Indoor air pollution controlling device

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Abstract: Air pollution is a global crisis which effects everyone and every thing both natural and man-made and is one of the biggest challenges faced by mankind today as air pollution, if left unchecked, can cause the earth to become inhospitable to most lifeforms. The need to curb air pollution at the point of occurrence is paramount but, in the meanwhile, it is also important to save ourselves from the adverse effects of air pollution. One such device which helps us do that is an indoor air pollution controller. While staying indoors, by using an air pollution controller we can save ourselves from toxic pollutants present in polluted air. But commercially available air pollution controllers have two major problems, first, they use HEPA filters which are needed to be changed from time to time which come at a cost, and second the cost of the air pollution controller/purifier is quite high and is therefore out of reach for a vast majority of the pollution. To overcome these two problems, we have designed a simple but quite effective indoor air pollution controller which uses water and activated charcoal (two very commonly available items) as the main constituents. Air is made to pass through a mixture of water and activated charcoal. In the mixture the micro dust particles and some polluting gasses get dissolved in water and as a result the out-flowing air is much cleaner than the input air, and because the items used are very easily available running cost and maintenance is very low.

Index terms: Air pollution, Air purifier, Activated Charcoal, Low-cost

I. INTRODUCTION

Air pollution occurs when harmful or excessive quantities of substances including particles, gases, and biological molecules are introduced into the Earth's atmosphere. It may cause diseases and allergies, even death to humans in severe cases; it may also be harmful to other living organisms such as food crops and animals, and may damage both the natural or built environment. Both human activity and natural causes can generate air pollution.

According to the 2014 World Health Organization report, air pollution in 2012 caused the deaths of around 7 million people worldwide. The outdoor air is polluted all around the world to different extents. It is more so in the urban areas than in the rural parts but both urban and rural areas have factors (e.g.: vehicles and industries in urban areas and dust storms and various farming machinery in rural areas) that lead to air pollution.

In India air pollution worsens in the dry seasons due to number of factors such as burning of crop stubs in the months of September and October in north Indian states of Punjab Haryana and Uttar Pradesh results in heavy pollution in the following winter months in major cities such as Delhi, Noida, Gurugram etc., thus people are rather advised to stay indoors unless they need to travel outside so that they inhale less polluted indoor air. Indoor air pollution and poor urban air quality are listed as two of the world's worst toxic pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report. It has been seen that pollutants in indoor air can reach toxic levels and the particulate matter in the indoor air is higher than permissible levels.

Indoor air quality can be improved by using indoor air purifiers which are effective in reducing pollutants in the air but air purifiers currently available in the market cost anywhere between 10,000 to 40,000 and therefore becomes an out of budget product for middle class Indian families and therefore most people do not give it a higher priority over other electronic goods such as air coolers. We have come up with a simple but quite effective design of a budget indoor air pollution controlling device which uses water and activated charcoal as its main two components and will reduce indoor pollution but will cost much less.

II.BASIC CONCEPTS

Our proposed air pollution controller is mainly based upon the property of adsorption shown by activated charcoal. Adsorption is referred to as adhesion of atoms, molecules or ions from a gas, liquid or dissolved solid to a surface. In this process a film of the adsorbate forms on the surface of the adsorbent. This process is different from absorption, in which a fluid (absorbate) is dissolved by a solid or liquid (the absorbent), respectively. Adsorption is a largely a surface phenomenon, which is not to be confused with absorption which involves the whole volume of the material. The term sorption defines both processes, while desorption is the reverse of sorption.

