Improving Durability in Technical Suit Technology

By Gregory Romanovsky

Table of Contents:

Acknowledgements:

I would like to acknowledge Ms. Posnock for spending countless amounts of hours in the lab helping with students and supporting me throughout the entire process.

Problem/Need:

Technical suits are made from hydrophilic materials, which means that the suit will absorb water, which means that there will be resistance from the water. This affects the swim because the material that is used to make the suit will not have as much water resistance as a material that is hydrophobic. This is because the water has resistance that creates a force that is exerted on the swimmer, which causes him/her to swim slower than if they were swimming higher on the water. We want to create a suit that is made from a material that is able to resist water.

Background:

Since 2008, swimming technical suits have been used in competitive swimming (Morrison, J., 2012). Ideal materials must have low drag coefficient so the swimmer can slice through water. Also, the materials of the suit must create certain levels of buoyancy so that the wearer will swim higher on the water and therefore swim faster due to less drag. Finally, the suit compresses the body into a conical shape, so that the swimmer will be able to travel farther in the water. Currently, nylon is used in tech suits, but it is not very durable, and many more effective materials, like Teflon, exist. Teflon properties include hydrophobicity, heat resistance, and low drag coefficients. Teflon lasts longer than any of the materials that are currently used to make tech suits. These properties allow the suit to have all the needed properties that are common for all tech suits.This idea was created when many people wanted to have a suit that would last for the much longer period of time. However, Speedo, TYR, and Arena make suits out of hydrophilic material ("Swimoutlet," para.8).

The suit needs to made out of a hydrophobic or hydrophilic material. This is essential because the suit repels water and also allow the swimmer's hips to be higher on the water (Hagedorn, 2013). The difference between hydrophobic and hydrophilic materials is that hydrophilic materials are able to absorb some water and hydrophobic materials are able to completely repel the water (Chandler, 2013). One of the properties that most technical suits have are that they are made out of hydrophilic material, which means that they will absorb water, which in turn does not allow the swimmer to swim completely at the top of the water. One way to change this is to make the suit out of a material that is hydrophobic. This would make the suit not absorb water, which means that the swimmer would not much resistance from the water.

Most of the leading brands that create tech suits for swimming use materials like nylon(polyamide), spandex, and elastane. The problem with these materials is that they are mainly hydrophilic, which means that they have the possibility to absorb water (Chandler, 2013). One of the ways that this absorptive quality can be changed is by replacing the hydrophilic material with hydrophobic materials because hydrophobic materials do not absorb any water. Another problem is that the materials wear out very quickly in pool due to the chlorine in the water ("Swimoutlet," para.8). A way that this can be improved is with the quality of the materials that are used to make the suits.

Most of the tech suits that are currently being used by everyone usually cost from a range of $100-$400 ("Swimoutlet," n.d). This cost is a problem because it usually makes many potential customers not buy any of the suits due to the cost. Also, the suit usually lasts for about

20 - 30 swims for that amount of money (“Swimoutlet,” n.d), so a way to improve this is to improve the materials that used to create the suit itself. One material is Teflon, and it has not been used in the textile industry before (Apparel Search, n.d.). This material is completely hydrophobic, which means that it will repel water. Also, it has a very low drag coefficient, which is 0.04 (“The Engineering ToolBox, n.d), so that means it will not create much drag in the water. But if the suit is not approved by FINA, it cannot be used in any national level meets.

A very important factor for tech suits is that they meet the FINA standards, so that they can be used in any meet (FINA, n.d.). This is an important factor because this little patch on the back of the tech suit is used to show that the suit has been approved by the FINA council, but if not then it can not be used at any state level meets or any meets in general (FINA, n.d.) These rules ensure that if a company wants to file an application for a tech suit so that it can be used in meets, they first have to make sure that the no person reacts to the materials that are used in the suit itself, then they need to fill out an application form for the product. All in all, this adds to cost a fee around $1900. If anyone would want to create a tech suit that can be used in any type of swim meet, they would have to file an application and pay the fee, but if FINA would say that it does not meet the requirements, then that person would have resubmit the application and pay that fine once again. The purpose for a FINA approval is so the suit is could be used in any type of swim meet.

