Plastic Paper With a Zero Net Carbon Footprint? A Study Evaluating the Quality and Possibilities of Reusable Hemp and Plastic Paper

By Maxwell Aierstok
Greenwich Central School Greenwich, NY USA
J-MATS-001

Abstract

Tons of plastic bags are thrown away every year and end up in landfills for a very long time. In America, people use billions of plastic bags every year and the world uses way more. Paper making is also a problem due to the trees it takes to make paper. This is why I used hemp as a solution because it is very easy to grow quickly and efficiently. At the current rate there could very likely be more plastic than fish in the sea by 2050. The objective of this study was to create a paper that can be used in the ways normal paper is while leaving a zero net carbon footprint and being easy to make. Plastic bags and paper making can affect the environment in many different ways including climate change and environment loss. Making paper using plastic bags and hemp was done by creating 6 papers using 6 different percentages of plastic: 0%, 5%, 10%, 15%, 20%, and 25%. For each paper I made the rest of the percentage with Hemp. To make each paper I used the same methods real paper is made with which is done by measuring and blending materials with water, pouring it out, pressing it, and drying it. I tested each paper multiple times for burst strength, tear strength, rip strength, and made sure each paper had a similar weight, size, and thickness.

Introduction

Plastic bags can have a negative effect on the environment and increase climate change. Plastic bags are usually a single use item meaning after being used once they are thrown away and not recycled. Out of all 300 million plastic items produced in the world around half of them are single use plastics. (Vasarhelyi, 2021) Plastic can pollute the air and cause damage to the environment. Plastic usually ends up in landfills and oceans after being thrown away. About 10 million tons of plastic end up in the ocean every year and plastic that was intended to be recycled often ends up in landfills decaying and harming the environment. (Anon 2022) This is one of the many things that contribute to climate problems.

Plastic also releases toxins into the environment. When plastic sits in landfills and oceans it decays but it also releases toxins into the air while doing so. When plastic is thrown away it is often put in with other garbage and around 40 percent of garbage thrown away is burned. So this means the plastic is also often burned. This makes the plastic which is made with lots of oil release toxins into the air and pollutes the environment. (Jacobsen, 2008) This is a big reason why reusing plastic is important and why plastic is harmful to the environment.

Plastic can also cause disease. Plastic can cause disease in many different ways. One way that plastic does this is by causing cancer due to a chemical used to make plastic called endocrine disruptors. (Center for Biological Diversity, 2005) Another way that plastic can cause disease is if plastic is clogging a sewer or gutter and it rains. This will cause the water to sit in the area and create the perfect area for growing bacteria. (Jacobsen, 2008) Plastic is a very bad material because of this and it is a big problem for people and other living creatures that live near landfills or in the ocean.

Plastic is a very big problem for animals as it can easily trap them and choke them or they can swallow and digest them. Both these causes can kill sea life and these are just some of the causes. Out of the nearly 40 species in the U.S. that have been affected by plastic since 2009. About 88 percent of them are either an endangered or threatened species under the endangered species act. (Anon, 2020) Due to all the plastic in the ocean, many animals have been killed or affected by all the hazards of it.

Paper is also a big problem due to all the cuttings of trees done to be used as supply to be made into paper. Using hemp is a better alternative than trees. Hemp grows quicker and easier than trees. For more than the past 8,000 years humans have cut down about half of the forests worldwide. (Melillo, 2021) The forests that are destroyed to make paper are home to many animals and getting rid of trees also makes the production of oxygen decrease and the amount of

carbon in the world will increase. Paper made from plastic would be extremely helpful because it would reduce both the amount of wood used and the amount of plastic used. Around one million plastic bags are being used every minute. (Jacobsen, 2008) These two problems are some of the biggest problems that have still not been solved. If my plastic paper was made in a typical paper mill using one bail of hemp weighing 500Ibs which is the normal amount of hemp in a batch of paper, then using 25% plastic in all the paper would save 9375 plastic bags from the environment.

Design Objective

My design objective is to create renewable paper with a lower carbon footprint than recycled paper by using hemp and reused plastic bags.

