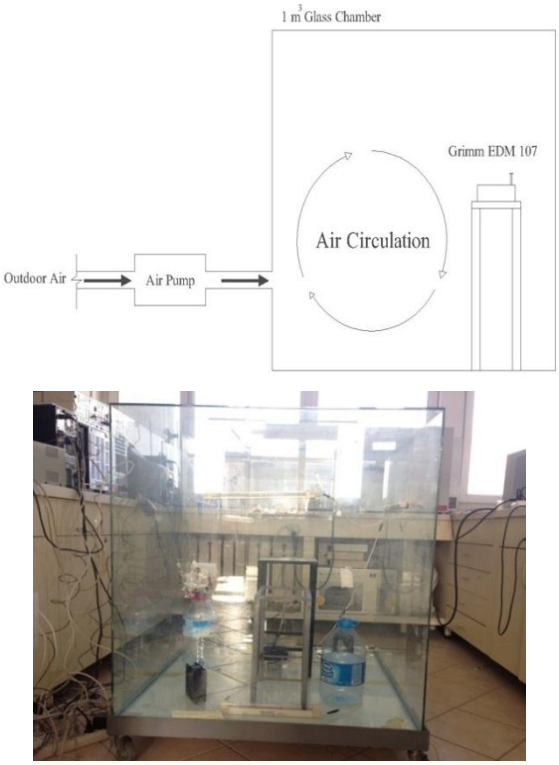

Figure 1. **1 m^3 Glass Chamber**.

The test initiated by pumping outdoor air into the 1 m^3 test chamber by using 160 l/min capacity air pump for 30 minutes. Therefore, the air that is inside the test chamber is flushed by 4800 l of outdoor air or at least three times before turning the “poyrazmatic” on.

Advance Researches in Civil Engineering
ISSN: 2645-7229, Vol.1, No.3, pages: 28-35

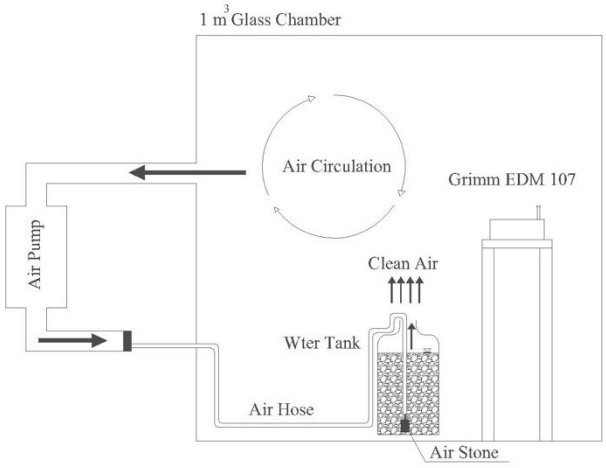

Figure 2. Operating Poyrazmatic in Glass Chamber.

Grimm EDM 107, placed within the test chamber is used for particulate matter measurements. Total of 36 air samples per day are taken every 5 minutes. The close up image of "Poyrazmatic" system used in this study is given in Figure 3.

Figure 3. Poyrazmatic.

The principle of the system is based on the vortex created within the air bubbles while the air bubbles are rising in water column and consecutive transfer of any particulate matter and associated bacteria and fungi's from air phase to water phase.

Advance Researches in Civil Engineering
ISSN: 2645-7229, Vol.1, No.3, pages: 28-35

3. Experimental Results and Discussions

Statgraphics Centurion XVI (version 16.1) computer program was used in order to evaluate all data collected during this study. The outdoor data set obtained during the sampling period is divided into three groups according to the PM values. The group indicated by the symbol "D" had low concentration days (0-10µg/m3), the medium group concentration indicated by the symbol "O" (10.1-30 µg/m3) and the group represented by the symbol "Y" represents high concentration days (30.1-60 µg/m3). ANOVA test was applied between the groups D - O - Y among the reduction coefficient (K values). Figure 4, show a box-and-whisker diagram between the groups. According to this diagram, the value of group D varies between -0.03 and -0.1, while the value of Y group varies between -0.1 and -0.18. Thus, is determined that K value or the rate of particulate matter decrease on high concentration days is higher than that of low concentration days.