Another important part is that the suit compresses the body into a more streamline shape. This is important because the streamline shape allows the swimmer to swim faster because the body of the swimmer resembles the body of a dolphin and they use the shape of the their body to swim faster (Fox, 2006). This compression eliminates any air pockets, which keeps out water, so that the water will not add any additional weight, and that helps improve swimming coordination (HP Nieva et al, 2011). These two aspects help the swimmer swim faster since the swimmer's body is shaped more like a tube, so that means since they have a smaller cross sectional area, and that would contribute a lower drag force (Allain, 2016).

The purpose of this project is to attempt to create a technical swimsuit that is more efficient at not absorbing water then other tech suits that are currently in the market. While other suits absorb water, Fastskin3 repels it (EuroSport, 2016). The reason for starting this project was because many swimmers have complained that various types of suits are not able to completely repel water. This project was started because we have noticed that most of the materials and the processes that are used to create tech suits should have the price tag that they currently do because prices for large seats of nylon go as little as $8.99, and the processes are just sewing together different materials. This suit, which has new materials that are essentially the same price as the materials that used to make most tech suits in the current market, but one fabric has more probability of not absorbing water, which is teflon.

As a high school swimmer who is expected to get amazing times, all of the hard work and commitment is defined by a large sum of money, but it should be defined by the dedication and

hard work put in by an athlete for any sport. This suit would make hard work and commitment matter more because it would expand more on the wearer's strengths, unlike the current top-of-the-line tech suits that help put the body into a more tubular shape, and that would help on a swimmer's weaknesses while the suit is on, but afterwards, they would make the same mistake as they normally would, but this suit would not change the shape of the body much, and that would teach the swimmer that they need to improve on that specific aspect.

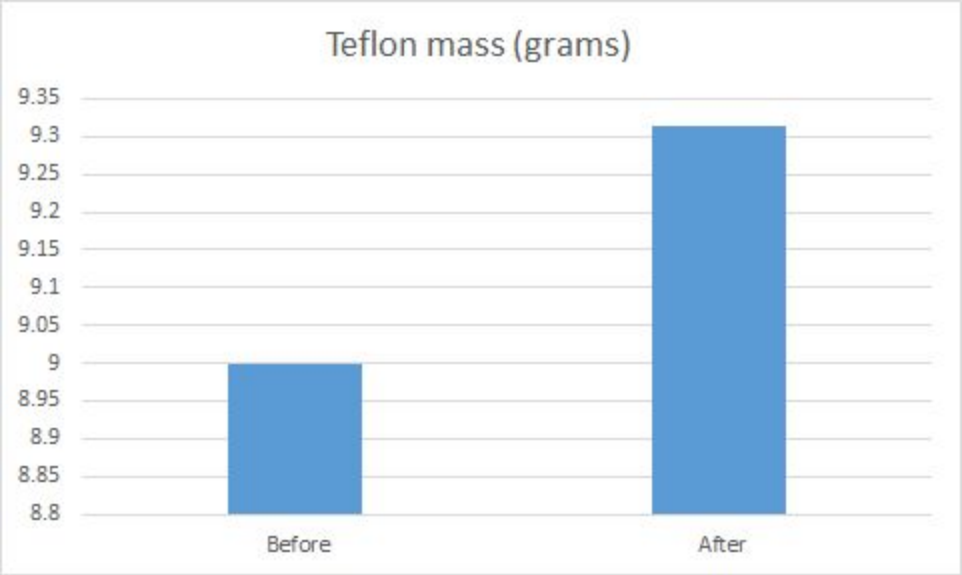
Design/Redesign:

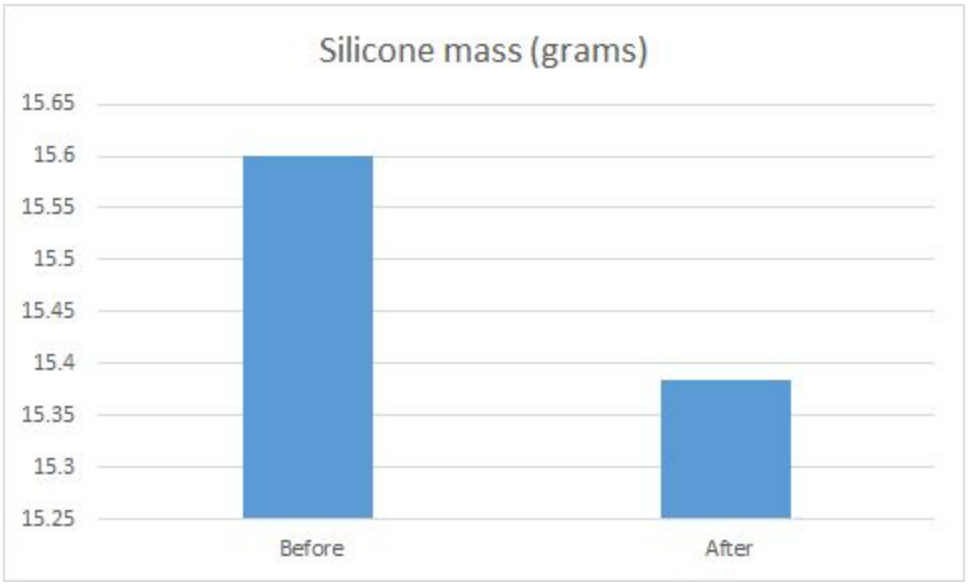
Originally, we proposed to create a technical suit out of teflon. First, we tested the change of mass between Teflon and nylon. This was done so that we could compare the water resistance between these two materials. The results showed that the nylon had more water resistance. After the suit was made, a redesign was proposed to make the suit more comfortable. The material that used for this was silicone. Next, we then measured the change of mass in the silicone. This was done because the current commercial suits use a mixture of nylon and silicone in their suits. After we finished testing the amount of water resistance of the silicone, we then sewed the silicone on the inside of the suit, so that when the swimmer has the suit on, he/she will be more comfortable.

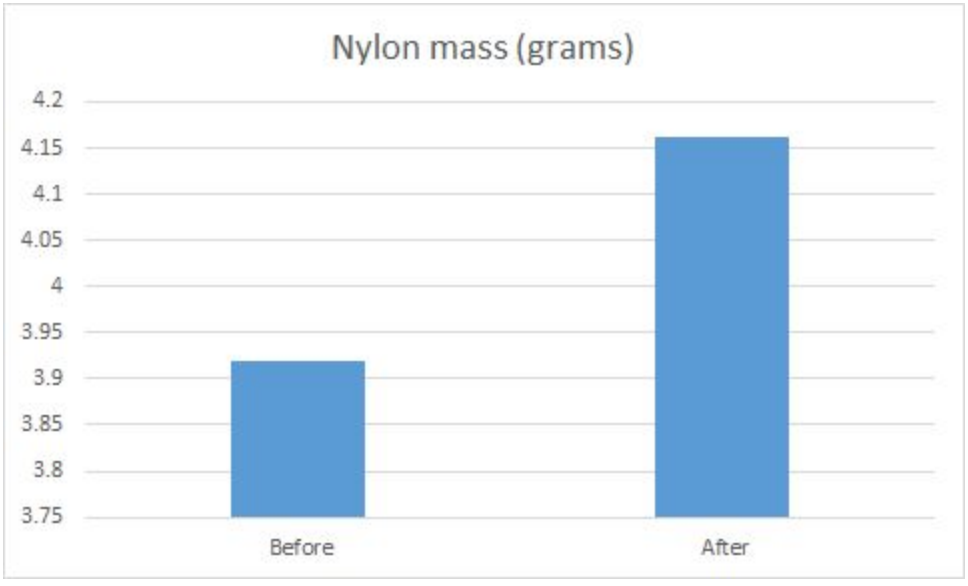
Data/Results:

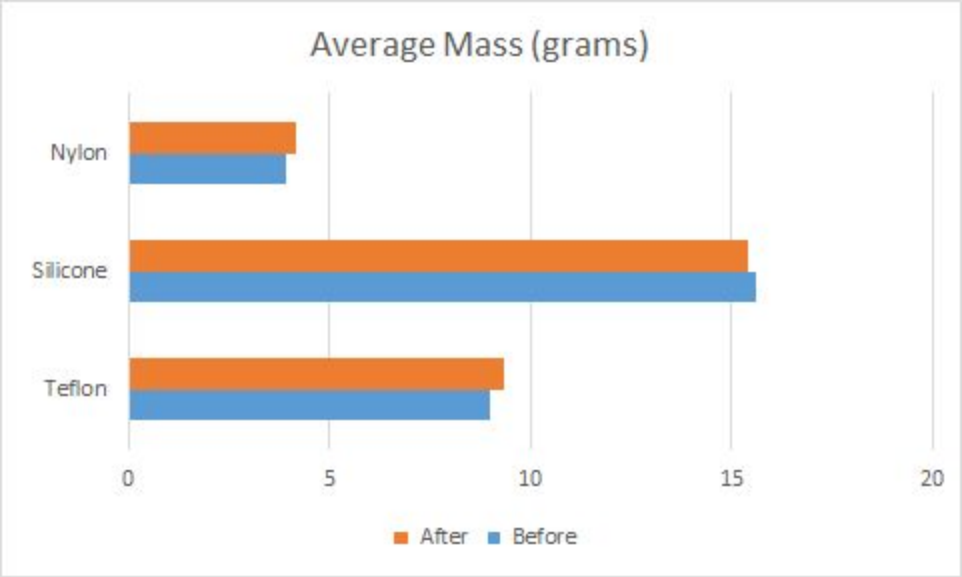
	Mass (g)	Mass (g)	Mass (g)
Materials	**Teflon**	**Silicone**	**Nylon**
Test 1(initial mass)	**9.00**	**15.60**	**3.92**
Test 2	**9.24**	**16.20**	**4.10**
Test 3	**9.40**	**15.31**	**4.45**
Test 4	**9.21**	**14.92**	**4.27**
Test 5	**9.62**	**14.35**	**3.62**
Test 6	**8.99**	**15.57**	**4.63**

Test 7	**9.18**	**14.69**	**4.17**
Test 8	**9.25**	**15.60**	**4.09**
Test 9	**9.23**	**15.39**	**4.31**
Test 10	**10.02**	**16.22**	**4.06**
Average	**9.31**	**15.39**	**4.16**




Silicone mass (grams)
15.65
15.6
15.55
15.5
15.45
15.4
15.35
15.3
15.25
Before
After


Nylon mass (grams)
4.2
4.15
4.1
4.05
4
3.95
3.9
3.85
3.8
3.75
Before
After



Analysis:

After measuring the initial mass of Teflon, nylon, and silicone, Teflon absorbed the least amount of water. The initial mass of a 30.48 cm x 30.48 cm sheet of Teflon was 9.00 grams. After submerging the sheet of Teflon in a bucket of water for 5 minutes, it was put in a Thermo Scientific MaxQ 4450 at 50 rpm for 10 minutes to simulate the time taken to swim a 500 meter freestyle and wait for the next event to begin. After 10 trials were completed, the average was taken of the mass, which was 9.314 grams after being submerged in water and then shaken, which is shown in Figure 1. The percent absorbance for this was 3.44%. The same dimensions were used for the silicone. The initial mass of this sheet was 15.20 grams. This was subjected to

the same tests as the Teflon, and the average mass, which was 15.385 grams after the tests is shown in Figure 2. The percent absorbance was -1.35%. The initial mass of this material was 3.92 grams. The tests that were performed on Teflon and silicone were repeated on this material, and the average mass was 4.162 grams after the tests is shown in Figure 3. Every trial result is shown in Figure 4. The percent absorbance was 6.12%.