Methods

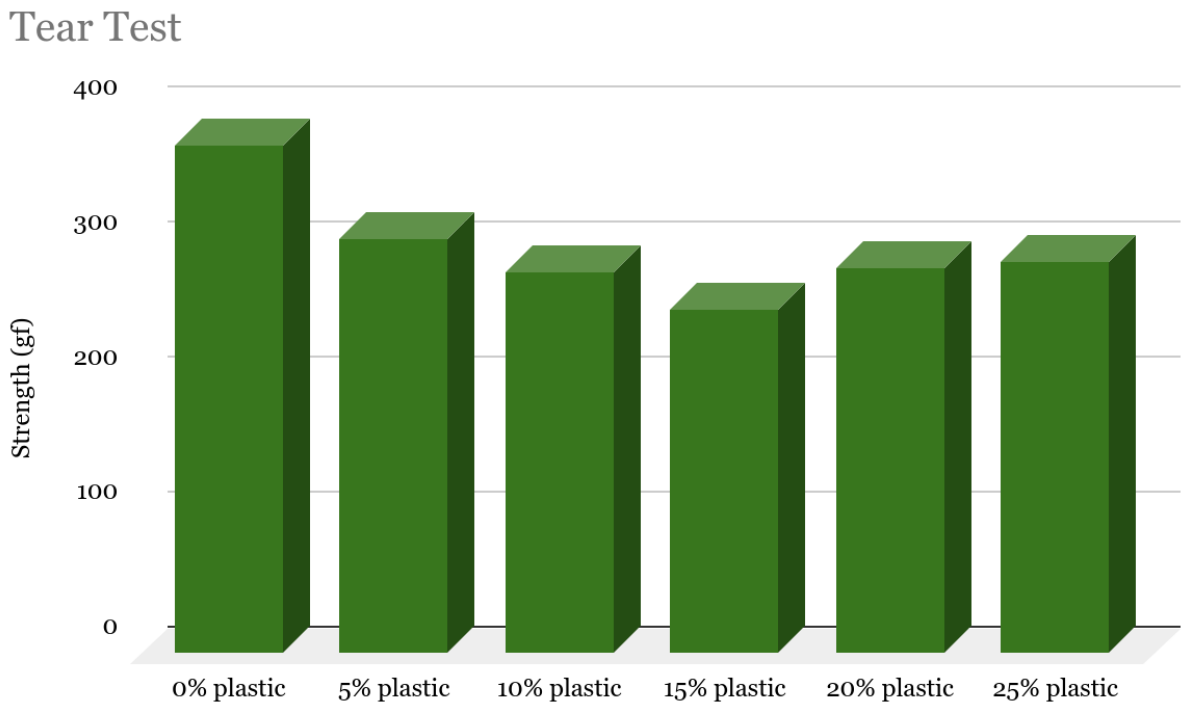
To make this experiment work I created six different papers each using different percentages of plastic and raw hemp. For each paper I used a total of 20 grams of material. For paper one I measured out 0% plastic and 100% raw hemp as the control. For paper two I used 5% plastic and 95% raw hemp. For the third paper I used 10% plastic and 90% hemp. For the fourth paper I used 15% plastic and 85% raw hemp. For the fifth paper I used 20% plastic and 80% raw hemp. For the final paper I used 25% plastic and 75% raw hemp.

To make each paper I first measured out the amount of plastic and hemp needed on a scale measuring in grams. Then I needed to cut the plastic into small sized pieces so it would mix with the hemp. After that I added 1 gallon of water instead of the normal 2 gallons in traditional paper because the plastic would float to the top if there was too much water. Next the plastic and raw hemp was blended together. After blending for one minute, I poured the solution onto a surface that strained out the water and let the pulp settle. Then a press squeezed and drained the paper solution. After the water was squeezed and drained out, I dried the paper using a machine and cut the paper into the sizes needed for each test. I also made sure that each paper is pressed out to the right thickness and dryed completely so the tests were as accurate as possible.

