Bandage Comparison Lab – Instructor's Version

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Date of Experiment:

OBJECTIVES

- Students will compare three different types of bandages based on absorption, adhesion, and tensile strength properties
- Students will gain experience using equipment for material science testing

INTRODUCTION

A bandage is defined as a strip of fabric used especially to cover, dress, and bind up wounds. In ancient times, bandages were mainly made out of plant materials, which were sometimes combined with animal hides. Like bandages today, bandages were used in ancient times as a first aid material to bind and dress wounds. One of the first documented applications of bandaging was used by ancient Egyptians.[1]

Today, the most common type of bandage used is known as an adhesive bandage. An adhesive bandage is a small bandage used for non-serious injuries. What separates an adhesive bandage from a normal bandage, as indicated by its name, is that one side is coated with an adhesive material. This allows for the bandage to stick to the skin much better than using gauze bandages. These bandages also have a non-adhesive absorbent pad attached to the adhesive side, which helps absorb fluid that might be excreted from the wound. In some cases, this pad will be medicated with some sort of antiseptic solution.

One of the most common brands of this kind of bandage is the Band-Aid® brand. In 2001, Band-Aid® marked the production of its 100 billionth bandage.[2] However; there are still many other brands that compete against this company, including several generic brands. In this lab, the teams will be comparing two generic brands of bandages to a Band-Aid® brand bandage. They will be conducting this comparison based on three characteristics; adhesion, tensile strength, and absorbency.

MATERIALS NEEDED

- Band-Aid® brand bandage
- Generic brand bandage #1
- Generic brand bandage #2

- Porcine Skin cut into a 21 x 68 mm strip (prepared by instructor)
- Force Test System
- Force Gauge (capable of reading up to roughly 10 N)
- Flash drive (for data)
- Scissors
- Length-measuring device (ruler, caliper, etc.)
- Tweezers
- Bench Scale (accurate up to 1/1,000 g)
- Weighing Paper
- 100 mL beaker filled with DI water
- Viscous Solution (42% glycerol by volume)

SAFETY CONSIDERATIONS

Laboratory goggles should be worn at all times in the lab. Gloves should also be worn when handling porcine skin and the bandages, as oil from hands can interfere with experimentation. Be careful when carrying and using scissors.

INSTRUCTOR'S NOTES

For this lab, it might be a good idea to have a laboratory technician that has experience with your force test system available to assist you. This lab contains many parts, and some of them can be quite time consuming when it comes to setup and data collection. Depending on the size of the class, it might be a good idea to split the groups up so that data can be collected in a timely and efficient manner. If your class contains several groups, it might be necessary to schedule times outside of regularly scheduled class for data collection. Additionally, the viscous solution should be made before absorption testing begins. Each group will only need roughly 100 mL of this viscous solution for testing.

PROCEDURE

PART 1 – Preparation for Data Collection

1. Obtain 12 types of bandages for each of the brands, so that you have a total of 36 bandages.
2. For each type of bandage, cut ten bandages so that the only piece left is the absorbent pad.
3. For the other two bandages, cut into rectangular pieces. They don't have to be all the same dimensions, but make sure that there is an equal amount of adhesive material on either side of the absorbent pad for each bandage.

4. After cutting, record the length and width of each bandage.
5. The following parts require that using these cut bandages as so: Part 2 – Adsorption Testing requires the bandages cut in step 2 of this procedure; Part 3 – Adhesion Testing requires the bandages cut in step 3 of this process; Part 4 – Tensile Testing also requires the bandages prepared in step 3, so label each of bandages cut in step 3 what test they will be used for, along with the measurements that you took in step 4.

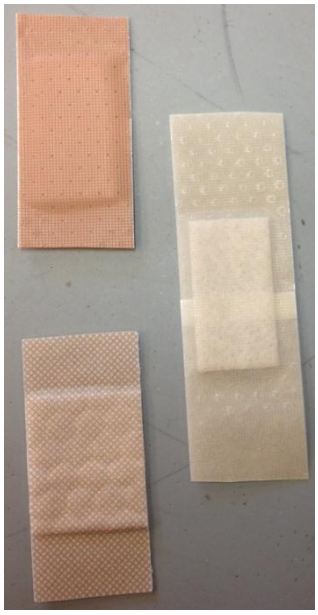

Figure 1. The proper shape of the adhesion bandages after preparation for the adhesion testing and tensile testing procedures of this experiment.

