Designing of a Prototype Heat-Sealer to Manufacture Solar Water Sterilization Pouches for Use in Developing Nations

by

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Submitted to the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science

at the

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ABSTRACT

Water purification proves to be a difficult task in many developing nations. The SODIS (SOlar water DISinfection) process is a method which improves the microbiological quality of water making it safer for drinking and cooking using the UV-A rays and heat from the sun. Even simple processes such as this, require components that are not easily attainable in many rural areas—in this case the recommended two-liter bottle. Amy Smith, an instructor in MIT's Edgerton Center, researched and tested the effectiveness of polypropylene collapsible water pouches in the SODIS process. Thus, a heat-sealing device that can be used in developing nations to manufacture collapsible water pouches is needed. This device is intended to allow individuals in developing countries to take advantage of the SODIS water purification process.

The approximately 60 watt prototype of the heat-sealing device is powered by a 12-volt solar deep-cycle battery and is made of simple materials so that it can be used and maintained in a variety of developing nations. A 20 inch nickel chromium strip is used as the heating element and Teflon forms a barrier between the heating element and the material to be sealed. A 4-mil polypropylene sheet is the pouch material of choice. It is placed on top of the Teflon strip, before a lever arm is lowered, the device is turned 'on' and the sheet is sealed via the heated nickel chromium strip.

Although the alpha prototype presented in this thesis has a number of positive attributes, such as using easily accessible or shippable components and making use of available power sources and/or batteries, there are areas for improvement. Making the device more robust, user friendly and versatile and making the seal strength more consistent and accurate are important characteristics that should be considered when designing a beta prototype.

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Title: Instructor, Edgerton Center

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1.0 Overview

In many developing nations, where resources and technology are limited, there is a great need for a simple, low-cost, water purification system. The SODIS process, which is explained in more detail in section 2.1 is a great example of a simple and low-cost method that can be implemented in developing nations across the globe. Unfortunately, to effectively take advantage of the process a unit to contain the water in during the process is needed. It has been discovered that polypropylene makes a great container material and this thesis explores one possible way to manufacture such containers on-site. The polypropylene pouches require an unconventional angle, a specifically timed heat to seal two sheets, and only two sheets, together and the device need to be powered by a source available on-site – this device was able to achieve all these design goals. Having such a resourceful heat-sealer which is compatible with available technology would be an incredibly valuable tool for implementing methods to combat water contamination.

This heat-sealing device, referred to as the alpha prototype, is intended to allow individuals in developing countries to self-sustain a water purification process. Background information on the SODIS water purification process and impulse heat-sealers are provided and the design process is documented by component prior to the evaluation of the entire device and suggestions for the beta-prototype are given.

2.0 Background

2.1 SODIS Method

The Solar Water Disinfection process (SODIS) is a simple technology used to improve the microbiological quality of drinking water.[1] The SODIS process uses two synergetic mechanisms to destroy the pathogenic microorganisms that cause water borne diseases, UV-A rays and an increased water temperature.[1] The UV-A and the increase in water temperature provided by the sun work together to disinfect small quantities of water, typically the amount stored in two-liter bottles. [1] Although two-liter bottles are abundant in the United States, they are not readily obtainable in many developing nations and shipping two-liter bottles from the United States to such nations would be an inconvenience with regards to cost and supply chain management.

If a purification process like SODIS were widely implemented in developing nations, many health benefits could be reaped by its users. There would be a decrease in the number of people who drink and cook with contaminated water and as a result the opportunity to pass along viruses and bacteria, like those causing diarrhea, would be limited.[1] For the SODIS method to be successful in nations with limited access to two-liter bottles, an alternative to the two-liter bottle must be identified. This alternative should incorporate one or more of the following: easy to ship, on-site manufacture, made from accessible raw materials and/or reusable.

Amy Smith, a MIT instructor in the Edgerton Center, had an idea for an alternative to using two-liter bottles in the SODIS process; she suggested using bladder-like water pouches similar to those used in camping hydration systems. In January 2005, Smith and her students evaluated the effects the different sizes and materials of existing collapsible water pouches had on the efficiency of the SODIS process.[2] Tests were performed on-site in a variety of countries and were conducted in real time. Overall, the substitution of these collapsible pouches was successful and was also found to alleviate two concerns found with using two-liter bottles: the pouch materials tested (polymer sheets) are easier to ship and the pouch can be manufactured on site, and certain pouch designs minimize re-contamination via separate filling and dispensing locations. Given a storage container has been identified, a method of manufacturing it must be established.

2.2 Designing the Water Pouch

2.2.1 Design Requirements and Testing

Amy Smith went to Haiti during IAP (January 2005) to examine the performance of different water pouches in the SODIS process and had students in Samoa, Guatemala and Ghana conduct similar studies. Water pouches were obtained from from camping hydration packs and came in different sizes, shapes and materials. There were 3 types of containers tested by Amy in Haiti, the study for which data was available, a 6-Liter polyethylene pouch, a 4-Liter polypropylene pouch and a 2-Liter PET bottle. Each container was filled with 2 Liters of local water and underwent to the SODIS process. Throughout the process, the water purification levels were recorded in order to chart the process' progress. Through Smith's testing it was determined which material and material thickness would offer the best compromise between robustness and UV transparency.

The design of the water pouch tested in January 2005 differs from the pouch that the alpha prototype was designed for. The pouches tested on-site lacked some functionality required of the final pouch design to be used in developing nations. One of these functions is for the pouch to be easily filled without a faucet or narrow pressurized stream of water. Many of the pouches on the market contain an injection molded or plastic extrusion spout, like the Nalgene® Cantene bottle in Figure2.1.

