A New Method of Creation and Cost Calculation of Ink and Paint From Soot Particles Collected from Automobile Exhaust - Sustainable Ink

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ABSTRACT

The world is currently facing the crisis of global warming due to multiple factors, one of them being automotive emissions, according to reports almost 4.6 metric tons of carbon is released into the atmosphere every year just by automotive exhausts. This leads to an increase in the amount of carbon in the atmosphere thus increasing air pollution. With the dangerous air coming out from the car exhaust, a black powder-like particle called soot is released into the air by automotive vehicles. This soot is seen as a waste product, but it can be collected easily from these exhausts, and trapped so that it does not merge with other atmospheric gasses. These soot particles can further be used to create ink, printer ink, and paint. In this work, we introduce a novel method of conversion of soot to ink and paint. The ink is made by mixing carbon soot particles and isopropyl alcohol in linseed oil, which is the main solvent, while resin and hardener are used for creating paint. The calculated density of ink made from Soot is approximately 0.92 g/mL, which is comparable to normal ink. Approximately 3 grams of soot was used to create 150mL of the formulated ink, which cost 39 Rupees.

KEYWORDS

Soot, Ink, Paint, Carbon, Air Pollution, Global Warming

INTRODUCTION

Indians for long used the old traditional method of making *kajal (Collyrium)* using the black particulate matter collected by burning oil lamps. This black particulate matter is known as soot. The soots have other sources as well, automobile exhaust being one of the sources. An enormous amount of soot is created by the internal combustion of engines. Soot is a carbon compound released due to incomplete combustion of any fuel. But, with soot, it also produces air pollution. Reports suggest that on-road diesel vehicles were responsible for nearly half of the health impacts of air pollution from vehicles worldwide in 2015, and two-thirds of impacts in India, France, Germany, and Italy [1]. This soot can instead be collected and used for various purposes. Making this waste product into something useful, thus reducing waste products in the atmosphere and creating a daily useful product from that.

This research paper aims to collect soot from engine exhausts and create black ink that can be used for various purposes. Engines working on petroleum-based fuels emit carbon dioxide (13%), water (13%) and nitrogen (73%) [2]. Currently, this carbon-rich substance plays a significant role in air pollution and negatively affects both the environment and human health. Soot is directly responsible for the increase in temperatures as these particles capture the sun’s heat and heat the earth's atmosphere. The more serious issue is, that once they come in contact with snow/ice they start melting thus, an increase in the amount of Soot in the

atmosphere can directly be linked to the melting being witnessed at both poles in the recent few decades. Soot is a black-colored powder-like substance and has the composition (C3H)n, and each particle of soot is made up of several thousand carbon atoms [3]. Two different variations in soot are found, the chemical formula of soot are C27H13 and C47H17 [4].

The reports created by the University Of Leeds, UK[4] suggest that black carbon (soot) is a significant cause of the rapid warming in the Northern Hemisphere at mid to high latitudes, including the northern USA, Canada, northern Europe, and Asia. It is also impacting the rainfall patterns in the south from the Asian monsoon. Soot being a particulate matter can easily be collected using different methods. It can be trapped before it is released into the atmosphere and the trapped soot can later be chemically altered for various purposes including creating black marker ink, printer ink, and paint. The different methods of converting soot to ink as previously invented are:

Method 1:

0.2 grams of soot is collected through vehicular exhausts and is heated at 200 degrees Celsius in a muffle furnace for purification. It is then mixed with 100ml of water at 100 degrees Celsius. It is then passed through 150 Herzberg, filtered, and dried, after which desiccation takes place at 150 degrees Celsius. The solution obtained is mixed with Di-methyl formamide (7ml) and calcium carbonate (0.7g). Then homogenization takes place at 20kHz for 40 minutes after which shear mixing is done where 0.2g of polyurethane resin is added followed by blending to create 10ml of soot ink. The method from [6].

Method 2:

10 dirhams (1 dirham is equivalent to 3 grams) of Arabic gum with a filtered honey consistency is put into a mortar with some soot. Pomegranate peel juice and iron sulfate water are combined in a pot and boiled with an amount of scrap until the mixture becomes like a sherbet. This sherbet soot and gum are gradually crushed in a mortar for one week. Then rose water, saffron, and myrtle water are mixed and filtered, and added to the ink[7].