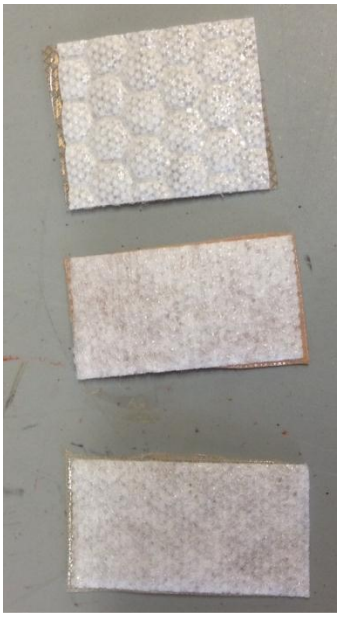

Figure 2. The proper shape of the adhesion bandages after preparation for the absorption procedure of this experiment.

NOTE: The Parts following Part 1 do not have to be completed in the exact order listed. Your professor or instructor will give you more details about the process for obtaining all the data needed for this lab.

PART 2 – Absorption Testing

For this part of experimentation, you will need the weighing paper, bench scale, beaker of water, the beaker of viscous fluid, and tweezers.

1. Measure the length and width of the absorbent pad.
2. Make sure your bench scale is turned on. Place the weighing paper on the bench scale, and tare the instrument. Do not remove the weighing paper from the bench scale.
3. Using the tweezers, place the absorbent pad on top of the weighing paper. Measure the initial mass of the absorbent pad.

4. Now, using the tweezers, place the absorbent pad in the beaker full of water. Let the bandage soak in the water for 1 minute.
5. After the minute is up, use the tweezers to pick up the absorbent pad. Lightly tap the tweezers on the side of the beaker to remove as much excess water as possible.
6. Place the bandage back on the bench scale and take a final mass reading.
7. Repeat steps 3 to 6 so that you have 5 data points for each bandage.
8. Now, repeat steps 3 to 6 but instead of using water, use the viscous fluid. This viscous fluid is roughly the viscosity of human blood. You will use up the other five bandages of each brand.

PART 3 – Adhesion Testing

For this part of experimentation, you will need to use the force test system. A professor or instructor will walk you through the following procedure.

1. Fasten the porcine skin to the force test system.
2. Adhere the selected bandage to the porcine skin so one piece of adhesive side is connected to the porcine skin, while the other is attached to the force test system. The setup should look similar to the figures below:

Figure 3. Side view of the proper setup for adhesion testing.

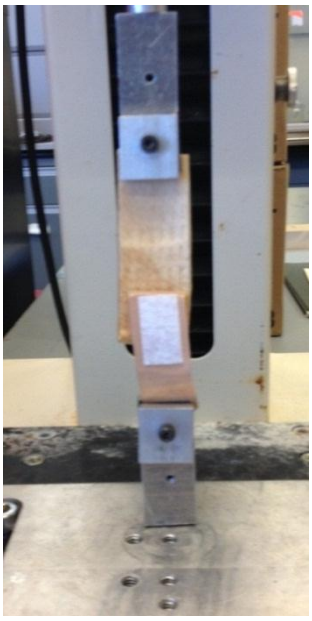

Figure 4. Forward view of the proper setup for adhesion testing.

3. Tare the instrument by setting the home point, then set the system so it will move upward at a rate of 20 mm/min.

4. Now, make sure that the machine is going to collect your data. You may also want to have the instrument give you a graph of the data being collected if possible.
5. Once the force test system is set up, start data collection. Data collection should end once the bandage is <u>completely</u> unattached from the porcine skin. Make sure that you save your data on a flash drive.
6. Repeat this process for the other two bandages. Give your data files specific names so you know which file corresponds to which brand.