Figure 2.1: Nalgene® Cantene Collapsible Water Pouch[7]

Which makes the pouch easier to fill - but because of the locations where these pouches are planned to be manufactured and used - a design which utilizes only one material is preferred. Another important feature of this pouch is for it to incorporate a separate filling and draining location, or special valves, which would prevent re-contamination of the post-process water.

From Amy Smith's research conducted in January 2005, some additional critical water pouch design parameters were formulated. These parameters influenced the material selection and fill-size of the final water pouch design.

Although the polyethylene pouch performed the best, most likely due to being the least filled and therefore creating the shallowest depth of water for the sun to penetrate, polypropylene was chosen as the final material.[2] There are various thicknesses of polypropylene available, however a thickness of 4-mil polypropylene allows for very successful water purification, unlike thicker types, and comes along with a sturdiness that thinner types cannot provide.

An advantage of using pouches as opposed to two-liter bottles is the increase in surface area provided for the UV-A rays to penetrate. It was found that the shallower the water in the pouch, the more efficient the water purification process; however, the bags should not be too large as they need to be easy to carry and transport, both filled and un-filled. A pouch around 12 inches by 12 inches and no thicker than a two-liter bottle when full, should satisfy both the process efficiency and portability concerns.

2.2.2 Filling the Pouch

One design goal of this pouch was for it to be easy to fill. A design incorporating a reversed funnel used to fill the pouch was considered and is displayed in Figure 2.2.

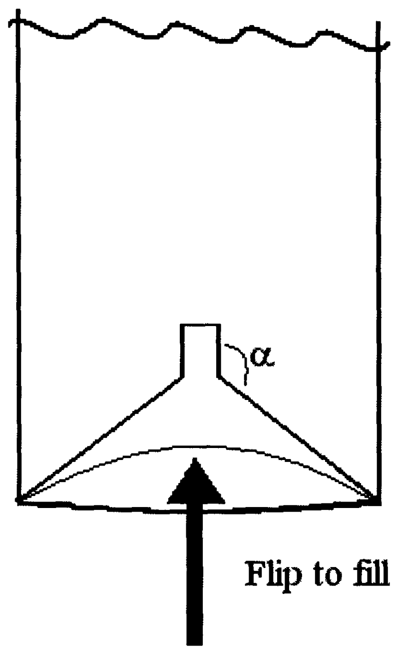

Figure 2.2: Funnel feature of Collapsible Water Pouch

If the funnel is deep it will create a large reservoir to hold the water as the pouch fills, however a funnel too deep will reduce the filled volume of the pouch. In order to identify the right sized funnel for the design a few different funnel sizes were evaluated. Five different bags with different α values and/or orientations were manufactured and filled by hand. Notes were made on ease of filling, the pouches filled diameter and the pouches ability to stand without assistance and were compiled in Table 2.1.

Table 2.1: Funnel Angle Analysis

Angle (in °) & orientation	Ability to fill	Ability to stand
105 – vertical	Difficult. Funnel very narrow and cannot hold much water.	Could not stand alone.
105 - horizontal	Initial filling easier. When about half full bag would lose its balance.	Able to stand. Fill funnel remained for the most part 'inside' the pouch.
120 - vertical	Relatively easy. Took a little while for water to channel through funnel.	Can stand with minor assistance. Funnel protrudes when pouch full.
120 - horizontal	Relatively easy.	Bag had a leak: may have influenced inability to stand.
135 – vertical	Good. Water pressure created from filling funnel opened valve with ease.	Funnel protrudes when pouch is filled – making it difficult to stand.

2.2.3 Final Design

The funnel with angle $\alpha = 135°$ was chosen. It allowed for a funnel that is deep enough to allow for a water pressure great enough to open the filling valve.

Another design goal was for the pouch to be easy to dispense, from a location other than the filling location. Having a separate dispensing spout and filling location prevents the clean water from coming in contact with contaminated water or hands. To prevent water spillage from the spout it will be 'sealed' using a tube of the polypropylene, see Figure 2.3.

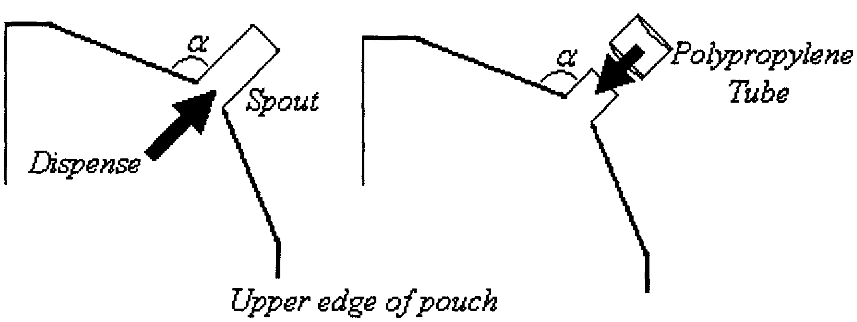

Figure 2.3: Pouch Dispensing Mechanism

Although there was slight leakage this option worked well enough for the purposes of this thesis. The dispensing spout angle was also decided to be 135 °, as to make the construction of the pouch simpler. This simplification allows for the need of only one heat-sealing device.

The final design for the purpose of this prototype incorporates both a filling funnel and a dispensing spout and is shown in Figure 2.4.

