



Degradation of cigarette butts in a beach simulation

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Introduction

In 2013, a smoking ban was passed for Wrightsville Beach to prevent the use of cigarettes on the beach strand. The purpose of this study was to observe the degradation process of cigarette butts in a coastal environment in order to compare collected butts to experimental butts for time-in-environment determination. This study could help aid in determining the effectiveness of the smoking ban, i.e. are the cigarettes found on Wrightsville Beach older (pre-ban) or newer (post-ban)?

In a previous study by Anglin, cigarette butts were categorized into four categories based on appearance to determine time-in-environment. These categories were days, weeks, months, and years. The goal of this study was to be able to prepare a guide similar to this one on the basis of experimental simulation.

Hypothesis: If we can observe the degradation of cigarette butts in an experimental setup, then we can determine the time spent in the environment for cigarette butts collected on a beach.

Materials

- KOOL Filter Kings cigarettes, smoked and unsmoked
- IKA K5 260 basic agitator
- Glass containers
- Sand
- Saltwater
- Solar simulator & timer



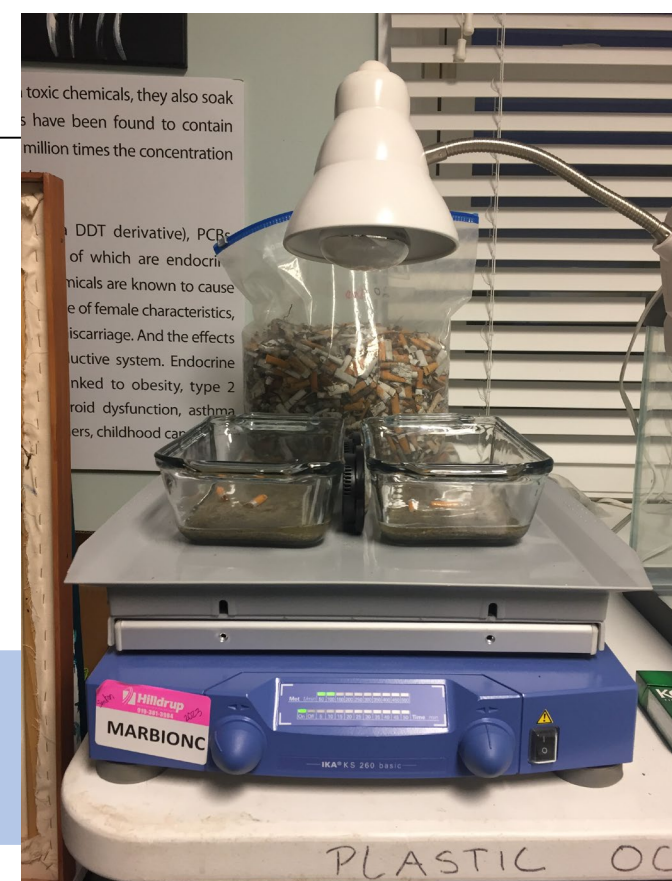
Experimental Setup

Two glass containers were set up on the agitator surface. Each was filled with 220 mL sand and 150 mL saltwater to start.

A solar simulator, consisting of a clamp lamp and UV/heat bulb, was situated approximately six inches above the containers. The solar simulator was set on a timer to simulate daytime and nighttime.

For each trial, a pin with a colored head was stuck in each cigarette butt for identification purposes.

After adding the cigarette butts to their respective containers, the agitator was set to 100 rpm for continuous agitation to imitate the movement of a cigarette butt moving around in the environment.



Trial 1

Four unsmoked cigarettes were used in this trial. Each was cut to an estimated "butt" size of approximately 35 mm. Two unsmoked cigarettes were added to each of two glass containers.

Observations

- Tobacco and other unidentified products immediately released into water
- Day 2 (2/29/20) – cigarette D already unraveled
- Day 6 (3/4/20) – cigarette B unraveled; cigarette D filter only
- Day 9 (3/7/20) – all cigarettes unraveled
- Day 28 (3/27/20) – cigarette butts are hard to the touch, almost like being cured

Cigarette ID	Starting Length	Week 1 Length	Week 4 Length
A	35 mm	35 mm	22 mm
B	33.5 mm	27 mm	23 mm
C	34 mm	34 mm	23 mm
D	34 mm	21 mm	21 mm

Table 1. Comparison of cigarette butt lengths from start to finish in Trial 1.

Trial 2

Two smoked and two unsmoked cigarettes were used in this trial. The unsmoked cigarettes were cut to "butt" size to reflect the smoked cigarette size of approximately 55 mm. The smoked cigarettes were added to one container and the unsmoked cigarettes were added to the other.