PART 4 – Tensile Strength Testing

1. Set up the force test system so that you can take tensile test measurements.
2. Place the bandage into the force test system. Your setup should look be checked by the instructor before starting testing.
3. Tare the instrument by setting the home point, then set the system so it will move upward at a rate of 20 mm/min.
4. Make sure that the machine is going to collect your data. You may also want to have the instrument give you a graph of the data being collected if possible.
5. Once the force test system is set up, start data collection. Data collection should end once the bandage has <u>completely</u> ripped. Make sure that you save your data on a flash drive.
6. Repeat this process for the other two bandages. Give your data files specific names so you know which file corresponds to which brand.

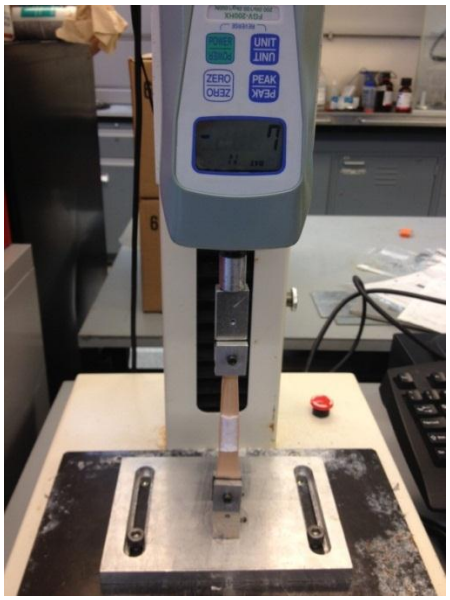

Figure 5. Tensile testing of an adhesive bandage. Make sure that the tensile testing setup is correct before starting data collection.

RESULTS

Make sure that all data files are given to each member of the team. Also, make sure that all results that needed to be written in your lab notebook were recorded.

DATA ANALYSIS

Once you have collected your data, you will need to normalize your data. For Part 2 of this experiment, you will need to know the amount of water that was absorbed by the absorption pad. To do this, you need to know the mass of water absorbed and the density of water. Use the following equation for this calculation:

$$volume\ of\ water\ absorbed\ (mL) = \frac{final\ mass\ (\ g) - initial\ mass\ (g)}{1.0\ \frac{g}{mL}} \tag{1}$$

Use the last calculation given on all the trials of your absorption data. You will also need to know the amount of water absorbed per area of the absorption pad. For each of the bandages, use the following equation:

$$Absorption\ of\ bandage = \frac{volume\ of\ water\ absorbed\ (mL)}{area\ of\ absorption\ pad\ (in^2)} \tag{2}$$

For Part 3 of this experiment, you need to normalize the length of the bandage that was peeled off. To do this, you must divide each length measurement in the set of data by the total length of bandage that was peeled off the porcine skin. To do this, use the following for each point:

$$Normalized\ length = \frac{length\ peeled\ at\ current\ data\ point\ (mm)}{length\ peeled\ at\ final\ data\ point\ (mm)} \tag{3}$$

For Part 4 of this experiment, you need to normalize both the force readings and the length measurements. For force readings to be normalized, these force measurements are used to calculate stress readings. A stress reading is the force exerted on the system divided by the area, shown below:

$$Stress = \frac{force\ exerted\ at\ the\ data\ point\ (N)}{area\ of\ the\ bandage\ initially\ (cm^2)} \tag{4}$$

For length measurements to be normalized, the length readings are used to calculate strain readings. A strain reading is the difference in length (the initial length subtracted from the new length) divided by the initial length. The equation is shown below:

$$Strain = \frac{length\ pulled\ at\ current\ data\ point\ (cm)}{initial\ length\ of\ the\ bandage\ (cm)} \tag{5}$$

Make sure that this is done for each data point for each bandage used in this section of the procedure.