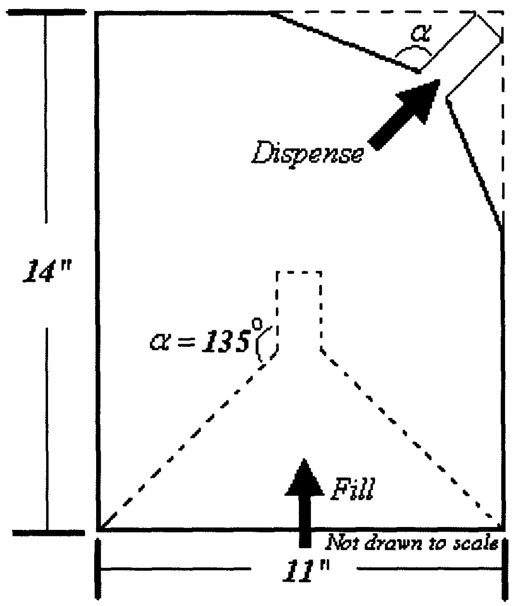

Figure 2.4: Final Pouch Design with Dimensions

2.3 Heat-sealers

There are generally four methods to heat seal polymers: hot wedge, radio frequency, ultrasonic and hot air.[3] The most common of these methods is the hot wedge method, and the most common type of hot wedge heat-sealer is the impulse heat-sealer.

Commercial impulse sealers, like that shown in Figure 2.5, are used in the following manner: the device is plugged in and the user sets the timer knob set to the desired heating time, the polypropylene is then placed on the sealing area and the sealing arm is pushed down. When the sealing arm is lowered it triggers an internal spring/switch which supplies power, or current, to the heating element for the time specified by the knob. The heat from the heating element travels through the non-stick Teflon strip covering the heating element to the polypropylene sheets sealing them together.

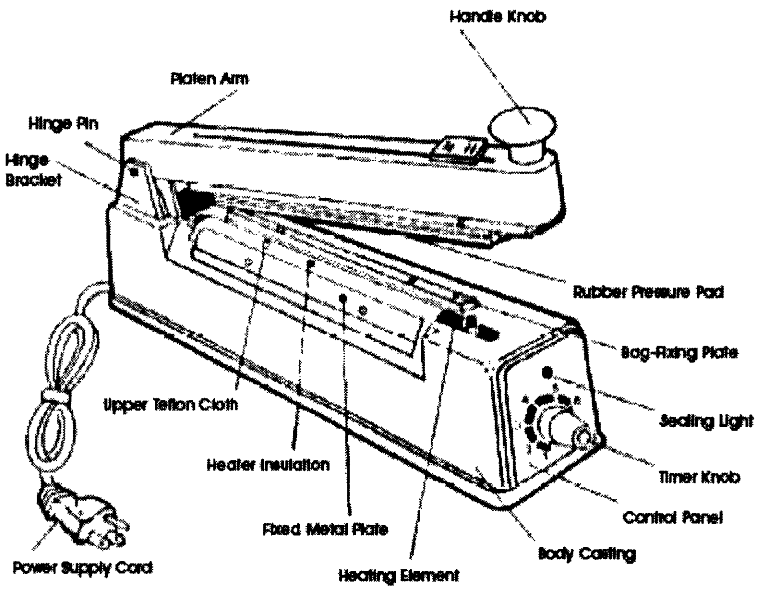

Figure 2.5: Parts Identification for ULINE® Impulse Heat Sealer[4]

Commercial impulse heat-sealers use a grid A/C power source. The energy from the electrical, usually an outlet, is converted into impulse power when the sealing arm is lowered. The impulse power of the device is proportional to its size. According to ULINE® Shipping Supplies, the impulse power ranges from 160Watts to 680Watts for 4 inch sealers to 20 inch sealers, respectively.[4]

A Nickel Chromium alloy (NiCr), typically called nichrome, is most commonly used as the heating element in hot wedge polymer heat-sealers. Typically composed of between 60-80% nickel and 20-40% chromium, nichrome has a high melting point, a high resistivity (low conductivity) and can be readily machined into different forms including strips and wires. The heating surface, in this case Teflon, a composite with high heat transfer properties, provides a non-stick surface so that the polymer being sealed does not melt onto the heating element. Externally a small timer knob appears to regulate the amount of time heat is sent to/through the element; in actuality there is a timer controlling the current flow inside the device.

3.0 Prototype Component Selection

The design of the heat sealer began with research of current impulse heat-sealers, the type of sealer the prototype would be modeled after. The components of an impulse heat-sealer of great importance to the prototype design are the power source, the heating element, the heating surface, and the heat regulating mechanism.

3.1 Power Source

Most commercial impulse heat-sealers are powered by 110V AC power sources, however the prototype should be powered by a source available in developing nations such as a car battery, or a low voltage DC supply. In order to determine whether this difference in power sources will create a problem with other specifications of the prototype, such as the material of the heating element preliminary calculations were made [see appendix A].

A car battery was the first power source to be considered, because of its use for other applications in many developing nations, and although it was a reasonable choice its use created a concern. The device would need to use the battery for an extended time and be significantly discharged. Since automitve3 batteries are not designed for deep discharge cycles they were not appropriate. Instead, it was determined that a 12 Volt deep cycle battery would be best. There were a variety of current ratings available but a battery with a maximum rating between 30 – 50A was preferred based on the current calculation in Appendix A. A deep-cycle battery better suited for the use that the heat-sealer will require. The Sun Xtender PVX-420T AGM battery from Northern Arizona Wind & Sun was selected, it is a 12-Volt battery and has a capacity of 40 Ampere hours, for the 20 hour rate.

3.2 Heating Element and Heating Surface

In order to test the varying heating elements a battery charger with an ammeter was used. This power supply is used in MIT Pappalardo lab to power a hot-wire foam cutter. A nichrome wire, and two leads which connect the nichrome wire to the battery terminals make up the set-up. By replacing the nichrome wire with different lengths of nichrome strips and supplying power to the test apparatus the current required for each strip could be determined. The entire set-up is configured on a work bench, similar to Figure 3.1.