Observations

- Tobacco and other unidentified products immediately released into water
- Day 2 (4/8/20) – all cigarettes unraveled, filters only; water copper-brown

Cigarette ID	Original Length	Starting Length	Day 2 Length	Day 5 Length	Day 8 Length
E	N/A	52 mm	22 mm	22 mm	22 mm
F	N/A	55 mm	25 mm	23 mm	22 mm
G	82.5 mm	54.5 mm	20 mm	20 mm	20 mm
H	83 mm	52 mm	21 mm	21 mm	21 mm

Table 2. Comparison of cigarette butt lengths from start to finish in Trial 2. "Original Length" not available for cigarettes E and F because both were smoked prior to obtaining. The butts remaining from smoking cigarettes E and F were used as templates for unsmoked cigarettes G and H.



Figures 1 (left) and 2 (right). Pictures of the cigarette butts from Trial 2 on Day 1 (set up) and Day 2, respectively. On Day 2, all four cigarette butts had degraded to filter-only and the water was an obvious copper-brown color.

General Conclusions and Future Research

From observation, it was evident that tobacco, and likely other compounds, were leached from the cigarette butts into the surrounding environment. The water had an obvious copper-brown color after placing the cigarette butts.

Unfortunately, no definitive conclusions can be drawn about time-in-environment for cigarette butts based solely from the results of this experiment. In Trial 1, cigarette butts had "degraded" to filter-only as soon as the next day and only as late as nine days total. Trial 2, on the other hand, resulted in cigarettes being degraded to filter-only within one day.

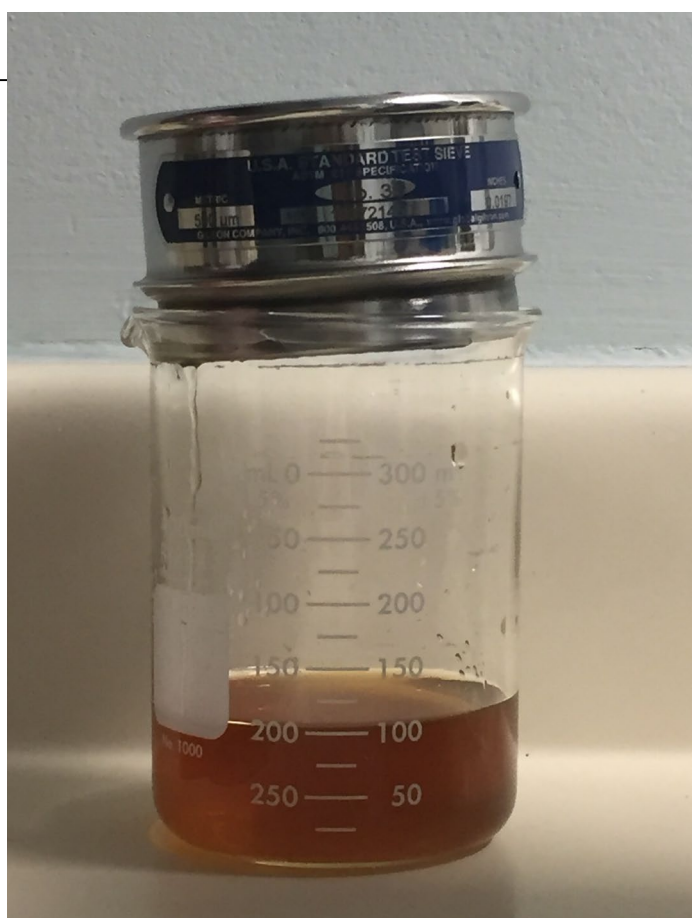
Future research should focus on determining the efficiency of this experimental setup and the impacts of efficiency on results, i.e. how much heat is exerted on the cigarette butts related to bulb type and distance to bulb, and how 100 rpm agitation effects the movement of the cigarette butts versus, for example, 50 rpm.

Study Extension: What's in a butt?

At the conclusion of Trial 2, water samples were collected from both containers so that one sample would contain leachates from smoked cigarettes and one sample would contain leachates from unsmoked cigarettes. Water samples were filtered using a 500 µm sieve and then sent to Environmental Chemists, Inc. for testing.

Compound	Sample	Concentration
Cadmium	Smoked	0.10* mg/L
	Unsmoked	0.10* mg/L
Chromium	Smoked	0.10* mg/L
	Unsmoked	0.10* mg/L
Mercury	Smoked	0.0014* mg/L
	Unsmoked	0.0014* mg/L

Table 3. Concentration of three heavy metals detected in water samples from smoked and unsmoked cigarettes. *High amount of solids. Reporting limit elevated due to matrix interference.



References:
Anglin, V. Cigarette litter: A survey of Carolina Beach and Wrightsville Beach, North Carolina. [Poster].

Acknowledgements:
Special thank you to Bonnie Monteleone for help and guidance, Pam Seaton for the agitator, and Environmental Chemist, Inc for running water samples.