QUESTIONS

1. Compare the absorbance of each bandage brand. Be sure to state which bandage brand had the maximum absorption rate and which had the minimum. Please provide the averages of the following measurements made: area, initial weight, final weight, water absorbed, and absorption rate.
2. With the adhesion testing data you collected, create graphs of Normalized Length versus Force (N) for each of the brands (this means that Normalized Length will be on the x-axis and Force will be on the y-axis). Can you see any trends in the data (i.e. a certain length where the force reaches a maximum, general shape of the data, etc.)? Be sure to submit the graphs along with your answer.
3. With the tensile testing data you collected, create graphs of Strain versus Stress (N/cm^2). Can you see any trends in the data? Be sure to submit the graphs along with your answer.
4. Of the three brands that you conducted experiments on today, which brand do you think is best to use? Use the graphs you just made along with your absorption comparison to justify your answer.
5. Based on your results, do you think that the viscosity of the solution affected the absorption rate of the bandages? Why or why not?
6. Do you think there were sources of error for this experiment? If so, state the specific source of error, and which part of the procedure you would find this error. If not, why is there a lack of error for this experiment?
7. What is one thing you could do that would improve the accuracy of this experiment?

ANSWER KEY

1. Compare the absorbance of each bandage brand. **Ans:** Firstly, the three bandage brands used for this experiment were CVS® brand bandages made of

sheer, CVS® brand bandages made from plastic, and Band-Aid® brand bandages. After conducting the absorption experiment, the following table was created*:

*- For full set of data points, see Appendix A

Table 1. Data obtained from absorption experimentation.

Water Runs			
Brand	CVS® - sheer	CVS® - plastic	Band-Aid®
Average Area (in^2)	0.434	0.443	0.585
Average Initial Weight (g)	0.083	0.081	0.103
Average Final Weight (g)	0.320	0.305	0.292
Average Water Absorbed (mL)	0.237	0.223	0.189
Average Absorption (mL/in^2)	0.601	0.541	0.331
Viscous Fluid Runs			
Brand	CVS® - sheer	CVS® - plastic	Band-Aid®
Average Area (in^2)	0.533	0.510	0.644
Average Initial Weight (g)	0.082	0.079	0.103
Average Final Weight (g)	0.334	0.324	0.293
Average Water Absorbed (mL)	0.252	0.245	0.189
Average Absorption (mL/in^2)	0.474	0.481	0.294

From this data, the bandage with the maximum absorption rate was concluded to be the CVS® sheer brand for the water runs and the CVS® plastic brand for the viscous fluid runs. For both runs, the Band-Aid® brand had the least average absorption. From this, it can be concluded that the Band-Aid® brand has the absorbent pad with the least ability to absorb fluids.

2. With the adhesion testing data you collected, create graphs of Normalized Length versus Force (N) for each of the brands (this means that Normalized Length will be on the x-axis and Force will be on the y-axis). Can you see any trends in the data (i.e. a certain length where the force reaches a maximum,

general shape of the data, etc.)? **Ans:** After normalizing the data, the following graphs were made[#]:

- An excel file of data can be given upon request

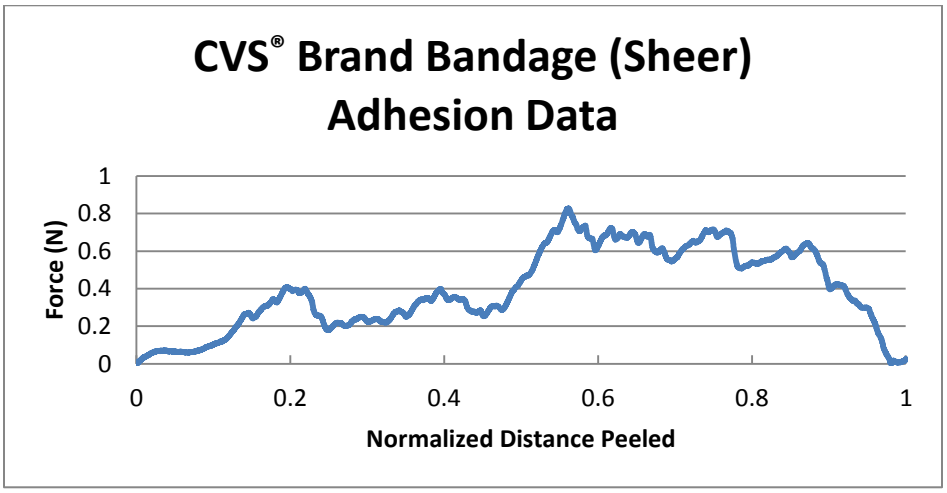

Figure 6. Graph of the adhesion properties of the CVS® brand sheer bandage.