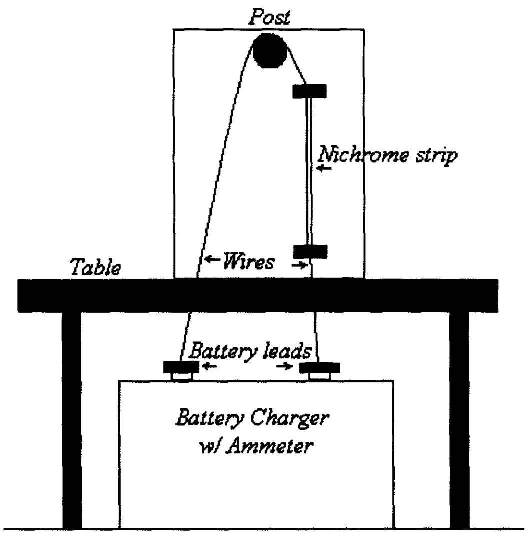

Figure 3.1: Pappalardo Lab Hot-wire Cutter Set-up

The resistance of the nichrome strip depends on three variables, the material composition, operating temperature, and the geometry. Three different length nichrome strips, 8, 16 and 20 inches, were integrated into the set-up independently and two power settings were supplied. For each power setting a Teflon strip was placed against the strip, followed by two pieces of polypropylene sheets, as seen in Figure 3.2.

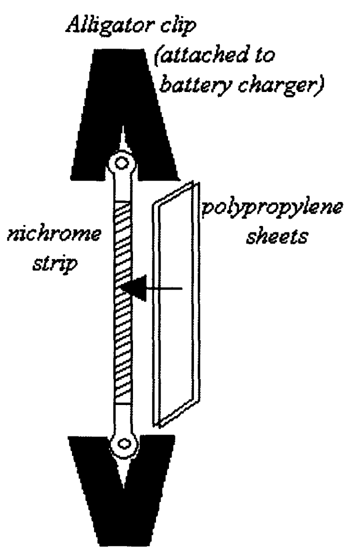

Figure 3.2: Close-up of Nichrome Strip Experimental Set-up

Observing how the polypropylene reacted to the heat provided by the nichrome strip, whether or not it melted or sealed, determined the necessary length of nichrome strip to be used in the alpha prototype. The results shown in Table 3.1 were obtained.

Table 3.1: Nichrome Strip Evaluation

	12 Volt – 2 Amp		12 Volt – 15 Amp	
8" strip	A read: ~11 A	Seal: Too hot	A read: N/A	Seal: N/A
Comments	Began glowing red hot before time to seal. Did not test 15 Amp setting			
16" strip	A read: 2.5-5A	Seal: Weak	A read: 6-7A	Seal: Yes
Comments	Difficult to seal at 2Amp setting, but burned hole in bare polypropylene (some are one sided holes). Turned a gold tint afterwards.			
20" strip	A read: < 2A	Seal: Yes	A read: 5A max	Seal: Yes
Comments	Was able to get a seal for the 2A setting when pressure applied. Strip remained same color throughout.			

The 20 inch strip was deemed the best option; its performance was comparable to the 16 inch strip however the additional 4 inches allowed for the strip to yield similar results at a cooler temperature. The 20 inch strip draws approximately 5 Amps of current through on a high setting, therefore a fuse or circuit breaker with a rating slightly greater than 5A is needed. The type of breaker is chosen will also depend on the specifications of the selected timer.

3.3 Timer

After a thorough Internet search for various relay timers it was discovered that the selection of off-the shelf relay or interval timers which can be powered at 12V DC with a current rating above 10 Amps were uncommon. The timers listed in Table 3.2 appeared to be strong options to consider:

Table 3.2: Dealy/Relay Timer Comparison

Product Name	**Current Rating**	**Time interval**	**Cost**
Elk-960 Delay Timer/Relay	7A, 30VDC	1 sec to 60 min	~$22.99
http://www.smarthome.com/manuals/7279.pdf			
Multi Mode Timer (Assembled)	10A, 240VDC	1-255 seconds	~$29.99
http://info.hobbyengineering.com/specs/DIY-k141.pdf			
Amperite CI series	15A, 30VDC	0.1 – 60 seconds	N/A
http://www.amperite.com/Uploads/ci.PDF			

The Elk-960 timer was the chosen timer for the prototype. Specifications can be found in Appendix B.[4] It comes pre-assembled, has a current rating of 7 amps, can be powered using 12VDC and offered a variety of relay and delay settings.

3.4 Miscellaneous – switch, fuses, etc.

The current rating of the breaker used must be equal to or lower than the current rating of the timer to prevent the timer from blowing. Because the Elk-960 timer was chosen a fuse with a capacity of 7A was selected to accompany it in the prototype. A fuse was selected over a circuit breaker because fuses were better than circuit breakers at this current rating in two categories: availability and price, two important factors in the building of the prototype heat-sealer.

An additional component was also considered at this time, the type of power switch which would be used to close the circuit. Two types of switches were purchased, an Automotive Illuminated Rocker Switch and a SPST Momentary Mini Push Button Switch. The push button switch was chosen because it was simpler to use and hook-up to the circuit. Although a lighted switch option would have been helpful, the Timer Module comes with an attached illuminated power indicator.