This research paper aims to invent an inexpensive method of creating inks from soot. The inks created in this paper show very similar properties as far as color and density are concerned. The soot is collected from the exhaust of automobiles, specifically BharatBenz trucks using a special device chamber for soot collection.

METHODOLOGY

Aim of the study

This study aims to introduce a new method of soot-to-ink conversion.

Instruments used -

All compositions were discussed in terms of W/W % (weight by weight percentage) and calculations of ink/paint were made in mL, while cost was calculated in Indian Rupees.

Data Collection Procedure -

The soot was collected by attaching a chamber to the back of a BharatBenz truck.

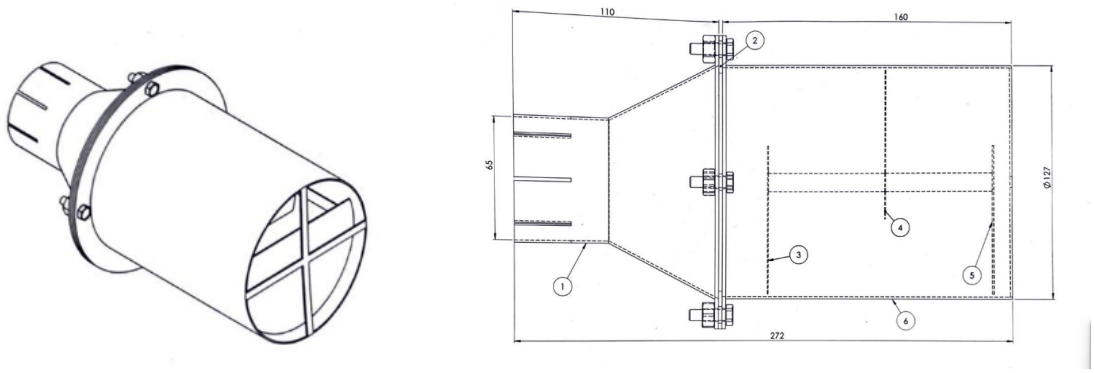

Figure 1. The 2D version of the chamber that was created and used for the collection of soot. It consisted of a diesel particulate filter (DPF), which collected the soot particles from exhaust emissions.

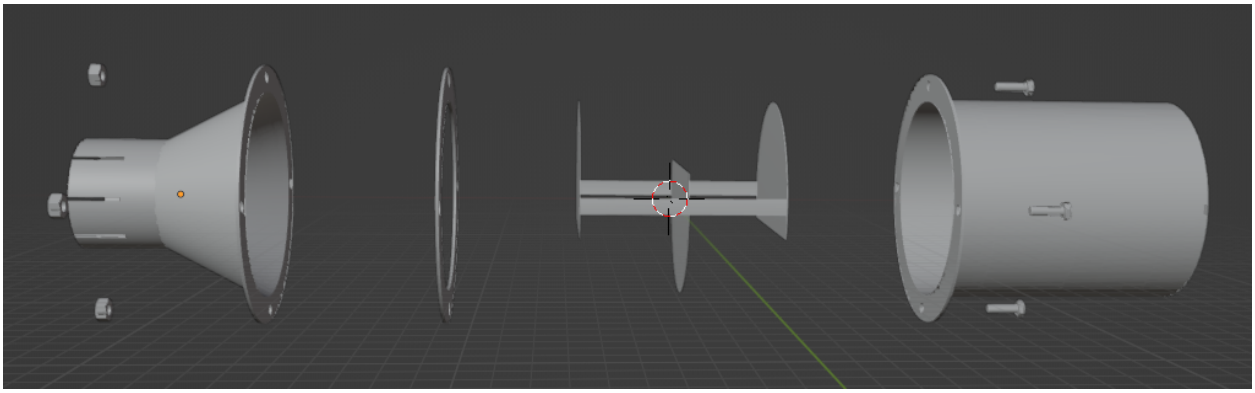

Figure 5. Open assembly design of the chamber in 3D model.

Figure 6. The final prototype of the chamber is attached on the exhaust pipe of a bharatbenz truck and soot being collected by the chamber respectively.

The filter has a mouth which gets attached to the exhaust of the automobile, specifically designed for BharatBenz trucks. The soot gets collected inside the chamber whereas the chamber allows the gases and heat to pass through it to the atmosphere.

