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Electrostatic Precipitation of Black Carbon

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ABSTRACT

Air Pollution has been one of the most conspicuous of all the problems we face today. In a country like INDIA where pollution ordinates are not well enforced the amount of pollution caused from the diesel engine exhaust is very high. The product aims to trap the black carbon coming out from diesel engine exhaust. The soot particles coming out from the diesel engine exhaust account for the form of pollution called PM2.5. In a country like INDIA where over 3000+ diesel locomotives are used as a means transport we also aim to trap the soot particles coming out from the engine exhaust of a locomotive. We are replacing the use of fossil fuels in industries for commercial production of black carbon. From the trapped soot particles, the black carbon will be separated and can used in making of tyres, ink etc. The process of making ink not only eliminates soot from polluting the air, but it also doesn't burn extra fossil fuels that making regular ink does.

KEYWORDS

Air Ionizer, Carbon Black, Electrostatic Precipitation, Pollution

INTRODUCTION

In the last few decades, Asia has grown exponentially. But this growth has come at a cost - air pollution. Soot is the major byproduct of the burning of fossil fuels. The pollution norms in most of the countries are not strong enough and hence the amount of particulate matter coming from the exhaust of diesel engines are very high. Our product traps soot particles from automobile exhaust and turn it into useful form of black carbon which can be used in making of tyres, beltsetc. Our product helps to prevent global warming, respiratory diseases if the soot particles enters human lungs. Moreover, this product helps to reduce the burning of fossil fuels in black carbon producing industries. The soot particles coming out of engine are of size 2.5 micron which have very harmful effects to environment and human health. The following illustration shows the carbon black emission from all over the world and its effects.

IMPACT OF BLACK CARBON

1. RUBBER REINFORCEMENT

Carbon black is a rubber-reinforcing additive used in a multitude of rubber products. In particular, in case of vehicles, large amounts of carbon black are used for tires. In addition, carbon black is used with rubber to dampen earthquake vibration, in the soles of shoes and in many other products.

2. COLORS AND PIGMENTS FOR PLASTICS

Compared with other colorants, carbon black has a high colouring power. Therefore. it is used as ink for printing newspapers, as ink-jet toner, and other such uses. It is also suitable as a pigment for heat-moulded plastics, car fenders, coating for electric wires and other products.

3. ELECTRIC EQUIPMENT AND CONDUCTIVE COMPONENTS

Since carbon black has excellent conductive properties, it is used as a component for magnetic tapes and semiconductors.

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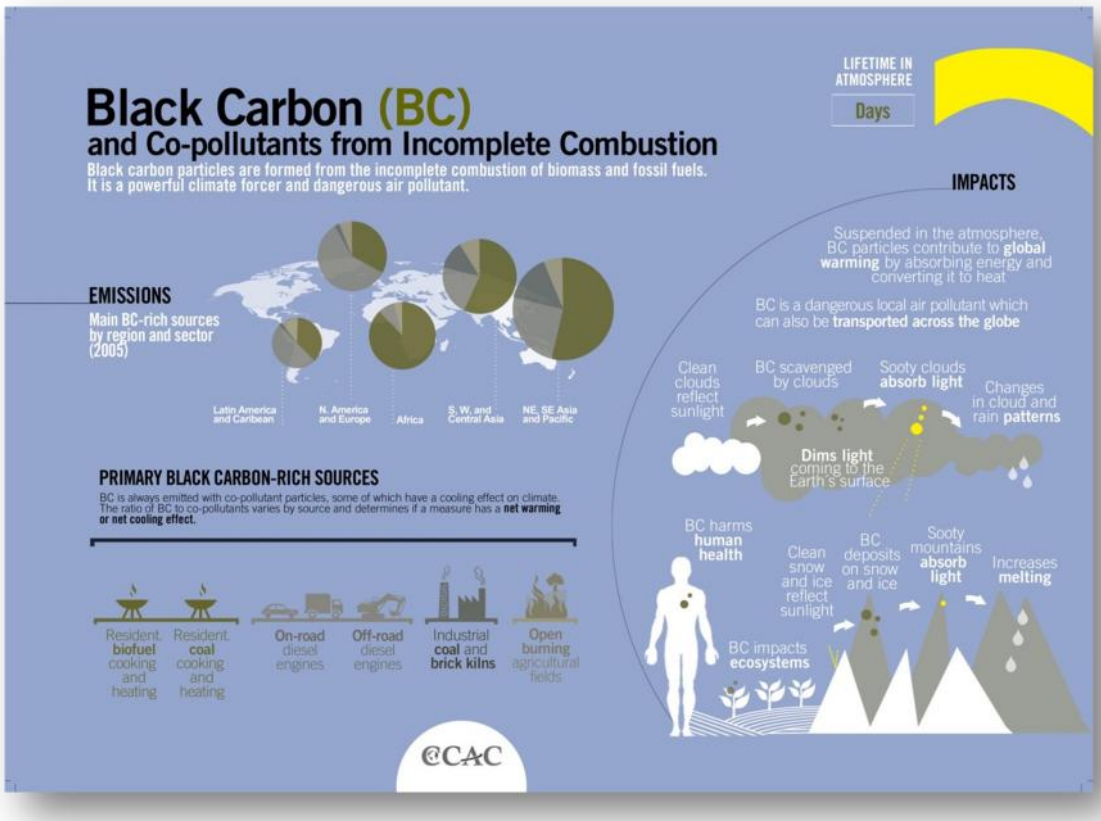