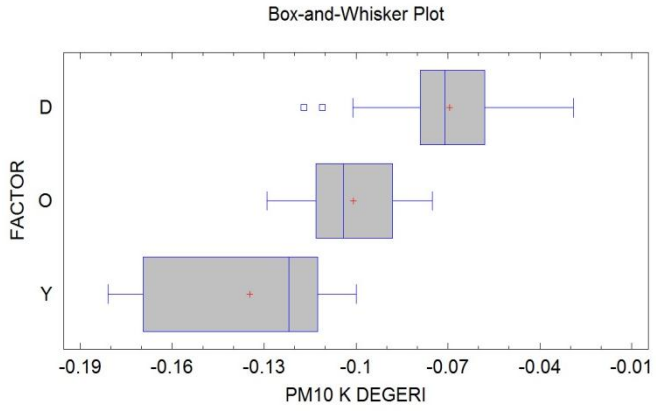

Figure 4. Box and Whisker Diagram for Three Groups.

Figure 4. Box and Whisker diagram for D, O, Y series of data collected during the entire sampling period. As expected we have seen major dust transport event during 1 Feb 2015 as shown in Figure 5. The dust transport event captured by NOAA MODIS/Aqua satellite imagery illustrates perfectly well the amount of dust transport. Though it seems that the dust traversed from western Anatolia the dust pulse also affected Ankara.

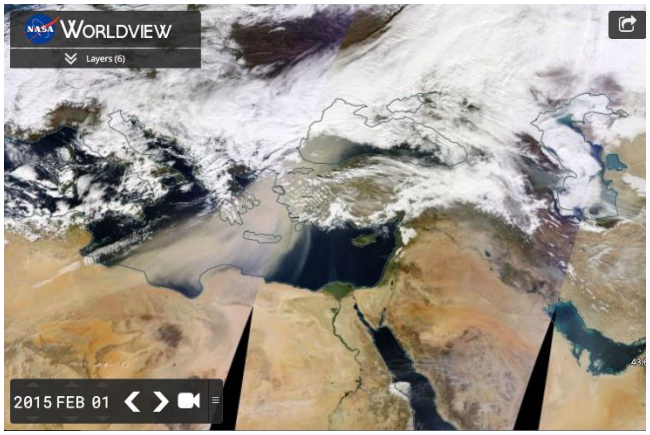

Figure 5. NOAA MODIS/aqua satellite imagery of 1 February 2015. Dust can be identified as yellow plume extending from interior of Libya towards Mediterranean, Western Anatolia, Black Sea and beyond.

Advance Researches in Civil Engineering
ISSN: 2645-7229, Vol.1, No.3, pages: 28-35

The other extreme recorded on 7 January 2015 as northerly winds dominated the entire Anatolia as shown in Figure 6. Once again MODIS/Aqua satellite imagery and superimposed HYSPLIT air mass back trajectory illustrates that the air mass was originated from polar regions and reached over Anatolia after traversing either snow covered areas and Black Sea.

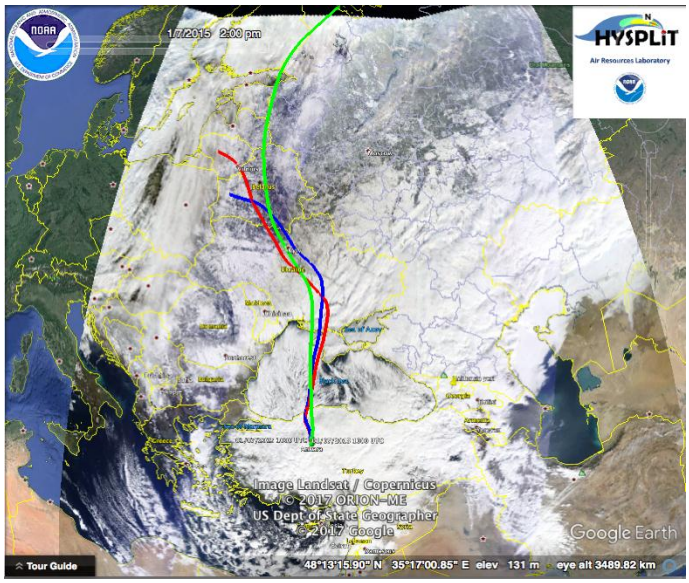

Figure 6. NOAA MODIS/aqua satellite imagery of 7 January 2015. 72 hrs air mass back trajectories for 500 (red), 1500 (blue) and 3000 (yellow) meters above mean sea level indicates that the air mass originated from north and reached over our sampling station traversing either snow covered regions or sea.

Such air mass reflect itself by their contrasting PM10 levels. During the dust transport case the initial PM level was around 55 µg/m3while during the northerly winds the PM level was at its minimum starting levels at around 7-8 µg/m3. With the operation of poyrazmatic significant reduction was achieved within minutes for dust laden air chamber and ultimate goal is reached nearly within two hours of operation. It is important to note that significant decrease is obtained for high PM levels even less than low PM ones and this shows that the basic principle of the system is fully operational. Fig.7, shows the associated K values for the PM10 data set on February 1, 2015 and January 7, 2015.