4.0 Prototype Design and Pouch Manufacture

4.1 Assembly

The prototype was assembled from the components listed:

- 32" x 11" slab of Plywood, 15/32" thick
- 10 ¼" Steel hinge, 1" deep
- Elk-960 Delay Timer Module
- #20 Wire from RadioShack®
- SPST Momentary mini pushbutton switch, rated 1.5 amps at 125VAC
- 20" Service Kit for ULINE® Impulse Poly Bag Sealer
    - Nichrome strip, Teflon adhesive strip, and Teflon strip
- Fast-acting 1 ¼" x ¼" Glass Fuses, rated at 7.0 amps at 250V
- Chassis Fuse Holder

- 20” Strip of wood, 15/32” thick
- ¼” Staples and gun
- #8-32 Flat Head Nuts and Bolts
- Solder and solder iron

4.1.1 Preparing the Base and Cover

To begin assembling the prototype the 15/32” plywood was cut into two rectangles, one 15 ¼” long by 10 ½” wide with a 4 ½” by 5 ½” opening, and the other 16” long by 11” wide as illustrated in Figure 4.1.

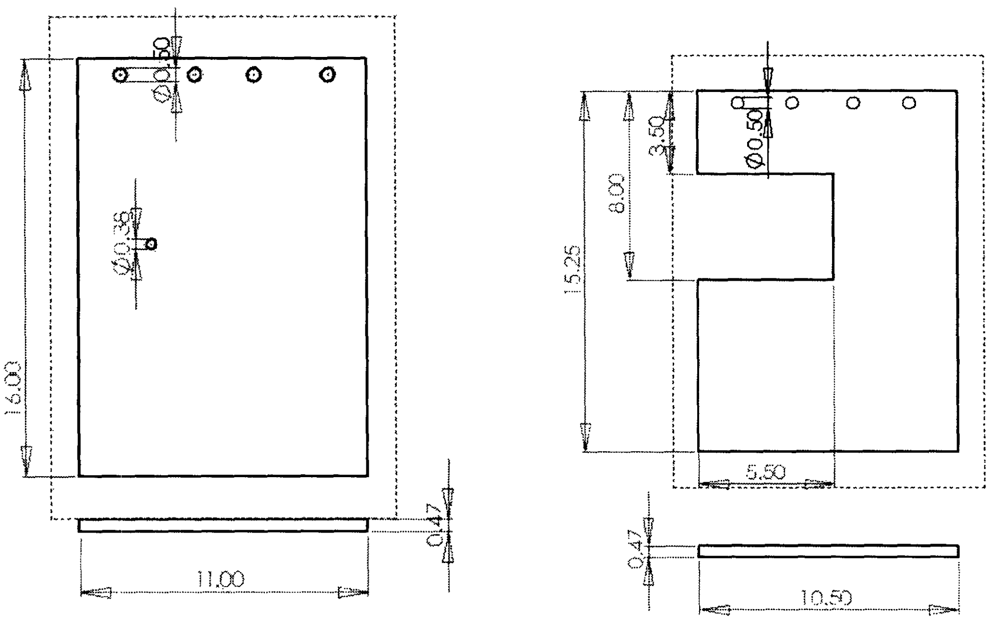

Figure 4.1: Dimensioned Drawings of the Cover and Base Boards

Next, four aligned ¼” diameter holes were drilled into both the steel hinge and the plywood before securing the hinge to the plywood with the #8-32 nuts and bolts and a 3/16” hole was drilled into the bottom board to house the power button. The fuse holders and the timer module were also fixed to the board.

4.1.2 Setting up the Heating Surface

The 20” nichrome strip was bent into a 135° angle with 13” of length on one side and approximately 7” of length on the other. This shape will create the angled contour of the funnel and spout, and will allow for length-wise sealing of the bag. Before securing the nichrome strip to the base board, the 15/32" thick strip of wood was be cut and placed along the board in the shape of the angled contour. Raising the surface of the strip prevents adjustments to the board such as staples, screws and wires from interfering with the sealing interface. Once the wood strips are secured onto the base board Teflon adhesive, from the replacement kit, were attached to the top surface where the nichrome strip will rest. The nichrome strip was then rested atop of the Teflon tape and the Teflon strip was layed over it. In order to make sure the nichrome strip remain configured in the necessary angle and does not come into direct contact with the polypropylene to be sealed the Teflon tape was stapled into the base board along the edges of the wood strip. An exploded view of this process is illustrated in Figure 4.2.

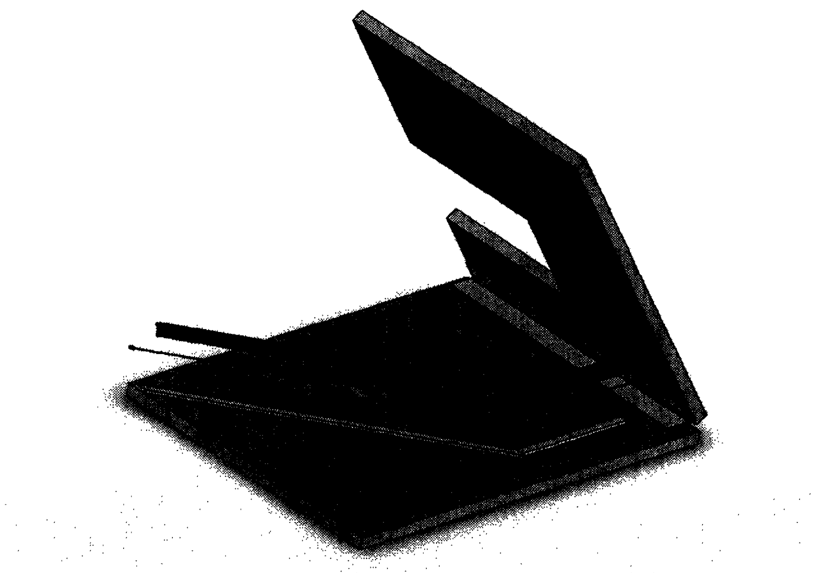

Figure 4.2: Exploded View of Heating Element on Base Board

4.1.3 Configuring the Circuitry

The Elk-960 Delay Timer Module comes packaged with a sample hookup sheet to assist users in configuring the timer module specific to their own needs. Using this reference as a guide the circuitry of the prototype was determined and is shown in Figure 4.2