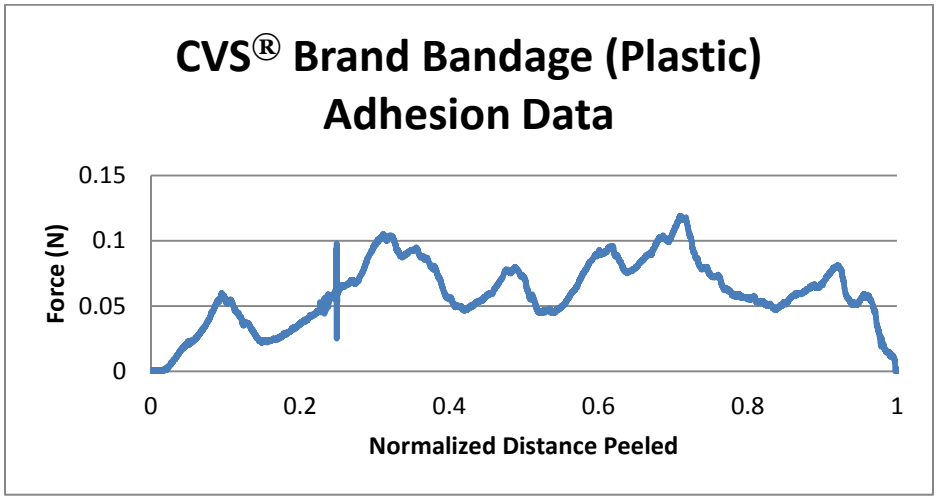

Figure 7. Graph of the adhesion properties of the CVS® brand plastic bandage.

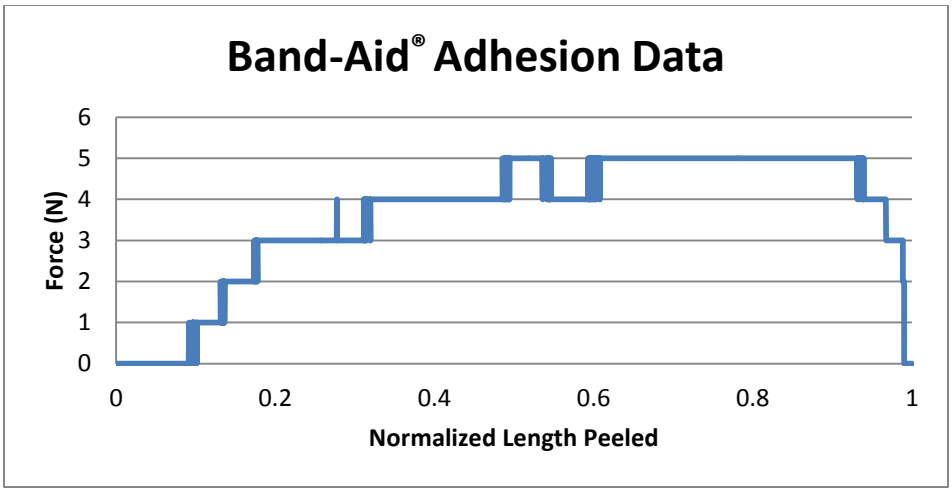

Figure 8. Graph of the adhesion properties of the Band-Aid® brand bandage.

From these graphs, we can see a general trend in the adhesion data. From the start of experimentation, the force required to peel the bandage increases until it reaches a maximum around a normalized peel length of 0.5 to 0.6. Once it reaches this maximum, the force required will slowly decrease until a normalized peel length of roughly 0.9, where it will drastically decrease until the bandage is completely removed from the skin.

