

Flame Retardant Effectiveness on Cotton Fabric



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ABSTRACT

This paper describes a science fair experiment that is trying to determine which fire retardant is the most effective on preventing fires. This is something that has a real life value to all home owners. The research I did helped me to select *Flamex-PF* as the product I felt would be the most effective. Research also showed that cotton is the most flammable fabric in homes. My hypotheses stated that *Flamex-PF* would both ignite more slowly and extinguish more quickly.

The results of the experiment only partially support my hypothesis. Four trials were performed with consistent results. This experiment did prove that using fire retardants can reduce the damage caused by fire and that *Flamex-PF* was the best.

INVESTIGATIVE QUESTION, PURPOSE AND HYPOTHESIS

Investigative Question: Which flame retardant is the most effective against making fabric burn?

Purpose: The purpose of this experiment is to prove that flame retardants do prevent and slow down fires in fabric and show people that using the most effective flame retardants could save lives and prevent burn injuries to people in homes, hospitals, hotels, etc.

Hypothesis: If *Flamex-PF* fire retardant is applied to cotton material, then it will take longer to ignite the material and will extinguish more quickly than cotton material that is treated with either *ForceField FireGuard* or *FRP-103 Dry Flame Retardant* because *Flamex-PF* has been tested and rated higher than the other two products.

INTRODUCTION

I decided to do this project because when I lived in Ecuador many houses did not have electricity and so candles were used for light instead. This was the cause of many fires that ended up burning children. My sister used to volunteer in the burn center of the government children's hospital, and she would tell me about the horrible fires that burned the kids.

Deaths from fires and burns are the fifth most common cause of injuries/deaths in the United States and the 3rd most common cause of fatal injuries in the home. In the year 2006 in the United States, every 162 minutes someone died because of a fire and every 32 minutes somebody was injured. I am interested in working with these products to help lower the number of these tragedies.

I began my research by looking on the internet for flame retardant products. I chose three products because they were different in their price, in their form (two were liquid and one was powder), and they all had different ratings. *Flamex-PF* was tested in accordance to NFPA-701, ASTM E-84, UL 723, UBC 8-1. *ForceField FireGuard* was tested in accordance to NFPA-701. The last product, *Dry Flame Retardant*, did not say that it was tested in accordance to any of these organizations. Since *Flamex-PF* was tested in accordance to many different standards, I thought that it would be the most effective.

I chose to use a thin cotton fabric because my research showed that it is one of the most flammable fabrics in homes. It is followed by polyester, then wool. Fabrics can be placed in three categories. They are readily flammable, moderately flammable, and relatively non flammable. Cotton falls in the readily flammable category. Since oxygen is needed for a fire, the ability for air to get through the fabric makes it more flammable. The saying "cotton breathes" is about the feature of air being able to pass through the fabric. Also, I found that the lighter weight the fabric the more it should burn, because air can travel through it easier.

MATERIALS AND METHOD

Materials:

- 1 spray bottle of Flamex-PF
- 1 bag of FRP-103 Dry Flame Retardant
- 1 spray bottle of ForceField FireGuard
- 1 candle
- 2 stopwatches
- 1 lighter or box of matches
- 1 non-flammable cookie sheet
- 16 squares of cotton fabric (13 cm x 13 cm)
- 1 ring stand
- 1 burette clamp
- 1 pair of stainless steel tweezers
- Aluminum foil



Method:

Variables:

The independent (manipulated) variable:

- The flame retardant used on the cotton material

The dependent (responding) variables are:

- The time it takes for the cotton to ignite
- The time it takes for the flame to extinguish

The constants:

- The amount of fire retardant used on each of the cotton square
- The temperature in the test room
- The type of material (same cotton piece)
- Size of cotton material (13 cm by 13 cm)
- Candle type
- Stopwatches

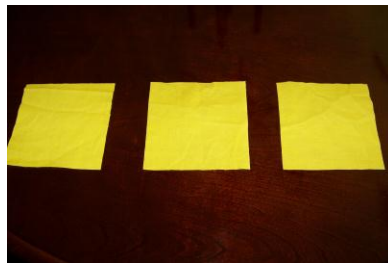
PROCEDURE

1. Prepare cotton fabric.

- (a) Wash and dry cotton fabric using warm water and small amount of detergent (no fabric softner)



- (b) Iron fabric and cut into sixteen 13 x 13 cm squares.