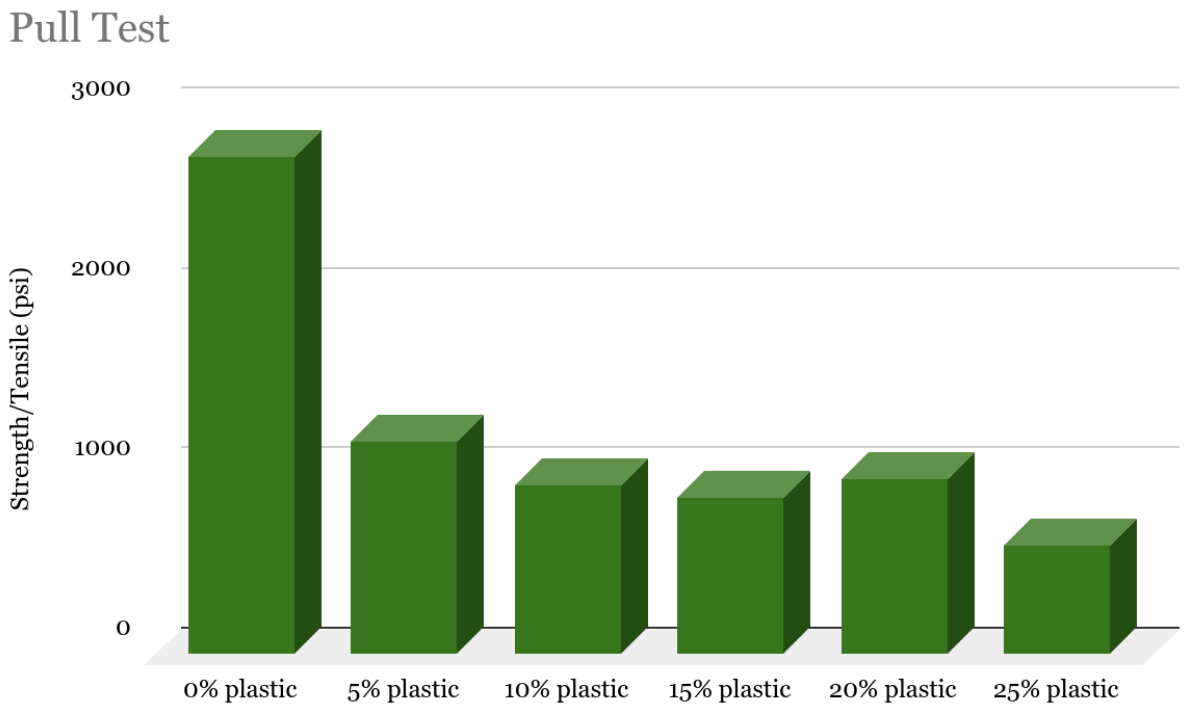
After the paper was done being made, I used a machine to measure the thickness, weight, and moistness. I then calculated each paper's density. Next, I wrote down the data and made sure each paper being tested has the same measurements. If they didn't have very close measurements, I would redo the paper and make it accurate for testing. After this they were ready to test.

To test the paper I ran three tests: Pull Test, Burst Test, and Tear Test. For the Pull Test, a machine was used that pulls the paper two separate ways until it is stretched to the point where it breaks. For this test two measurements are taken in the machine. The Tensile (psi) and Elongation (%). The tensile measurement is taken in psi where the paper is measured on ability to withstand the pressure from being pulled apart. The elongation is the measurement to see what percent the paper can expand before tearing apart. For the Burst Test a rubber ball filled with liquid is slowly filled up with the paper being compressed against it until the ball bursts through the paper. This machine measures in psi. For the final test, the Tear Test (grams force/gf), a machine grabs the top of the paper and an arm is dropped which tears the paper horizontally.