3. With the tensile testing data you collected, create graphs of Strain versus Stress (N/cm^2). Can you see any trends in the data? **Ans:** After normalizing the data, the following graphs were created[#]:

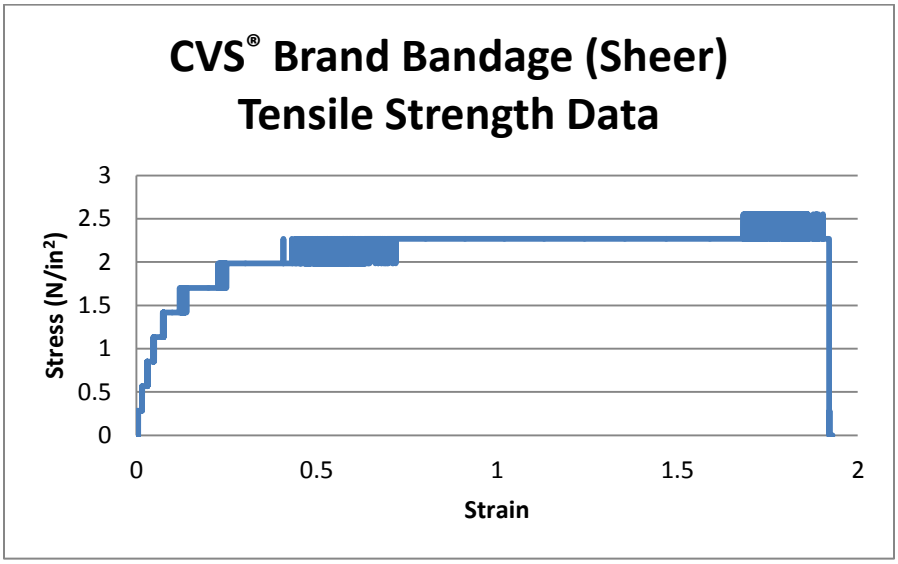

Figure 9. Graph of the tensile strength data for the CVS® brand sheer bandage.

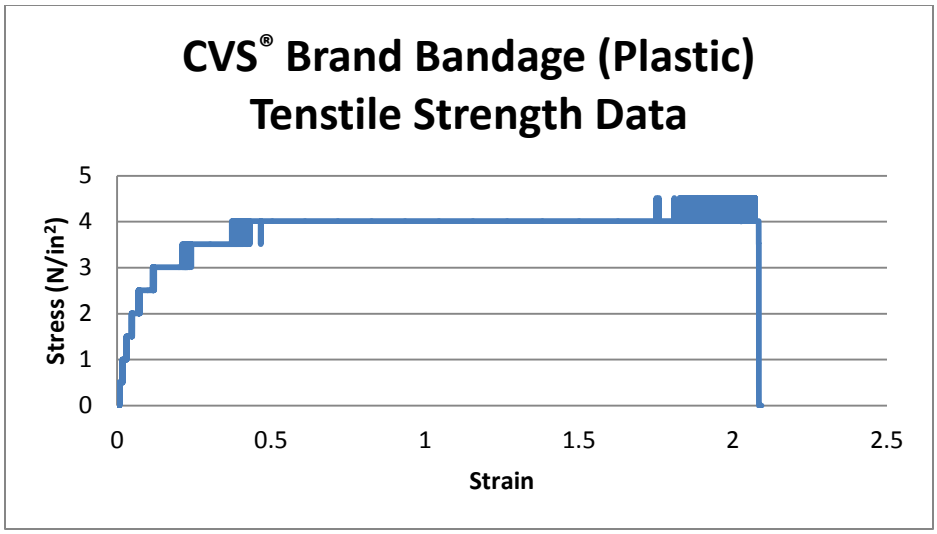

Figure 10. Graph of the tensile strength data for the CVS® brand plastic bandage.