2. Divide the 16 squares of fabric into 4 groups of 4 pieces each and label:

- FF – ForceField FireGuard
- PF – Flamex-PF
- D – FRP-104 Dry Flame Retardant
- Do not label the last group (control group)

3. Treat cotton fabric (use tweezers to handle fabric):



- (a) Lay 4 squares for each group on a separate piece of aluminum
- (b) Saturate group 1 (FF) by spraying 20 times on each side
- (c) Saturate Group 2 (PF) by spraying 20 times on each side

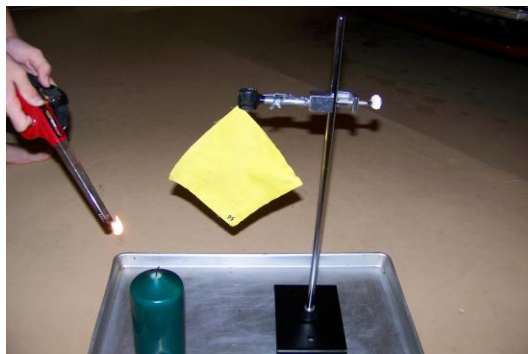
- (d) Saturate Group 3 (D) by first mixing powder with water (1 cup of Dry Flame Retardant mixed with 1 liter of water) and then dipping the fabric in the solution
 - (e) Do not spray anything on Group 4 (control group).
4. Hang all squares on a string by two clothespins to dry for 24 hours.



5. Gather materials and get ready to test over the non-flammable cookie sheet.



6. Take one square of the cotton fabric and clip it onto the ring stand using the Burette clamp and light the candle with lighter.



7. Take the lighted candle and ignite the cotton fabric vertically so the fire is directed onto the end of the cotton fabric.
8. Measure Responding Variables:
 - (a) Start stopwatch 1 when the lighted candle is placed under the cloth.
 - (b) Stop stopwatch 1 when the cotton ignites.
 - (c) Start stopwatch 2 when the cotton ignites.
 - (d) Stop stopwatch 2 when the cotton finishes burning.
 - (e) Record readings from both stopwatches.
9. Repeat steps 6, 7 and 8 for each piece of fabric to be tested until all trials are done.
10. Record all data for all groups in the notebook.