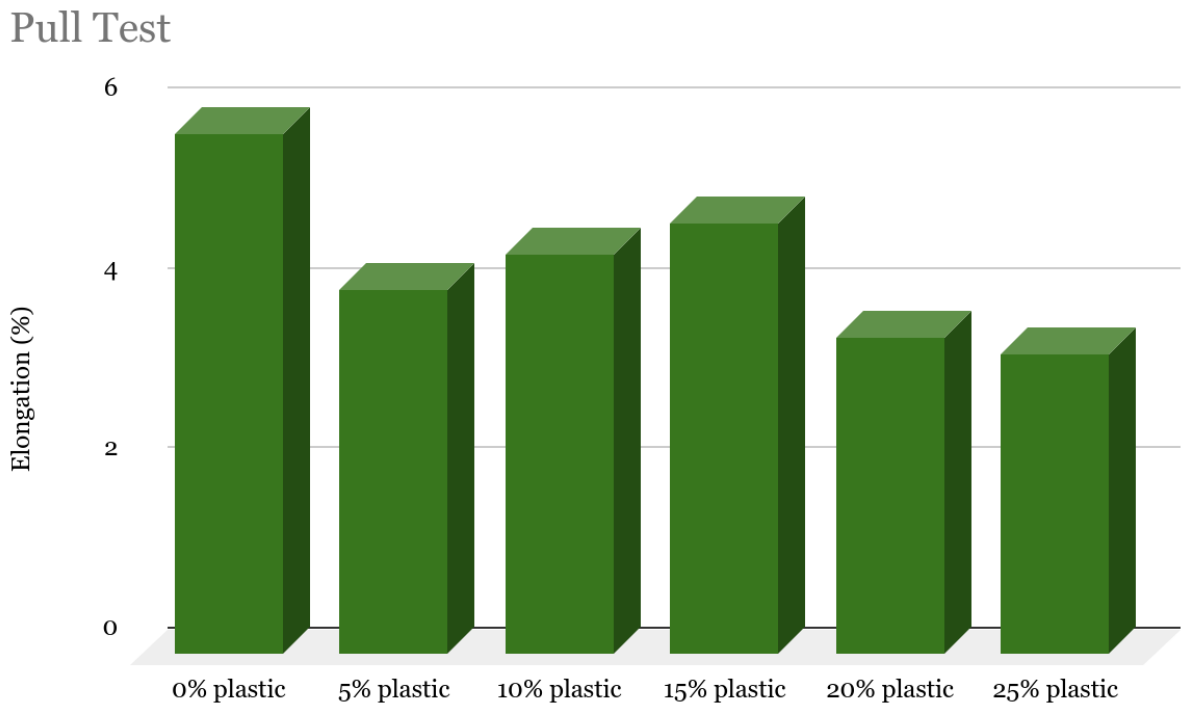
Results



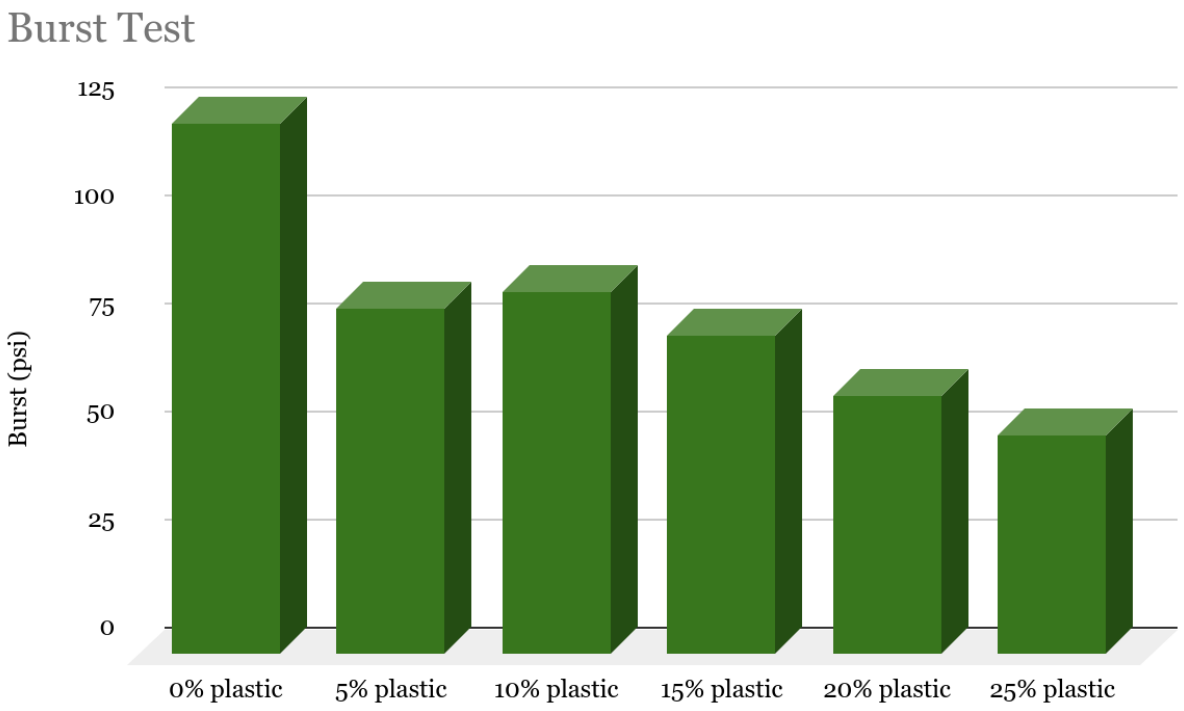
This graph shows the strength (gf) of each paper during the Tear Test. In this test the control paper did best. As the plastic percent in the papers rose, the papers got weaker until 20% where they began to rise in strength again. In this test 15% plastic paper was the weakest.