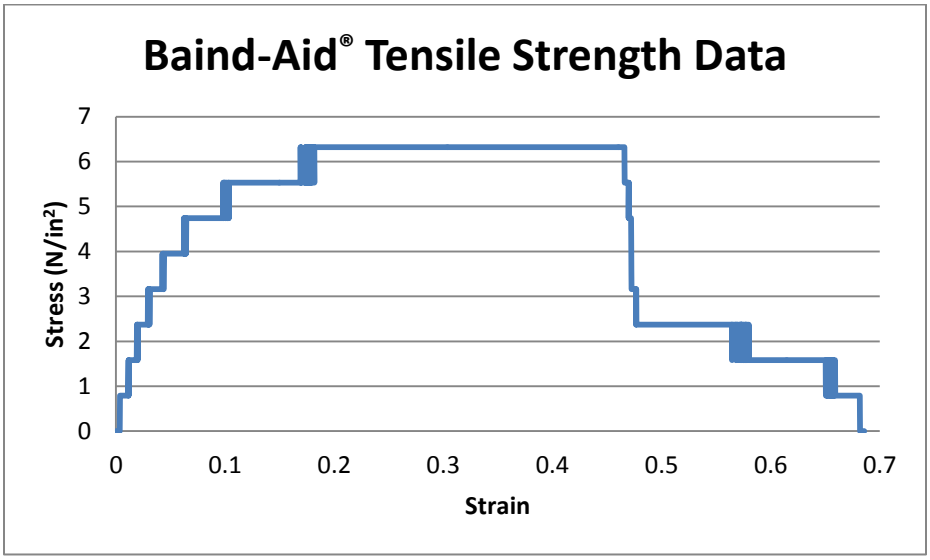

Figure 11. Graph of the tensile strength data for the Band-Aid® brand bandage.

From these graphs, we can once again see a trend in tensile strength data. Once experimentation began, the stress showed a sharp increase until it reached a maximum. It then stayed at this maximum for a relatively long period of time, and then showed a sharp decline. The Band-Aid® brand bandage had a shorter period of staying at a maximum, and also had a longer period of decline.

4. Of the three brands that you conducted experiments on today, which brand do you think is best to use? **Ans:** This answer may change depending on the student and also on the brands of bandages used. According to the data collected and the graphs made, it would appear that the Band-Aid® brand

bandage is the best to use. This is based on the adhesion test and tensile strength test results. From the graphs made, it appears that the Band-Aid® bandage could withstand the highest force during adhesion testing and also had the highest stress withstood during tensile testing. Even though it did not have the best strain and absorption results, these are considered less important than adhesion and stress by the experimenters.

5. Based on your results, do you think that the viscosity of the solution affected the absorption rate of the bandages? Why or why not? **Ans:** According to the data collected during the absorption section of this procedure, it would appear that the viscosity of the solution affected the absorption rate of the bandages. From the data, it shows that the absorption rate decreased as the viscosity increased. This could be because there are molecules in the viscous solution that are larger than water molecules. So, when the absorbent cloth absorbs these larger molecules, they take up more space, which means that the cloth will hold less of these molecules when compared to water molecules.
6. Do you think there were sources of error for this experiment? If so, state the specific source of error, and which part of the procedure you would find this error. If not, why is there a lack of error for this experiment? **Ans:** There will always be some error involved in experimentation. In this case, there are several possible sources of error. For example, in absorption testing, how violently the experimenter tapped the absorbent cloth before weighing can affect the measurements. If the cloth is not tapped hard enough, water droplets can stay on the cloth, even if they were not absorbed. Additionally, if the cloth is squeezed too harshly with the tweezers, it can cause some of the liquid to escape from the bandage. In adhesion testing and tensile testing, if the setup is not correct upon the beginning of experimentation (porcine skin dried before attachment to force test system and bandage, bandage properly connected to force test system and porcine skin, etc.), then this will introduce error into the procedure.
7. What is one thing you could do that would improve the accuracy of this experiment? **Ans:** This answer will vary. One thing that would improve the accuracy of testing done during experimentation is using a more accurate force gauge. Unfortunately, the setup that was available for adhesion and tensile testing only came with two force gauges; one would read from 0.1 to 1.0 N, and the other would read from 2 to 1000 N. It would be best if a force gauge that could read from 0.1 to 10.0 N was used, since it would give more accurate adhesion and tensile testing readings, leading to more accurate data.

