

Hong Kong Student Science Project Competition 2023

Template of Extended Abstract (Investigation)
(Word Limit: 1,600 words, Pages: 3 pages only)

Team Number:

Project Title: Re: cigarettes

Project Type: Investigation

*To our best knowledge, there are no * similar works in the field.*

I. Background

Cigarette pollution has been a major problem in recent years. Yearly, 6 trillion cigarettes are smoked worldwide, and 4.5 trillion cigarettes are littered in the environment. In a campaign, a total of 13,806,887 litter items were collected, of which 2,127,565 were cigarette butts. Cigarette butts are such a big part of the pollution since the amount of cigarette butts accumulate due to the poor biodegradability of the cellulose acetate filter as they take 7.5–14 years to disappear. The filters consist of 15,000 detachable strands of plastic fibers linked to each other by glycerol triacetate. Therefore, when the filters are incorrectly discarded, the filters can quickly release their strands, either detached as microfibrils or gradually fragmented, leading to an unignorable source of microplastics.

In fact, more than 300,000 tons of potential microplastic fibers reach aquatic environments from this source each year, where marine animals can easily mistake them for food thus entering the food chain, polluting our food and causing health problems. Additionally, there is a concern in terms of water quality affected by this type of waste, since filters contain several toxic and chemical substances like nicotine, arsenic, tar, pesticides, as well as heavy metals like mercury.

II. Objectives

As the filters release a lot of toxic chemicals and pollute our environment, we hope to develop a way to degrade the cigarette filters and reuse them to achieve the 12th goal of the 17 development goals. The 12th goal is to ensure sustainable consumption and production patterns. As cigarette filters are one of the largest consumptions (Ocean Conservancy, 2016), seeking a way to decompose them will ensure sustainable consumption of cigarettes and therefore achieving the 12th goal.

III. Hypothesis

As more than 95% of cigarette filters are made out of the plastic cellulose acetate, we can effectively break down the majority of cigarette filters by finding a way to clean and deacetylate cellulose acetate, resulting in reusable cellulose. The procedures done by factories are complicated and expensive, whilst the resulting products only being plastic pallets for reuse. Changing cellulose acetate into cellulose not only helps the biodegradation, but also opens up opportunities for making paper products such as coasters, paper, boxes and bags, etc out of cigarette filters.

IV. Methodology

Part 1: Burning

- 1) Burn the cigarettes and use a vacuum pump attached on to the cigarette by a plastic tube in fume cupboard to mimic the action of a person smoking
- 2) Extinguish the cigarette after it is burnt until the filter
- 3) Unwrap the filter paper to reveal the filter only, and cut away burnt parts of the filter

Part 2: Cleansing

- 4) Add 50m of water per 0.5g of cigarette filters to a beaker. Bring the water up to a boil
- 5) After the water starts to boil completely, Turn the temperature and RPM of the heat plate up to 150°C and 180 respectively, and add in the cigarette filters. Start a stopwatch and take out the cigarette filters after 3 minutes.
- 6) Rinse the filters with distilled water
- 7) Pour out the dirty water, replace with new clean water and repeat one more time.
- 8) Add 50m of ethanol per 0.5g of cigarette filters to a beaker. Bring the ethanol up to a boil
- 9) After the ethanol starts to boil completely, Turn the temperature and RPM of the heat plate up to 200°C and 600 respectively, and add in the cigarette filters. Start a stopwatch and take out the cigarette filters after 5 minutes.
- 10) Rinse the filters with distilled water
- 11) Pour out the dirty ethanol, replace with new clean ethanol and repeat two more times.
- 12) Rinse the filters with distilled water and transfer to another beaker

Part 3: Deacetylation

- 13) Add 30 ml of acetone per 0.5g of cigarette filters to a beaker. Turn the temperature of the heat plate up to 100°C and bring the acetone up to a boil.
- 14) After the acetone has boiled, add in the cigarette filters and turn the RPM of the heat plate up to 150 RPM. Start a stopwatch and turn off heat, add in 40 ml of sodium hydroxide ethanol solution into the solution directly after 4 minutes.
- 15) Start a stopwatch and turn off stirring after 3 more minutes. Set aside for at least 15 minutes.

Part 4: Extraction

- 16) Pour the solution through a vacuum filter and collect the residue (cellulose). Transfer the filter paper along with the residue onto a 50°C hot plate for drying.

V. Results

After the process and vacuum filtration, we are left with a white precipitate on the filter paper, and after drying, the precipitate can be scraped off and collected.

VI. Conclusion

- By extracting cellulose from cellulose acetate in cigarette filters, we are able to collect the extracted cellulose. The white powder implies that it is possible to obtain cellulose from cigarette filters.
- It meets our hypothesis. This way, we are able to reduce the amount of pollution caused by cigarette filters in the environment while also reusing cellulose acetate in the form of cellulose in cigarette filters.