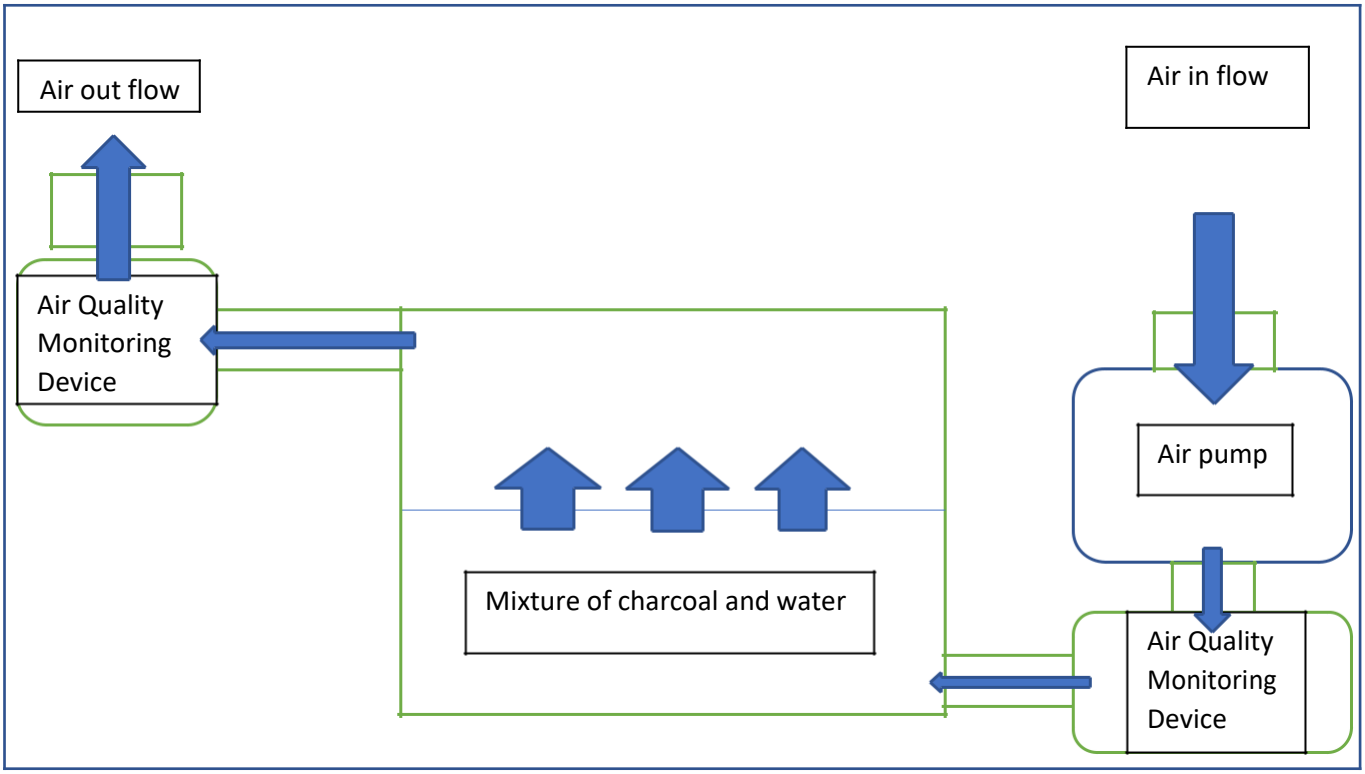
Similar to that of surface tension, adsorption is but a consequence of surface energy. In bulk material, all the bonding requirements (ionic, covalent or metallic) of the constituent atoms of the material are filled by other atoms in the material. However, atoms on the surface of the adsorbent are not wholly surrounded by other adsorbent atoms and therefore can attract adsorbates. The exact nature of the bonding depends on the details of the species involved, but the adsorption process is generally classified as physisorption (characteristic of weak van der Waals forces) or chemisorption (characteristic of covalent bonding). It may also occur due to electrostatic attraction.

Adsorption is present in many physical, natural, biological and chemical systems and is widely used in various industrial applications such as activated charcoal, heterogeneous catalysts, capturing and using wasted heat to provide cold water for air conditioning and other process requirements (adsorption chillers), water purification, increasing storage capacity of carbide-derived carbons and synthetic resins.

III. PROPOSED MODEL

Our air pollution controlling device uses Activated Charcoal and water as the main two constituents that will help to reduce the pollutants and dust particles present in the air. Activated carbon, also called activated charcoal, is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption or chemical reactions. Due to its high degree of micro-porosity, one gram of activated carbon has a surface area in excess of 3,000 m^2 (32,000 sq. ft) as determined by gas adsorption. An activation level sufficient for useful application may be obtained solely from high surface area. By the property of adsorption activated charcoal traps molecules of toxic chemicals on its surface and the water traps the dust particles present in the air thus purifying the air.

We use an air pump to pump air into the mixture of activated charcoal and water and use an air quality monitoring device to monitor the air continuously for change in number of dust particles in the range PM 10 to PM 2.5.