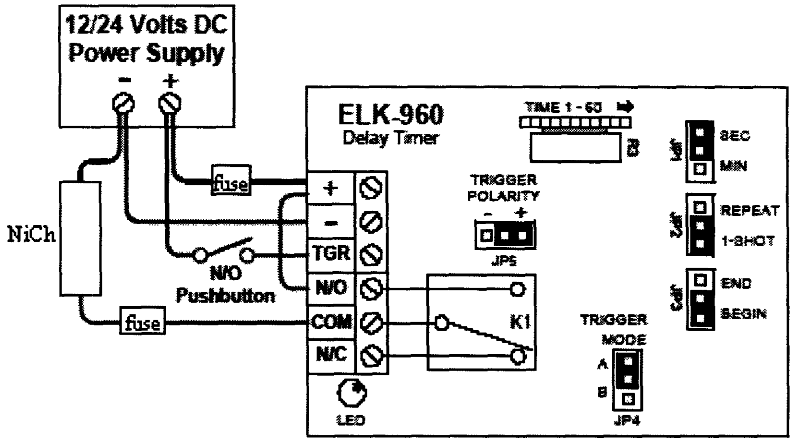

Figure 4.3: Delay Timer Module – Apparatus Integration and Hook-up[6]

The set-up only differs in that the prototype includes 7A fuses in the circuitry to prevent components, such as the timer from being overloaded. Wire was cut to the necessary length needed to make the indicated connections without interrupting the design and function. Before using the device all wires and leads were soldered.

4.2 Use and Manufacture of Pouches

The heat-sealer design is simple, yet effective. The total assembled device is illustrated in the solid model labeled Figure 4.3 and is shown in real-form in Figure 4.4.