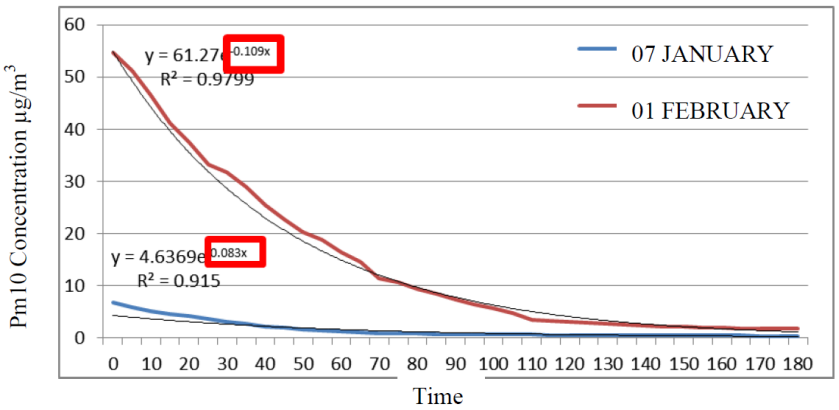

Figure 7. 7th January 2015 & 1st February 2015 K Value for PM_{10}.

4. Conclusions and Discussions

This is the first experimental study that confirms the logic behind the poyrazmatic cleaning setup. Experiments have shown that this approach is correct and this simple system can remove %98 of the particulates matter thus improve indoor air quality, significantly. Of course, future studies should concentrate on the size of the air bubbles as well as the height of the water column. Optimizing these two parameters should increase the surface area as well as retention time of air bubbles in the water column before they burst hence particulate matter removal efficiency can be increased hence it may well decrease the cleaning time. If preferred, the system can be automized by sensing the intake particulate matter as to arrange these two parameters if one wants to include some technical details. It should be noted that no odour addition is recommended since our experiments has shown that people feels the difference immediately one they step into a room that has been filled with air passed through poyrazmatic. These are suggestions for future studies since the purpose of this study is to investigate whether the objective "poyrazmatic" principle can be practically reduced atmospheric particulate matter hence avoid migraine attacks as shown by Doğanay et al,2009 [9]. We do hope that such low cost easy to install air purification system to be used by everyone especially at their sleeping rooms as to avoid the adverse effects of desert dust transport and this technique is especially advisable for Iranian population.

5. References

[1]- Beeldens, A., 2006, **An environmentally friendly solution for air purification and self-cleaning effect: theapplication of TiO2 as photocatalyst in concrete**, In: Proceedings of transport research arena Europe, TRA, Göteborg, Sweden.

[2]- Wang, N., Yang, Y., Al-Deyab, S. S., El-Newehy, M., Yue, J., and Ding, B., 2015, **Ultra-light 3D nanofibre-nets binary structured nylon 6-polyacrylonitrile membranes for efficient filtration of fine particulate matter**, Journal of Material Chemistry, 3, 47, 23946–23954.

[3]- Clausen, G., and Alm, O., 2002, **The impact of air pollution from used ventilation filters on human comfort and health**, Proceedings of the 9th international conference on indoor air quality and climate, 4. Roterdam: Netherlands in-house publishing, 338-343.

[4]- Chapuis, Y., Kivana, D., Guy, C., and Kirchnerova, J., 2002, **Photocatalytic oxidation of volatile organic compounds using fluorescent visible light**, Journal of Air Waste Management Association, 52, 845-854

[5]-Wang, S., Ang, H. M., and Tade, M. O., 2007, **Volatile organic compounds in indoor environment and photocatalytic oxidation: state of the art**, Environment International, 33, 694-705.

[6]- Nath, R. K., Zain, M. F. M., and Jamil, M., 2016, **An environment-friendly solution for indoor air purification by using renewable photocatalysts in concrete: A review**, Renewer Sustainable Energy Revivion, 62, 1184–1194.

[7]- Jung, J. S., and Kim, J. G., 2017, **An indoor air purification technology using a non-thermal plasma reactor with multiple-wire-to-wire type electrodes and a fiber air filter**, Journal of Electrostatic, 86, 12–17.

[8]- Ren, H., Koshy, P., Chen, W. F., Qi, S., and Sorrell, C. C., 2017, **Photocatalytic materials and technologies for air purification**, Journal of Hazards Materials, 325, 340–366.

[9]- Doganay, H., Akcali, D., Goktas, T., Caglar, K., Erbas, D., Saydam, C., and Bolay., H. ,2009, **African dust-laden atmospheric conditions activate the trigeminovascular system**, Cephalalgia, 29, 10, 1059-1068.