REFERENCES

1. Icon Group International. The 2009 Report on First Aid Bandages and Dressings: World Market Segmentation by City. European Institute of Business Administration. 2009.
2. Johnson & Johnson Consumer Companies, Inc. Brand Heritage – A History of Innovation. Updated 24 January, 2012. http://www.band-aid.com/brand-heritage/history-info. 2013.

Appendix A. Raw Absorption Data

Water Runs

CVS® Sheer Adhesive Bandage						
Run	Area	Area (in^2)	Initial Weight (g)	Final Weight (g)	Water absorbed (mL)	Absorption of pad (mL/in^2)
1	0.895x0.33	0.295	0.084	0.316	0.233	0.787
2	0.865x0.32	0.277	0.083	0.330	0.247	0.891
3	1.0x0.535	0.535	0.085	0.299	0.214	0.400
4	0.985x0.53	0.522	0.083	0.323	0.240	0.459
5	1.05x0.515	0.541	0.082	0.334	0.252	0.466

CVS® Plastic Adhesive Bandage						
Run	Area	Area (in^2)	Initial Weight (g)	Final Weight (g)	Water absorbed (mL)	Absorption of pad (mL/in)
1	0.865x0.37	0.320	0.080	0.261	0.181	0.566
2	0.855x0.31	0.265	0.081	0.297	0.217	0.817
3	0.995x0.525	0.522	0.083	0.321	0.237	0.454
4	1.05x0.515	0.541	0.082	0.309	0.228	0.421
5	1.091x0.52	0.567	0.082	0.336	0.255	0.449

BandAid® Adhesive Bandage						
Run	Area	Area (in^2)	Initial Weight (g)	Final Weight (g)	Water absorbed (mL)	Absorption of pad (mL/in)
1	0.77x0.62	0.477	0.099	0.295	0.196	0.411
2	0.795x0.64	0.509	0.108	0.312	0.204	0.401
3	0.745x0.875	0.652	0.102	0.280	0.178	0.273
4	0.745x0.86	0.641	0.105	0.294	0.189	0.296
5	0.745x0.87	0.648	0.103	0.279	0.176	0.272

Viscous Fluid Runs

CVS® Sheer Adhesive Bandage						
Run	Area	Area (in^2)	Initial Weight (g)	Final Weight (g)	Water absorbed (mL)	Absorption of pad (mL/in)
1	0.535x0.99	0.530	0.081	0.374	0.293	0.553
2	0.54x1.0	0.540	0.081	0.327	0.246	0.456
3	1.0x0.545	0.545	0.083	0.305	0.222	0.407
4	0.995x0.525	0.522	0.082	0.318	0.236	0.451
5	0.995x0.53	0.527	0.082	0.347	0.266	0.504

CVS® Plastic Adhesive Bandage						
Run	Area	Area (in2)	Initial Weight (g)	Final Weight (g)	Water absorbed (mL)	Absorption of pad (mL/in)
1	0.990x0.510	0.505	0.077	0.310	0.233	0.461
2	0.990x0.515	0.510	0.076	0.363	0.287	0.563
3	0.985x0.520	0.512	0.083	0.318	0.235	0.458
4	0.975x0.525	0.512	0.081	0.352	0.271	0.529
5	0.995x0.515	0.512	0.076	0.278	0.202	0.394

BandAid® Adhesive Bandage						
Run	Area	Area (in^2)	Initial Weight (g)	Final Weight (g)	Water absorbed (mL)	Absorption of pad (mL/in)
1	0.865x0.725	0.627	0.100	0.302	0.202	0.322
2	0.870x0.730	0.635	0.102	0.291	0.190	0.298
3	0.875x0.745	0.652	0.107	0.312	0.205	0.314
4	0.875x0.745	0.652	0.101	0.276	0.175	0.268
5	0.875x0.745	0.652	0.108	0.283	0.175	0.268