Block diagram of the proposed air pollution controller

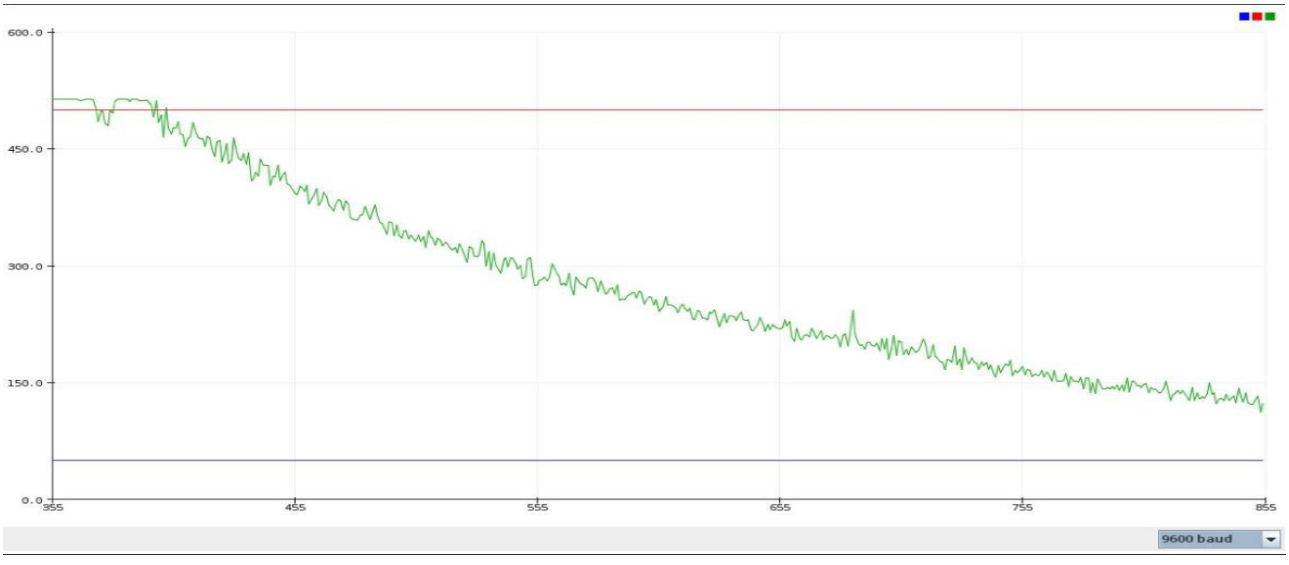
IV. IMPLEMENTATION AND RESULTS

We used a low power air pump to pump air into the mixture and got the following results:

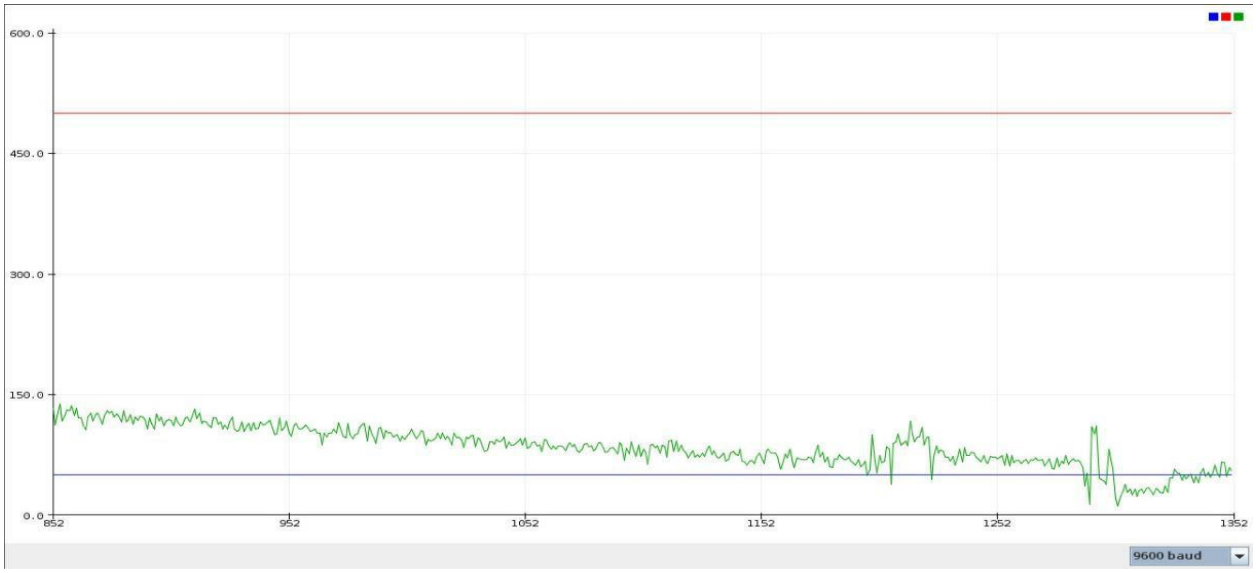
Volume of air to be purified = 8294 L,

the flow rate of the air pump=210 L/hr

Time required to purify the volume of air=0.66 hr, in this time frame we saw PM 2.5 drop from 500 at the beginning of the experiment to 4 at the end of the experiment (the safe limit of PM 2.5 being 50). The graphs shown below have amount of particulate matter in the Y axis and time in the X axis.



(I)



(II)

From graph (I), (II)we can see the aforesaid result in which P.M 2.5 drops from 500 to below the permissible limit (indicated by the blue line)

V. CONCLUSION

Thus, we can conclude that air is being purified by the mixture of water and charcoal and it is happening in a definitive limit of time and is not an infinitely running process. The maintenance of our air purifier involves only changing the water from time to time and cleaning the activated charcoal by putting them under running hot water to clear the pores so that their property of adsorption is not reduced over time. Apart from that the only running cost is the cost of electricity which is required for running the air pump and the air quality monitoring device. We can look forward to developing this commercially so that a larger population can safeguard themselves from effects of indoor air pollution or air pollution in general.

VI.REFERENCES

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