Source:http://www.ccacoalition.org/en/slcps/black-carbon

BLACK CARBON CONTRIBUTION OF A VEHICLE

EXAMPLE OF BC CONTRIBUTION FOR A SPECIFIC VEHICLE

Euro III double deck bus tested over MLTB on chassis dyno

CO2 g/km over cycle	**1500**
PM g/km over cycle	0.35
Typical %C in PM	70
Net BC g/km in PM	0.245
GWP of BC over 20 years*	2000
Net effect of PM as CO2 g/km equivalents	**490**
GWP as % of CO2 emissions	**33%**

Source:https://www.clientearth.org/reports/black-carbon-summit-presentation-richard-o-sullivan.pdf

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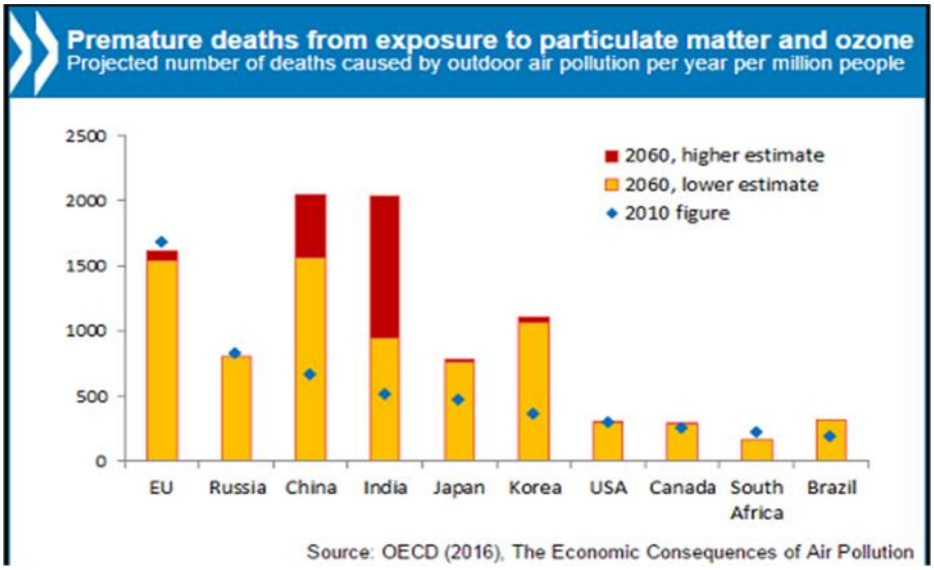
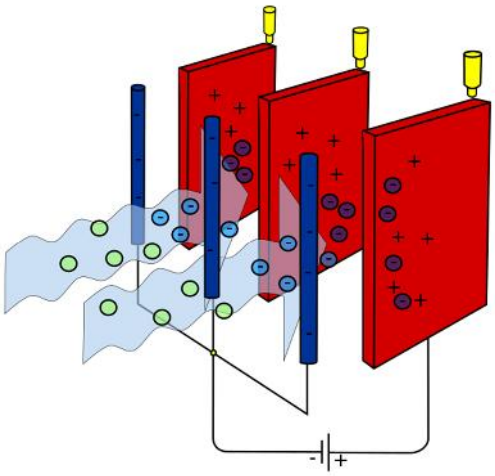


PRINCIPLE

1. Electrostatic precipitation

Electrostatic precipitation is a method of dust collection that uses electrostatic forces, and consists of discharge wires and collecting plates. A high voltage is applied to the discharge wires to form an electrical field between the wires and the collecting plates, and also ionizes the gas around the discharge wires to supply ions. When gas that contains an aerosol (dust, mist) flows between the collecting plates and the discharge wires, the aerosol particles in the gas are charged by the ions. The Coulomb force caused by the electric field causes the charged particles to be collected on the collecting plates, and the gas is purified. This is the principle of electrostatic precipitation.

By the principle of electrostatic precipitation, it negatively charges the soot particles passing through the mesh and the charged particles will be attracted to a positive chamber. The trapped soot particles by certain treatments and using chemicals the black carbon will be separated out. The process of making ink not only eliminates soot from polluting the air, but it also doesn't burn extra fossil fuels that making regular ink does. This device helps to reduce air pollution to a greater extent and moreover it helps to prevent premature deaths which are caused due to particulate matter pollution.