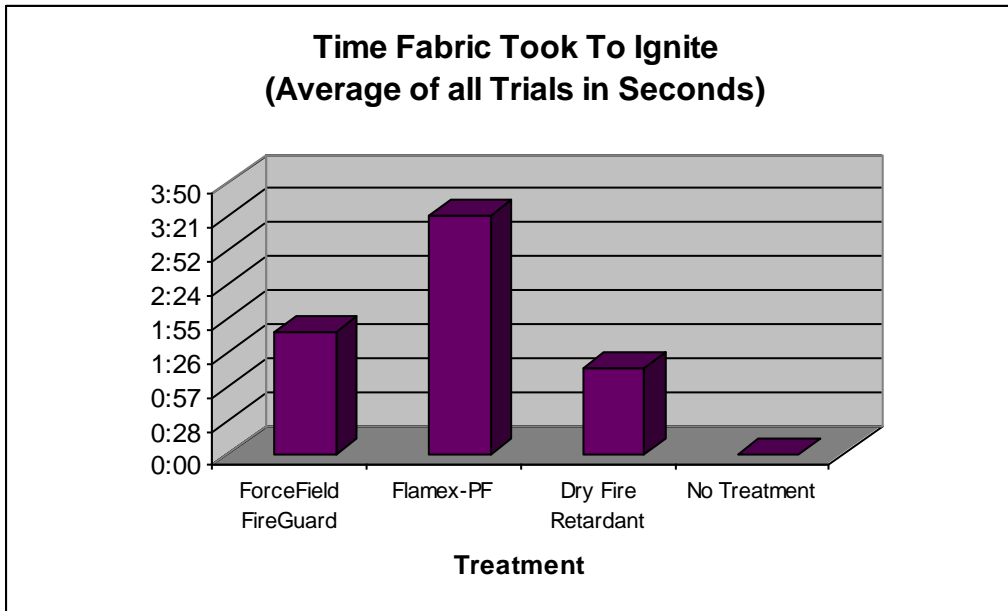
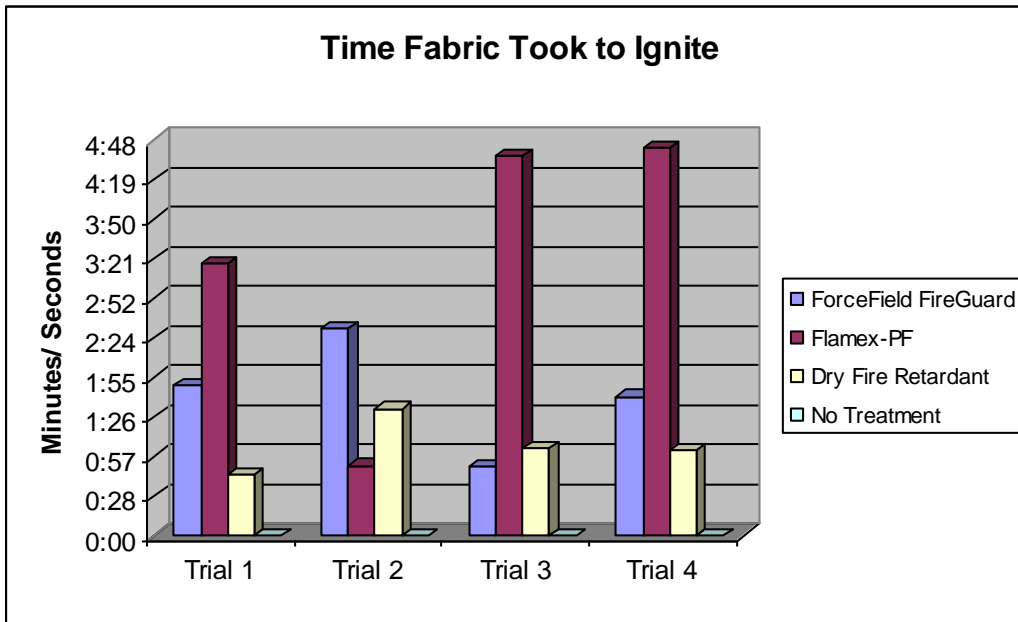
RESULTS

In my results I have two different responding variables, which are how long it takes the cotton to ignite and how long it takes for the fire to extinguish after it begins to burn. I picked these two variables because I felt that they were the most important when it comes to fire prevention. It was obvious that the cotton fabric with no treatment reacted very differently when compared to the cotton fabrics that had the fire retardants on them. Although there was a difference in the speed that the treated fabrics ignited, you can see that there is only a very small difference in how long the treated fabrics burned.

The charts and tables below show the results for each of the two responding variables with the result of each flame retardant used and then the average making it easier to read and see which product performed the best. I performed four trials to ensure that I was accurately comparing the products.