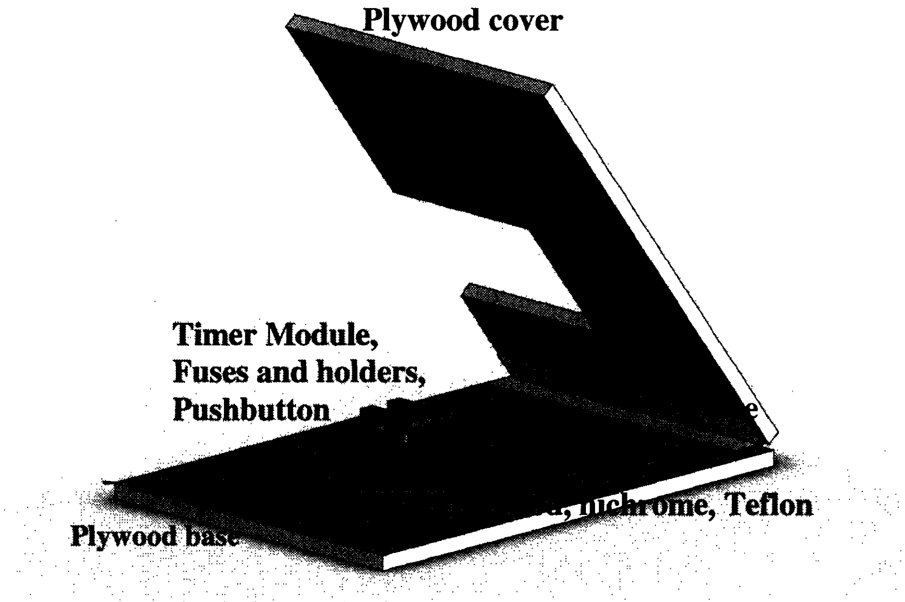

Figure 4.4: Solid Model of Alpha-Prototype

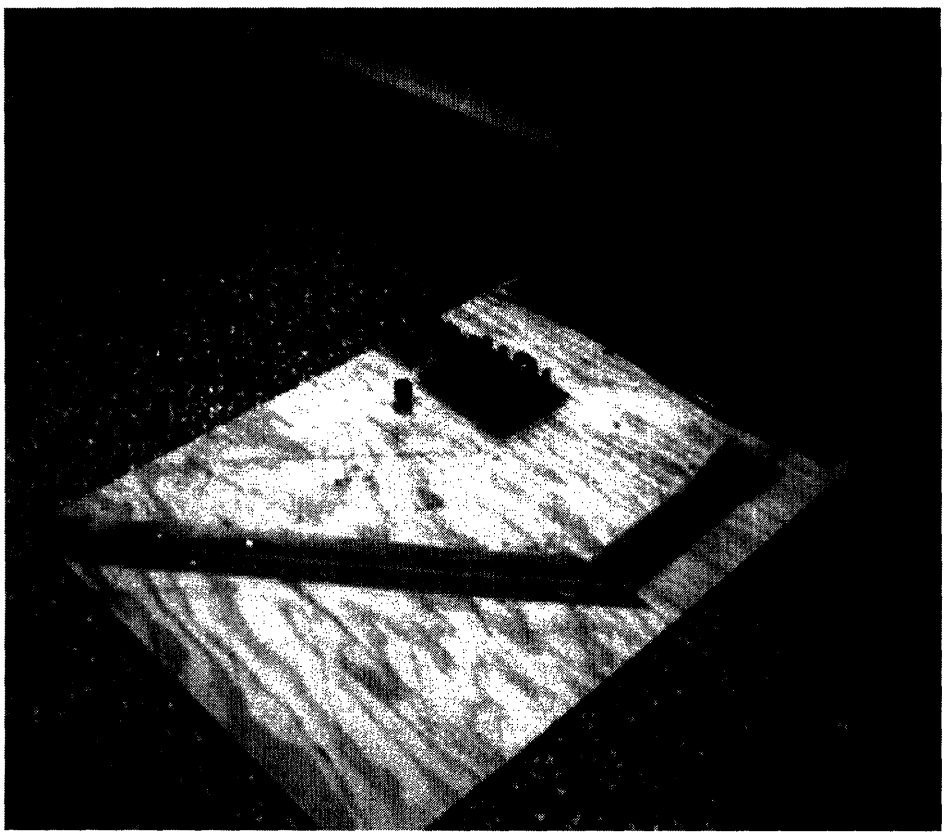

Figure 4.5: Photograph of the Actual Alpha Prototype

To use the device two polypropylene sheets or a bag would be placed on top of the heating surface (Teflon strip) and the cover would be lowered and pressure applied. Next, the timer dial would be made sure to be on the correct setting and the black mini push button pressed triggering the nichrome strip to heat up and the red indicator light to come on. The cover should be lifted after, and only after, the red indicator light on the timer module goes out. The polypropylene bag is then removed with its new seal.

The design works as almost as predicted and seals the 4-mil polypropylene bags in a time of 15-20 seconds. However, the seal strength can vary along the length of the seal with tiny holes in some locations and unsealed polypropylene in some other. This is most likely due to an uneven application of pressure.

To make a complete collapsible water pouch two bags are needed. One is aligned upright in the first section (reverse and repeat on the opposite side) before being cut out around the seal edge to create the inner, bottom, funnel. The second bag is then placed in the second outline, with the funnel piece inserted inside (with a sheet of paper inserted inside of the funnel to prevent multiple sheet sealing) and the bottom side is sealed together. Next, the entire product is placed in the third outline (again, reverse and repeat on the opposite side) and the top, dispenser, is formed. The result is a collapsible water pouch ready to be filled with water and placed in the sun!

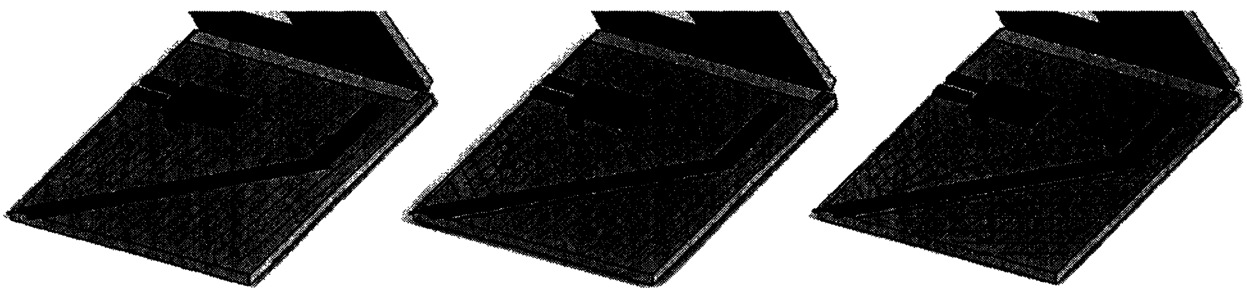

Figure 4.6: Color-coded Sealing Instruction Diagram

4.3 Suggestions for Beta-Prototype

During the design and assembly of the alpha-prototype many areas for improvement were noted; they include, but are not limited to:

- Inconsistency in sealing: Unlike a commercial impulse sealer the alpha prototype does not always create a complete seal along the nichrome's length each run.

Perhaps the beta version of this device better care can be taken to ensure that the nichrome is located in the ideal sealing location and that no other materials around or next to it are affecting its performance. If necessary to guarantee a seal an additional nichrome strip or rubber backer can be placed on the inside of the cover board, mirror image to the one on the base board.

- Robustness: The device itself is rather inexpensive – made out of wood and a $20.00 circuit board, etc. Depending on the weather in the region this device is to be used, checking into the type of wood that will not be affected by the environment, insects or animals such as termites, etc.
- Automation: Using the device without having to press the button, and physically press the cover down when sealing would make the device more user friendly. Placing a switch that gets pressed down by the cover when it is lowered and adding a latch to secure the cover board to the base board would be one way of achieving these goals.
- Accuracy: One weak point of this design is the lack in time interval variability in the ELK-960 Delay Timer Module. Although it provides the opportunity to change the delay from 1 sec to 60 minutes, it can only be adjusted by whole seconds or minutes when in any given unit of time. Heat-sealing polypropylene is very time sensitive and should occur within a matter of seconds. The beta prototype should include a delay/relay timer that can vary its time by tenths of a second, perhaps ranging from 0.1 to no more than 60 seconds.
- Versatility: Now that an initial prototype has been designed, it should not be difficult to create a similar device with a different seal angle and/or shape. Depending on the size of seal needed and the amount of power sources available on-site a design could be created that could heat seal components of the pouch in one step, versus two as the alpha-prototype does. In addition, different shaped heat-sealers provide the opportunity to make pouches for various uses.

5.0 Conclusion

An alpha prototype heat-sealer, for the purpose of manufacturing collapsible water pouches in developing nations, was designed and prototyped. It performed adequately well and was able to meet the design goals set forth by previous studies and available resources such as the ability to be powered by an available power source, to create an angular seal, and to be made from relatively low-cost materials to name a few. Although in theory the design is simple and effective, the prototype proved that are opportunities for improvement. After further testing and development, preferably in the form of a beta (or higher) prototype, a design that will meet all of the needs for use in developing nations will be met and there can be purer drinking and cooking water for many people.

