Pollutant Purification System For Kitchen

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Abstract –

Air pollution has become the world's single biggest environmental health risk. "There is nothing more important than a good, safe and secure home". It is believed that a house is the most secure and healthy environment for any individual. However, the house can also be a source of various air pollutants that can have a significant adverse impact on health. Indoor air pollution is caused by pollutants that enter your home from outside and pollutants that are created as a by-product of household activities. People use a variety of heat sources to cook food, including liquid petroleum gas (lpg), wood, and electricity. Each of these heat sources can create indoor air pollution during cooking. Pollutants that originate in your kitchen are Nitrogen Dioxide, Carbon Monoxide, Formaldehyde, Particulate Matter. Aim of this project is to construct affordable system which purify the polluted air during cooking in kitchens.

Keywords: various sources, pollutants emitted, diseases, exhaust fan, catalytic converter, purify , healthy air.

1. INTRODUCTION

Environmental pollution is not only affecting the way our ecosystem works but is also causing a range of health issues for humans and animals. In recent years, indoor & kitchen air pollution has emerged as a leading cause of health issues in metros of India and abroad. Indoor air pollution is caused by pollutants that enter your home from outside and pollutants that are created as a by-product of household activities. People use a variety of heat sources to cook food, including liquid petroleum gas (LPG), wood, and electricity. Each of these heat sources can create indoor air pollution during cooking. Natural gas, liquid petroleum gas (lpg) and propane stoves can release carbon monoxide, formaldehyde and other harmful pollutants into the air, which can be toxic to people and pets. Using a wood stove or fireplace to cook can result in high levels of indoor air pollution from wood smoke. Cooking can also generate unhealthy air pollutants from heating oil, fat and other food ingredients, especially at high temperatures. Self-cleaning ovens, whether gas or electric, can create high levels of pollutants as food waste is burned away. Exposure to these can cause or worsen a wide range of health problems such as nose and throat irritation, headaches, fatigue and nausea. Young children, people with asthma and people with heart or lung disease are especially vulnerable to the harmful effects of indoor air pollution. The pollutants emitted from cooking are NOx, CO, HC. The effect of this pollutant on human being are heart attack, lungs cancer, respiratory infections in children's, asthma.The exhaust fan is use to collect the polluted air of kitchen and gives the way to air to flow in duct, in that duct catalytic converter is placed which consist of nobel metals like platinum, palladium & rhodium. And polluted air get purify.

2. LITERATURE REVIEW

2.1 **U.S. Environmental Protection Agency (EPA)** It focuses on air cleaners for residential use; it does not address air cleaners used in large or commercial structures such as office buildings, schools, large apartment buildings, or public buildings. In addition to providing general information about the types of pollutants affected by air cleaners, this document discusses the types of air-cleaning devices and technologies available, metrics that can be used to compare air-cleaning devices, the effectiveness of air-cleaning devices in removing indoor air pollutants, and

information from intervention studies on the effects that air cleaners can have on health and on health markers

2.2 **Vannan Kandi Vijayan, Haralappa Paramesh**[2] Studies appear to suggest, that reduction in particulate matter and allergens results in reducing symptoms and in certain cases, preventing disease progression across all age groups, including the elderly and children. The evidence is apparent, in chronic respiratory diseases, such as asthma and in cardiovascular health.

2.3 **Podgorski, Bałazy, & Gradon**[10] Fibrous filter this Filtration technology is currently the integral part of air purification techniques that focus on particulate matters.

John and Reischl 1978 Glass fiber filter is another mature filtration technique with a high efficiency (99.0%), which is similar to that of the hepa filter.

3.PROBLEM STATEMENT

Design and development of pollutant purification system to eliminate harmful pollutants emitted in kitchens like NOx, CO, HC Formaldehyde & Particulate matter.

4.OBJECTIVE

4.1 This technology contribute to reduce pollutants emitted in kitchen and leads to low air pollution level and promoting great environmental kitchens