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Relationship between electrostatic precipitator collection efficiency and the particle size

Migration velocity of dust $\omega \propto a$

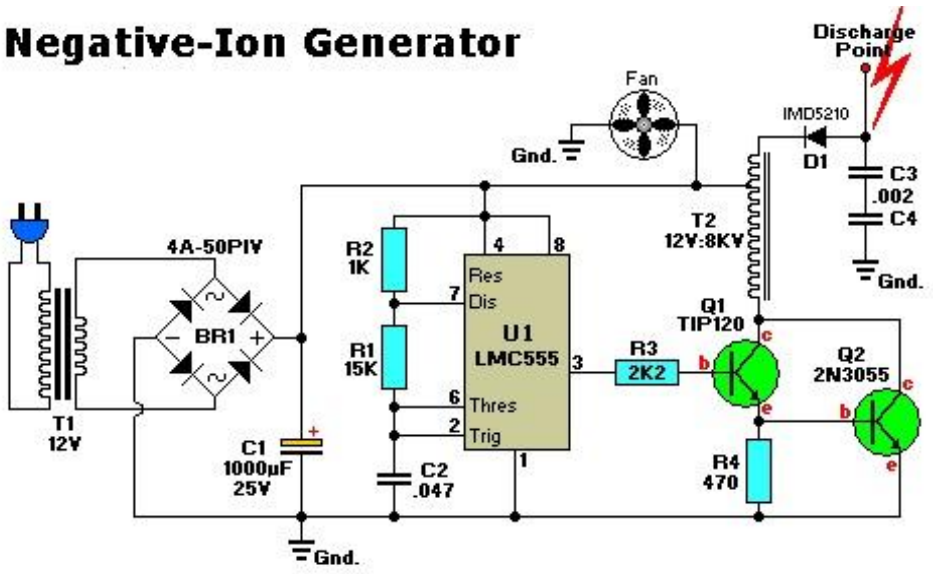
Dust collection efficiency $\eta = 1 - \exp(-\omega \times k \times t)$

Where k is a device constant, t is the treating time for the procces gas to pass through the electrostatic precipitator.

2. AIR IONIZATION

Air ionization specifically refers to air molecules either gaining an electron or losing an electron (or sometimes more than one, in either case). As a general rule, this is what is being referred to whenever ionization is mentioned, whether in air or other molecules. Ionization can be caused by extreme heat, which creates charged plasma (the electrons being shed from the atoms), but this generally does not apply in air ionization (except perhaps with lightning strikes, etc.). When this kind of ionization does occur, it is usually only a matter of seconds (or less) before the electrons return to their atoms. Direct electrical discharges and/or strong magnetic fields can also ionize the air. This often happens near power lines and other high-voltage equipment, such as transformers. The most common form of air ionization, however, is simple static electricity. The movement of the atmosphere over the ground can cause a few electrons to be "stripped off" the atoms. Over a large area, the electric charges can build up, and the result is a discharge of lightning.

An air ionizer (or negative ion generator or Chizhevsky's chandelier) is a device that uses high voltage to ionize (electrically charge) air molecules. Negative ions, or anions, are particles with one or more extra electron, conferring a net negative charge to the particle. Cations are positive ions missing one or more electrons, resulting in a net positive charge. Most commercial air purifiers are designed to generate negative ions.



IMPACT

Air Pollution has been one of the most conspicuous of all the problems we face today. In a country like INDIA where pollution ordinates are not well enforced the amount of pollution caused from the diesel engine exhaust is very high. Our product traps soot particles from automobile exhaust and turn it into useful form of black carbon which can be used in making of tyres, belts etc. Our product helps to prevent global warming, respiratory diseases if the soot particles enters human lungs. Moreover, this product helps to reduce

the burning of fossil fuels in black carbon producing industries. This product not only saves the environment but also allow the customers to make money by trapping the soot particles and handing over it to us. We are planning to pay a certain amount depending upon the amount of soot particles they trap by using our precipitator installed in their automobile. As long as we keep our environment clean and pollution free, we too can live disease free.

ADVANTAGES

- Used to make inks
- It is a rubber-reinforcing additive used in a multitude of rubber products.
- It is used as a component for magnetic tapes and semiconductors.

DISADVANTAGES

- Causes pollution towards a great extent
- Quite Difficult to Contain/maintain
- Since extremely small, can cause respiratory diseases etc.

CONCLUSION

In the last few decades, Asia has grown exponentially. But this growth has come at a cost - air pollution. The air pollution caused from the diesel engine exhaust is very high. Our product traps soot particles from automobile exhaust and turn it into useful form of black carbon which can be used in making of tires, belts etc. The soot particles coming out of engine are of size 2.5 micron which have very harmful effects to environment and human health. Our device is a component that can be fitted to the exhaust of any diesel engine. Hence the need for reducing air pollution will be more vital during the coming years, hence by introducing such a product like this, the rate of pollution can be considerably lowered. It not only lowers the rate of air pollution, but also prevents the health problems arising due to air pollution.

REFERNCE

1.http://www.ccacoalition.org/en/slcps/black-carbon

2.https://www.clientearth.org/reports/black-carbon-summit-presentation-richard-o-sullivan.pdf