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Appendix A

Preliminary Power Calculations used to Determine Necessary Current Rating of Power Source

Power should be around 380W for a 12 inch (.3048m) sealer (http://www.uline.com/PDF/IH-163.PDF)

Power/Length 1246.71916 W/m

Power = IV = 380 W

Voltage should be 12 V for car battery

so, I = P/V = 31.66666667 Amps

Is 31 Amps reasonable for a car battery?

Yes.

Next, find the Resistance needed

R = P/(I*I) = 0.378947368 ohms

Appendix B

Data Sheet for Elk-960 Delay/Relay Timer

OVERVIEW

The ELK-960 features adjustable delay time of one (1) second to approximately sixty (60) minutes. It can be operated by **12** to **24** volts D.C. and can be triggered by a negative (-) or positive (+) voltage. The operating mode and the relay condition can be set as follows: **BEGIN**- Relay turns on when triggered and back off when delay time expires. **END**- Relay turns off when triggered and back on when delay time expires. The delay time can start when the trigger is first applied (**B** mode) or when the trigger is removed (**A** mode). The ELK-960 relay can be set to provide a single **1-SHOT** output or to **REPEAT** (pulse on and off). All options are selected using easy to change mini-jumpers.

TERMINAL DESCRIPTIONS

+ Positive power input. Connect a +12 to +24 Volts D.C. source. **Warning: Do not exceed +24 Volts D.C., Damage will occur.**

- Negative power (ground) input. Connect to a negative or ground terminal of the power source.

TGR Trigger voltage input. Connect a 4.5 to 24VDC trigger source. Place jumper **JP5** (TRIGGER POLARITY) in the "+" position to trigger from a positive voltage or in the "-" position to trigger from a negative. The trigger voltage may be 4.5 to 24VDC, regardless of the main powered input (12Vdc to 24VDC).

N/O Normally Open side of the relay contacts. No connection to COM when the relay is off.

COM Common or "pole" side of the relay contacts. When the relay is off, COM is internally connected with the N/C contact. When the relay is on, COM is internally connected with the N/O contact.

N/C Normally Closed side of the relay contacts. This terminal is internally connected with the COM terminal when the relay is off.

NOTE: The ELK-960 automatically triggers (turns on) and runs through a delay cycle when first powered up. To reduce waiting time and speed up installation, set jumper JP1 to SEConds and adjust R3 to 1 before applying power. Once power is applied, change the settings as required.

SETTINGS AND JUMPER DESCRIPTIONS	
R3	This knob is used to increase or decrease the delay time from 1 to 60. Full clockwise is 1, halfway is 30, full counter-clockwise is 60. The arrow is a reference point.
JP1	**SEC** = Delay time in seconds. Adjustable from 1 ~ 60.[1] **MIN** = Delay time in minutes. Adjustable from 1 ~ 60.[1]
JP2	**REPEAT** = (Adjustable pulse) Relay cycles ON / OFF at delay time interval using a 50/50 duty cycle.[2] A trigger input will temporarily stop the cycle. **1-SHOT** = Relay activates only once per trigger.
JP3	**END** = Relay turns off when triggered and back on when delay time expires. **BEGIN** = Relay turns on when triggered and back off when delay time expires.
JP4	**A** = Delay time starts when trigger is removed. **B** = Delay time starts when trigger is first applied.
JP5	**+** = Selects positive polarity for the input trigger. **-** = Selects negative polarity for the input trigger.

[1] Times are approximate. When adjusted to the highest setting (60 minutes) the actual time delay will be slightly greater.

HINT: For a delay time in minutes, adjust and test with jumper JP1 in the SEConds position. (IE: For a 15 minute delay, adjust and test to 15 seconds) Then move jumper JP1 to MINutes. This quickly provides a reasonable equivalent delay time in minutes.

[2] A 50/50 duty cycle means the OFF and ON times will be equal.

03/04

Delay Timer

ELK-960

APPLICATION:

The ELK-960 is an economical and flexible solution for many general-purpose time delay applications. The unit operates on 12 to 24 Volts D.C. and can be selected for positive or negative trigger logic. Setup is easy with thumbwheel adjustment between 1 and 60 seconds, a quick jumper setting converts the time from seconds to minutes. The timer can be configured to activate once for each trigger, or pulse as soon as power is applied.

ELK PRODUCTS, INC.

Delay Timer

ELK-960

7 62158 00960 0

Economical Time Delay Relay Module

FEATURES:

- Operating Voltage Range: **12** to **24** Volts D.C.
- Adjustable Delay Time.
- Positive or Negative Low Current Trigger.
- **SPDT** (Form "C") Relay.
- Selectable Initial Relay State: ON / OFF.
- Output Modes: One-Shot or Repeat.
- LED Indication of Relay Status.
- Lifetime Limited Warranty, call for details.
- Packed In Reusable Poly Storage Box.

SPECIFICATIONS:

- Time Settings: 1 Sec to ~ 60 Min.
- Relay Contact Rating: 7A @ 30 VDC.
  10A @ 125 VAC.
- Operating Voltage: 12 to 24 Volts D.C.
- Trigger Voltage: 4.5 - 24 Volts D.C.
- Input Trigger Current: 1.2 mA.
- Current Draw With Relay On: 40mA.
- Size: 3"x2.2"x1" (Fits Std.Snap Track).

Features and Specifications subject to change without notice.

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Instructions Printed On Inside

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