

Chemistry 110
Spring 2012
Dr. Abrash

Solids in Cigarette Smoke

Pre-lab lecture

What is the purpose of this lab?

It's claimed frequently that cigarette smoke contains many harmful substances. It's also claimed that cigarette smoke is harmful not only to smokers but to those who are present when they are smoking. This experiment is designed to measure how much of some of these harmful materials are present both in inhaled smoke and in second hand smoke.

How will we do this?

We'll set up an apparatus that will draw smoke through filter paper. It will be a dual apparatus, that with one part "smokes" the cigarette, drawing the smoke through one piece of paper, and with the other part, captures the smoke that come off of the tip of the cigarette, the so called second hand smoke, and draws that through another piece of filter paper.

What does the filter paper capture?

The lab write up says that the filter paper traps the solid particles in the smoke. Part of what I want you to do in this experiment is to try to evaluate whether this is what's going on in the experiment.

Does the filter paper capture everything it's supposed to?

Make observations during the experiment and tell me what you think.

Does the filter paper only capture what it's supposed to?

Make observations during the experiment and tell me what you think.

Why do we care about solid particles? I thought that tar and nicotine were the main dangers in cigarette smoke.

Tar and nicotine are only the beginning. There's lots of evidence that small particulate materials cause significant damage to lung tissue. In addition, some recent studies show that a significant percentage of the nicotine is carried on small solid particles.

Another hazardous material that we can't measure in this experiment is carbon monoxide, a gas which permanently removes the ability of a blood cell to transport oxygen. The body of a smoker compensates for this by producing more red blood cells. The evidence for this is in a simple test called a hematocrit, which is higher for smokers than anyone except runners who run at high altitudes. Although the production of extra blood cells compensates for the lost oxygen carrying capacity, the extra high density of red blood cells creates health problems in its own right.

How can we tell how much material is captured?

We weigh the filter paper before we use it to trap the solids, and again afterwards.

Doesn't the amount of the cigarette that burns affect how much material we capture?

Yes. For this reason we'll try to burn the same amount of cigarette each time, and will weigh each cigarette before and after "smoking".

Then we'll compare the amount of trapped material to the amount of cigarette burned by taking their ratio.

How do we make sure that we burn the same amount of cigarette each time.

You're going to draw a circle around the cigarette 2 ½ cm from the unlit end. You'll stop burning the cigarette when it reaches this circle. (Note that this is a change from the procedure in the handout.)

Won't drawing the circle change the weight of the cigarette?

Absolutely. For this reason, you'll draw the circles on your cigarettes before you weigh them.

Does the speed that the cigarette burns matter?

Yes, it matters a lot. It has a big effect on the ratio of solids in second hand smoke to smokers smoke.

So what do we do about it?

You make sure that each cigarette takes about the same amount of time to burn, within the range of three minutes to five minutes.

After the experiment is over, how do we prove that our cigarettes took this long to burn?

From your notebook record. You note down the time when your cigarette began burning, and the time at which you extinguished it.

What are the calculations we need to do?

First, calculate the mass of the cigarette consumed.

Mass of cigarette consumed = mass of cigarette and watch glass – mass of burned cigarette and watch glass

Then calculate the mass of solids left on filter papers

Mass of solids = mass of filter paper after smoking – mass of filter paper before smoking

Now calculate the mass of solids per gram of cigarette in units of milligrams

mg of solids / g of cigarette consumed = (mass of solids on filter paper/mass of cigarette consumed) x 1000

Next we'll calculate the relative amount of second hand smoke to smokers smoke, by calculating the percentage of the smoke that is second hand – NOTE – this calculation is not correct in your lab manual.

% second-hand smoke = (mass of second-hand smoke/(mass of solids in smoker's smoke + mass of solids in second-hand smoke) x 100

Finally, calculate the average of the mass of solids per gram of cigarette and for the relative amount of second hand smoke to smokers smoke. Remember to do this separately for the filtered and unfiltered cigarettes.

average = (value 1 + value 2)/2

Won't it be hard to see significant patterns with only two runs?

Yes, so you'll pool your results at the end of the experiment. Write down your averages for mass of solids per gram of cigarette and for percentage of the smoke that is second hand. Make sure that you copy down all of this information into your notebooks.

Are there any hints you can give on how to make the procedure work best?

Funny you should ask. I have one or two.

1. To make sure that you use about the same amount of cigarette each time, draw a circle around the cigarette about 2.5 cm from the end you're not going to light. Burn the cigarette to this circle each time.

2. When using the filter cigarettes, make sure that you light the end without the filter.
3. When weighing the cigarettes and filter papers, make sure that the filter papers are labeled and the cigarette circled BEFORE weighing.
4. Use the same balance for all of your measurements.
5. We will be using house vacuum as the source of our vacuum and not water aspirators.
6. When you assemble your apparatus:
 - a. make a cone of the filter paper before you put it in the filtration flask.
 - b. to light the cigarette, open the vacuum valve very slightly. Light the match and hold it over the cigarette, then very slowly increase the vacuum until the cigarette lights. Then lower the upper funnel until it's as far down as it will go without touching the burning cigarette. Slowly increase the vacuum while watching the burning cigarette until it is just high enough that the "second-hand smoke" does not escape from the upper funnel.
7. When the burn is done DO NOT TURN OFF THE vacuum yet. Instead remove the stopper from the smoker's smoke flask, and replace it with a solid (cork or rubber) stopper. Then collect for one more minute.
8. Remove the cigarette with a tweezer from the lower funnel, and tap the ash off into a beaker. Then put out the cigarette onto the watch glass you used to weigh it.
9. Before you dispose of the cigarettes and matches make sure that they are completely extinguished by wetting them.

What do I turn in for the lab report?

1. All the information requested in the data sheets on pages 29 and 30.
2. The answers to the questions on page 28.
3. A table showing the pooled results from the class.
4. For question 1 and 2 on page 28, answer it based on the data that the class pooled (i.e., everyone's data not just yours).
5. In addition to the questions above, please answer the following question:
 - a. Did this experiment measure what it claims to measure?
 - b. What evidence do you have to support your answer in question a? In answering these questions, remember that the experiment can either measure more than it claims, less than it claims, or both! Consider your observations carefully.

Notebook records

Be careful to include the prelab, a good procedure, careful records of your observations (very important in this experiment), and complete records of your data. Use the proper correction methods, initial each page, and have your notebook record witnessed.

Honor Stuff!

All aspects of the experiment can be done collaboratively with your lab partner(s).