4.2 To creating air pollutant purifiers with the zero operating cost

4.3 To develop an purification system that have almost low emission of pollution

4.4 There is no use of non conventional energy sources for purification of air

5. METHODOLOGY

5.1 Steps: Fig.1 refers to steps involved

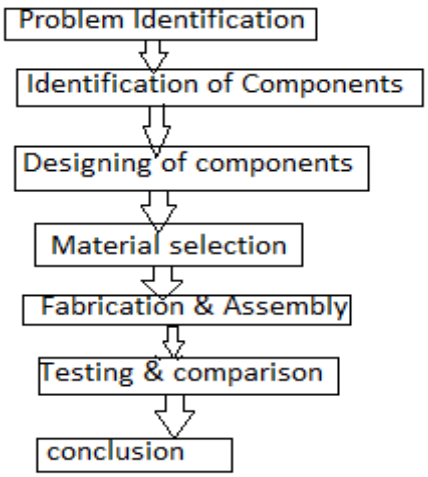

Fig.1 Methodology

5.2 Cad Moel

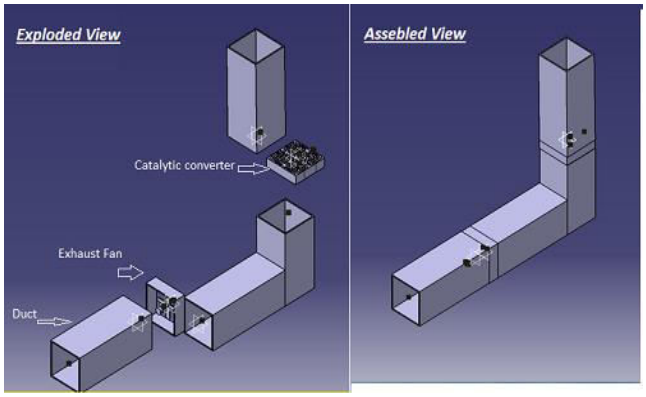

Fig. 2 Cad Model

5.3 COMPONENTS OF THE SYSTEM

5.3.1 Exhaust Fan

Every home needs a proper cooling and ventilation system since even daily activities such as cooking, bathing, etc., can have adverse effects on the overall health of your home. The steam and moisture generated from the kitchen and bathroom can cause the interior of your home to become humid and damp. For this reason, an exhaust fan is essential to maintain a healthy airflow and ventilation.

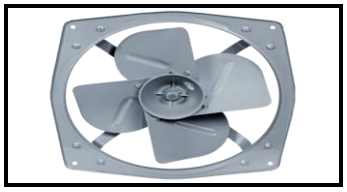

Fig.3 Exhaust Fan

5.3.2. Battery

A twelve-volt battery has six single cells in series producing a fully charged output voltage of 12.6 volts. A battery cell consists of two lead plates a positive plate covered with a paste of lead dioxide and a negative made of sponge lead, with an insulating material (separator) in between They generate electricity through a double sulfate chemical reaction. Lead and lead dioxide, the active materials on the battery's plates, react with sulfuric acid in the electrolyte to form lead sulfate. Sulfation can be avoided if the battery is fully recharged immediately after a discharge cycle.

Fig.4 Battery

5.3.3 Air Duct

Ducts are conduits or passages used in heating, ventilation, and air conditioning (HVAC) to deliver and remove air. The

needed airflows include, for example, supply air, return air, and exhaust air.Ducts commonly also deliver ventilation air as part of the supply air. As such, air ducts are one method of ensuring acceptable indoor air quality as well as thermal comfort. A duct system is also called ductwork. Planning (laying out), sizing, optimizing, detailing, and finding the pressure losses through a duct system is called duct design.

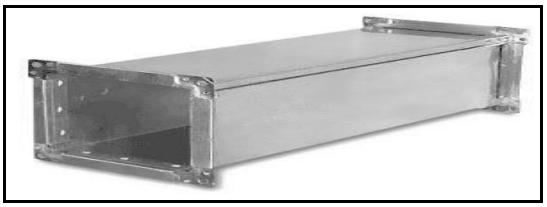

Fig.5 Air Duct

5.3.4 Solar Panel

Photovoltaic modules use light energy from the sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can be either the top layer or the back layer. Cells must be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are connected electrically in series, one to another to a desired voltage, and then in parallel to increase amperage. The wattage of the module is the mathematical product of the voltage and the amperage of the module. Selection on the basis of design calculation of solar panel is 50 watts/12 volt, ultra cleared tempered glasses, Cell conversion efficiency > 19%,(l*w*h) (430x335x35) mm

5.5.5 Catalytic Converter

catalytic converter is an exhaust emission control device that reduces toxic gases and pollutants in exhaust gas from an internal combustion engine into less-toxic pollutants by catalyzing a redox reaction (an oxidation and a reduction reaction). Catalytic converters are usually used with internal combustion engines fueled by either gasoline or diesel—including lean-burn engines as well as kerosene heaters and stoves.

Three-way catalytic converters (TWC) have the additional advantage of controlling the emission of nitric oxide (NO) and nitrogen dioxide (NO2) (both together abbreviated with NOx and not to be confused with nitrous oxide (N2O)), which are precursors to acid rain and smog. Since 1981, "three-way" (oxidation-reduction) catalytic converters have been used in vehicle emission control systems in the United States and Canada; many other countries have also adopted stringent vehicle emission regulations that in effect require three-way converters on gasoline-powered vehicles. The reduction and oxidation catalysts are typically contained in a common housing; however, in some instances, they may be housed separately. A three-way catalytic converter has three simultaneous tasks.

Reduction of nitrogen oxides to nitrogen (N2)

$$2\ CO + 2\ NO \rightarrow 2\ CO_2 + N_2$$

$$HC + NO \rightarrow CO_2 + H_2O + N_2$$

$$2\ H_2 + 2\ NO \rightarrow 2\ H_2O + N_2$$

Oxidation of carbon monoxide to carbon dioxide

$$2CO + O_2 \rightarrow 2CO_2$$

Oxidation of unburn hydrocarbons (HC) to carbon dioxide and water, in addition to the above NO reaction

$$HC + O_2 \rightarrow H_2O + CO_2$$

These three reactions occur most efficiently when the catalytic converter receives exhaust from an engine running slightly above the stoichiometric point. For gasoline combustion, this ratio is between 14.6 and 14.8 parts air to one part fuel, by weight.