The similarities and differences between the three materials was that the nylon was taken from a TYR swimsuit that is used by many competitive swimmers. This was the control for this experiment. The Teflon and the nylon were both able to repel all of the water from the testing sheets, but silicone absorbed most if not all the water that it came in contact with. The Teflon, when compared to the control suit fabric was more effective at repel. The nylon fabric when compared to the suit fabric was the same. The results from the tests showed that the silicone in most of the commercially made swimsuits is used for comfort and not to resist water.

Conclusion:

The purpose for my project was to create a more effective design for a technical swimsuit. We first used a tech suit that is made by TYR, and compared it to two different materials. Those materials were Teflon and silicone. We were testing the amount of water that was absorbed and the compression of the different materials. The materials were submerged in water for 5 minutes then they were put in the MaxQ 4450 for 10 minutes at 50 rpm, and then the mass of the different materials were taken to see how much water was absorbed. We believed that the Teflon would absorb the least amount of water and have about the same amount of compression that the suit had, but according to the data that was collected, the TYR suit had the most water resistance. With our data, it was found that the commercially made suit was . Also,

for a redesign, it was proposed that we would combine the silicone on the inside of the suit for the wearer to have more comfort when wearing the suit.

Works Cited

Allain, R. (2016, August 09). Wanna Swim Like Phelps? Take a Dive Into the Physics of Drag. Retrieved December 14, 2016, from https://www.wired.com/2016/08/wanna-swim-like-ledecky-take-dive-physics-drag/

Chandler, MIT News Office, D. L. (2013, July 16). Explained: Hydrophobic and hydrophilic. Retrieved November 10, 2016, from http://news.mit.edu/2013/hydrophobic-and-hydrophilic-explained-0716

(n.d.). Retrieved January 19, 2017, from http://www.engineeringtoolbox.com/friction-coefficients-d_778.html

E. (2012, July 17). New hi-tech suits beckon. Retrieved February 16, 2017, from http://www.eurosport.com/swimming/new-hi-tech-suits-beckon_sto3351000/story.shtml

Fox, Karen. "January/February 2017." *Discover Magazine*. N.p., 20 Feb. 2006. Web. 13 Dec. 2016.

FINA REQUIREMENTS FOR SWIMWEAR APPROVAL (FRSA). (n.d.). Retrieved November 17, 2016, from https://www.fina.org/sites/default/files/frsa.pdf

Hagedorn, Evan. "Physics of Swimming: Conditions that Affect the Passive Drag on a Swimmer in Streamline Position." N.p., 9 May 2013. Web. 1 Mar. 2017.

Morrison, J. (2012, July 27). How Speedo Created a Record-Breaking Swimsuit. Retrieved December 13, 2016, from https://www.scientificamerican.com/article/how-speedo-created-swimsuit/

Neiva, H. P., Vilas-Boas, J. P., Barbosa, T. M., Silva, A. J., & Marinho, D. A. (2011). 13th FINA World Championships: Analysis of swimsuits used by elite male swimmers.

(Swimoutlet, n.d.). Retrieved November 09, 2016, from https://www.swimoutlet.com/p/tyr-avictor-prelude-male-high-short-jammer-tech-suit-swimsuit-8124540/?color=11046

(Swimoutlet, n.d.). Technical Suit Guide - Speedo Fastskin, FSII, Aquashift and more at SwimOutlet.com. Retrieved November 10, 2016, from https://www.swimoutlet.com/technical-suit-basics

Teflon Definition for the Clothing and Textile Industry. (n.d.). Retrieved December 14, 2016, from http://www.apparelsearch.com/definitions/fiber/teflon_definition.htm

Toussaint, H. M., Truijens, M., Elzinga, M. J., de Ven, A. V., de best, H., Snabel, B., & de Groot, G. (2002). Swimming: Effect of a fast-skin™'body'suit on drag during front crawl swimming. *Sports Biomechanics*, *1*(1), 1-10.