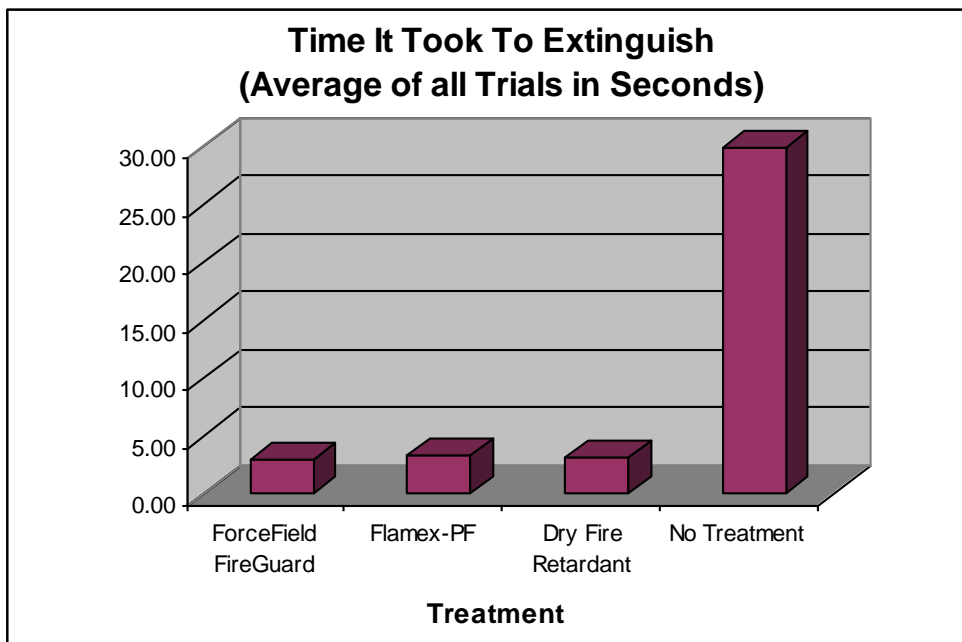
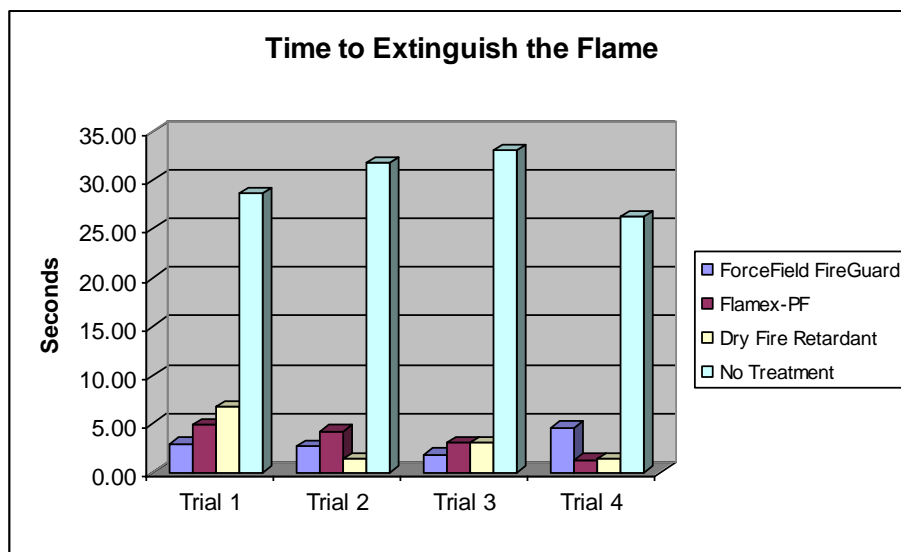
**Flame Retardant Performance
Time Fabric Took to Ignite (In minutes/seconds)**

	Trial 1	Trial 2	Trial 3	Trial 4	Avg.
ForceField FireGuard	1:49	2:31	0:50	1:41	1:42
Flamex-PF	3:18	0:51	4:36	4:42	3:21
Dry Fire Retardant	0:44	1:32	1:03	1:02	1:12
No Treatment	0:00	0:00	0:00	0:00	0:00



**Flame Retardant Performance
Time to Extinguish the Flame (In Seconds)**

	Trial 1	Trial 2	Trial 3	Trial 4	Avg.
ForceField FireGuard	2.96	2.66	1.84	4.63	3.02
Flamex-PF	4.84	4.26	3.03	1.30	3.36
Dry Fire Retardant	6.75	1.43	3.09	1.40	3.17
No Treatment	28.57	31.78	33.06	26.25	29.92



CONCLUSIONS

Based on the results of my experiment, my hypothesis was partially proven correct. *Flamex-PF* did take significantly longer for the fabric to ignite. As shown in the data from the experiment in my results section, *Flamex-PF* took 3 minutes 21 seconds longer than the fabric with no treatment, and it was approximately 2 minutes longer than fabrics treated with the other two products. However, *Flamex-PF* was not come out better in the time it took to for the flame to extinguish. Although *ForceField FireGuard* extinguished more quickly, I believe that in this part of the experiment the times where so close that it didn't make much of a difference.

I am glad that I did more than one responding variable because if I had only done the section of how long it took to extinguish, then my hypothesis would have been disproved. I believe that this experiment proved that *Flamex-PF* really is the best brand.

If I could do this experiment again, I would change the material to a thicker piece of cotton because the one I used was so thin that it allowed the fabric to become completely saturated by the liquid. I also would have not saturated the material completely. I would probably choose to more lightly spray the material on each side to see if that made a more significant difference.

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