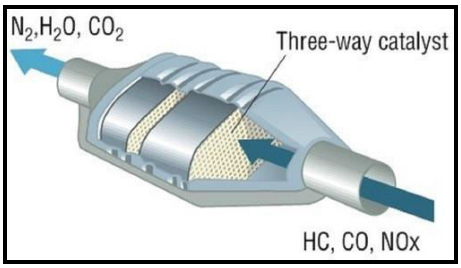

Fig.6 Catalytic Converter

6.WORKING PRINCIPLE

At the time of cooking lots of pollutants like Nitrogen Dioxide, Carbon Monoxide, Formaldehyde and particulate matters are emitted which are very harmful to human beings.

To eliminated pollutants the polluted air is passed over catalytic converter. The air should get passed over the catalytic converter, for that purpose exhaust fan is used which gives the way to polluted air. The exhaust fan is operated by using lead acid battery having capacity 12 volts of power. The battery is charged using solar panel which is up of ultra cleared tempered glasses having capacity 50 watts,12 volts.

The exhaust fan collects the polluted air and send it in air duct manufactured of galvanized sheet metal. At the middle of air duct catalytic converter is placed which is three way

catalyst formulated with noble metals like rhodium, palladium & platinum. On passing air over the catalytic converter pollutants get reacted with noble metal and conversion of HC,CO, and NOx takes place into n2,h2o,and co2,pollutant purified air is out to the atmosphere.

7. DESIGN CALCULATION

Calculating the size of fan needed

Calculate the volume of the room in cubic meters by multiplying its length x width x height. Then multiply the room volume by the required number of air changes per hour, i.e.

Fan flow rate (m3/hr) = Length(m) x Width(m) x Height(m) x air changes per hour

Case study:-

A kitchen measuring 3.65m by 3.048m by 3.048m requires ventilating due to a buildup of fumes and heat. The recommended number of air changes per hour is 8 – 10, to ensure adequate ventilation the higher figure will be used.

Fan volume (m3/hr) =3.6576 x 3.048 x 3.048 x 10

= 339.13m3/hr.

Selecting a fan that exceeds this value will ensure good ventilation.

8. ADVANTAGES

1. Air Purifiers Remove Nitrogen Dioxide, Carbon Monoxide, Formaldehyde and particulate matters.
2. Air Purifiers Remove Outside Fumes and Pollutants in Urban Environments
3. Air Purifiers Protect Children, the Elderly, and the Chronically Ill from Respiratory Illnesses
4. Air Purifiers Produce Clean Air Which Improves Mood Levels When Inhaled
5. Air Purifiers Generates Calm Noise, Which Improves Sleep Quality
6. Air Purifiers Increases Air Circulation, Which Results in the Entrapment of More Pollutants
7. This system does not required any conventional source of energy.
8. It is very economical.
9. Maintenance cost is low.

CONCLUSION

Conclusion of the system is that reduction of toxic gases and pollutants in exhaust gas from an kitchen

As well as conversion of pollutants like HC,CO,NOx, formaldehyde, to less toxic pollutants by catalyzing redox reaction to N_2,CO_2,H_2O.

REFERENCES

1. Shrivastava R. K., Saxena Neeta and Gautam Geeta, “Air pollution due to road transportation in india”, Department of Mathematics, S.M.S. Govt. College, Gwalior (INDIA), Volume 8 , September 2013
2. Vannan Kandi Vijayan, Haralappa Paramesh1, Sundeep Santosh Salvi, Alpa Anil Kumar Dalal, “Enhancing indoor air quality –The air filter advantage”, ICMR Bhopal Memorial Hospital and Research Centre and National Institute for Research in Environmental Health, Bhopal, Madhya Pradesh, Vol 32 ,Issue 5 Sep - Oct 2015
3. U.S. Environmental Protection Agency (EPA), Office of Radiation and Indoor Air, Indoor Environments Division.
4. Guoliang Liua, Manxuan Xiaob,1, Xingxing Zhangc,∗, Csilla Galc, Xiangjie Chen, “A review of air filtration technologies for sustainable and healthy building ventilation”,College of Texitile&Clothing, Yancheng Institute of Technology, China, 26 September 2017
5. Guy Hutton, “Assessment Paper Copenhagen Consensus on Human Challenges”,2011
6. Rinki Jain (Associate Fellow, TERI) ,Karnika Palwa (Research Associate, TERI),
7. “Air Pollution and Health. Discussion Paper by The Energy and Resources Institute”2015
8. Julie M Pardiwala, Femina Patel, Sanjay Patel, Institute of technology, nirma university, ahmedabad, “review paper on catalytic converter for automotive exhaust emission”, 10 december, 2011
9. converter for automotive exhaust emission”, 10 december, 2011

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