This graph shows the tensile measurement for the Pull Test (psi). In this graph the control paper performed the best and as the percentage goes from 0% plastic to 25% plastic the strength weakens gradually. In this test 25% plastic was the weakest and performed the worst.



This graph shows the Elongation (%) from the Pull Test in which the control had the best strength and stretched the farthest without tearing, however the 15% plastic got close to reaching the same results as the control. Once the graph hit 20% it continued to lower back down. The worst paper was 25% plastic.



This graph shows the Burst Test (psi). In this test the control paper did the best, and as plastic percentage rose the paper was easier to burst and was weaker. In this test 25 % plastic was the worst.

Disscussion

My data shows whether or not plastic can be put in paper and helps to determine how much plastic can be used until the paper is no longer useful. Although my data shows normal paper is better, my paper with plastic is still useful and way better for the environment than adding plastic bags to landfills or having them end up in oceans. I accept my claim that states usable paper can be made with plastic and a zero net carbon footprint. Throughout my data I found that the control (0% plastic) was the best paper and had the best results for each test. I found that 25% plastic was the worst and had the worst results in 3 of the 4 test measurements. 5% was the best paper that included plastic and was the closest to beating the control during the tear test where they were only 68.8 psi apart. 5% plastic paper also got close to reaching the control on the pull test (tensile) where 5% was only 1587 psi apart from the control while 25% was 2161 psi away from reaching the control. One of the main reasons I got these results where the control did best everytime was due to the control having a tighter bond with all the hemp fibers unlike in

the plastic paper where the plastic fibers were too big to correctly bind together with the hemp fibers which are way smaller causing a weaker paper.

Limitations

For this experiment there were many limitations. One of the biggest limitations for this project was that I could not melt the plastic so it could better mix with the hemp fibers due to the toxins it could release that could be potentially harmful. Another problem that affected making the paper was how hard it was to get the plastic into small fibers like the hemp, which was a lot smaller than the plastic, making it hard to intermix the two. This caused the hemp and plastic not to form a strong connection making it so the paper became weaker and not as strong as just hemp itself. For the testing stage of this project I did not have many limitations; however, I could not mess up since I had a limited amount of paper.

Future Studies

The next logical step I would take to improve my project would be to find better ways to intertwine the hemp and plastic and make the plastic smaller by getting pre grinded plastics or using dry ice to freeze the plastic and make it brittle so I could grind it into small grains. These would both improve the strength, look, and abilities of plastic paper and possibly allow it to be just as good if not better than normal paper.

Literature cited

Vasarhelyi, Kayla. “The Climate Impact of Single Use Plastics.” *Environmental Center*, 25 Feb. 2021, www.colorado.edu/ecenter/2021/02/25/climate-impact-single-use-plastics.

“Would Stopping Plastic Pollution Help with Climate Change? How Do We Do It?” *MIT Climate Portal*, climate.mit.edu/ask-mit/would-stopping-plastic-pollution-help-climate-change-how-do-we-do-it. Accessed 24 Oct. 2022.

Jacobsen, Sharon. *Plastic Bag Pollution*. 2008.

UN Environment Programme. “Plastic Bag Bans Can Help Reduce Toxic Fumes.” *UN Environment*, 2 May 2019, www.unep.org/news-and-stories/story/plastic-bag-bans-can-help-reduce-toxic-fumes.

“Oceana Shows the Impact Plastic Waste Is Having on Animals.” *WUSF Public Media*, 30 Nov. 2020, wusfnews.wusf.usf.edu/environment/2020-11-30/oceana-shows-the-impact-plastic-waste-is-having-on-animals.

Melillo, Jerry. “Forests and Climate Change.” *MIT Climate Portal*, 7 Oct. 2021, climate.mit.edu/explainers/forests-and-climate-change.