RESULT

Soot is collected from any source of incomplete combustion like vehicles, lamps, burning of wood/plastic, etc. For this research, soot was collected using a chamber attached to the back of Diesel trucks; BharatBenz. The Soot collected was then used to create ink. The two different methods of creating ink from soot particles are discussed in this research paper. In this section, will be discussing a new method of ink and paint creation from soot collected from automobile exhaust.

Printer Ink Creation

The filtration of soot was done after collection from the soot-collecting device. The soot particles collected were filtered using a simple device that segregated the particles as printer or toner ink required more fine particles as compared to the soot used to make paint for paintings. The soot particles were segregated into 2 different types of beakers and then heated to get rid of any impurities. After the filtering process, the soot can be converted to ink. Soot was converted into ink by a simple process using only 2 additives and vegetable oil as the main solvent: Linseed Oil Carbon Soot – 17% - 20%, Isopropyl Alcohol – 3% - 18%, Oils – 50% – 65%, and Additives – 1% - 5%.

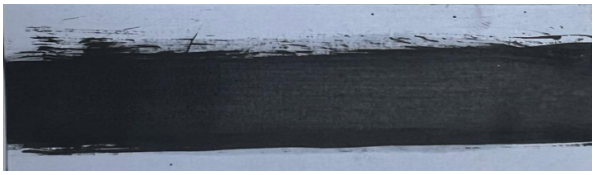

Figure 7: Soot ink

Figure 8: Canon Printer Ink

Linseed oil is used as the main solvent, which takes up the black color from the soot particles while isopropyl alcohol is added as a thinner which helps fix the consistency of the ink while also reducing drying time/spread of the ink. For 10 mL of ink, 6 mL of linseed oil is fixed with 4 mL of isopropyl alcohol and soot. This ink was compared to normal printer ink as well as ink made using vegetable oil. The ink made using only vegetable oil was wet and took a lot of time to dry, it easily spread out. But the one made using vegetable oil with isopropyl alcohol had less spread and dried out quickly thus being very similar to the actual printer ink.

Paint Creation

The paint from soot conversion process is discussed in this section. Paint created can easily be used to make canvas paintings and has been tested in different conditions. The link does not have any short-term effect when placed in direct contact with sunlight and does not fade away on rubbing. Soot can be converted into paint by the following process: For lampblack heavy pigments - Mix Soot particles with 25 ml of linseed oil, for lighter tones/smock black paint - Mix Soot particles with 35 ml of Linseed oil, and for fixing the paint add 10 gm of hardener or lacquer

spray paint. The calculation of price is done as follows: Linseed Oil costs 100 rupees for 100 mL, and Isopropyl Alcohol for 150 rupees for 1. So for making Thus, the estimated price for 1 mL of ink is 0.26 rupees. Therefore for a 150mL refill bottle, the price of ink would be 39 Rupees.

Physical and Chemical Properties

The density of the ink was calculated by calculating the ratio of mass of the soot and volume of the soot in a container. The mass of soot ink came out to be 46.43 grams and the volume was 50 mL. Thus, the density of ink created from soot was 0.92 g/mL. whereas the density of normal printer ink ranges from 1.01 g/cm3 to 1.007 g/cm3. Hence, the density of the ink created is comparable to the normal day-to-day used ink.

DISCUSSION

The method discussed in this research paper can be used to create ink and paints for day-to-day applications. The method turned out to be an inexpensive method for ink creation using soot. Some of the properties observed of the ink that is created in this work are: the density is comparable to normal ink. Soot ink has a drying time of approximately 4 seconds while conventional ink takes approximately 5.7 seconds to dry. A great advantage of this method is of course the cost of ink production, but it is also a sustainable method that effectively reduces air pollution. The ink was tested in direct sunlight for a short duration, and no major changes in the ink properties and texture were observed.

CONCLUSION

The chamber was created to collect the soot successfully and store the soot particles when connected to the exhaust of the BharatBenz truck. The chamber effectively traps these soot particles before they enter the atmosphere and thus helps in reducing air pollution. Soot collected by the chamber is then filtered by heating and then separated using filters to segregate particles.

The discussed formula is both efficient and inexpensive for the conversion of soot to ink and the ink created by the same has similar characteristics to normal factory-made ink.

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