

UPGRADING WILDFIRE-RESISTANT SHELTERS WITH A SUPERABSORBENT POLYMER LAYER

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Objective:

Current fire shelters are expensive and don't offer a guarantee of both safety and survival. This project aims to implement a layer of Superabsorbent Polymer (SAP) into a fire shelter to guarantee the safety of the individual for an affordable price.

Background:

- In 2020, California Wildfires alone destroyed 10,500 structures and killed 33 people
- Superabsorbent polymer is a powder that can absorb 100x its own weight in water within 2 minutes.
- SAP has many uses, such as diapers, cold packs, medical waste, etc.

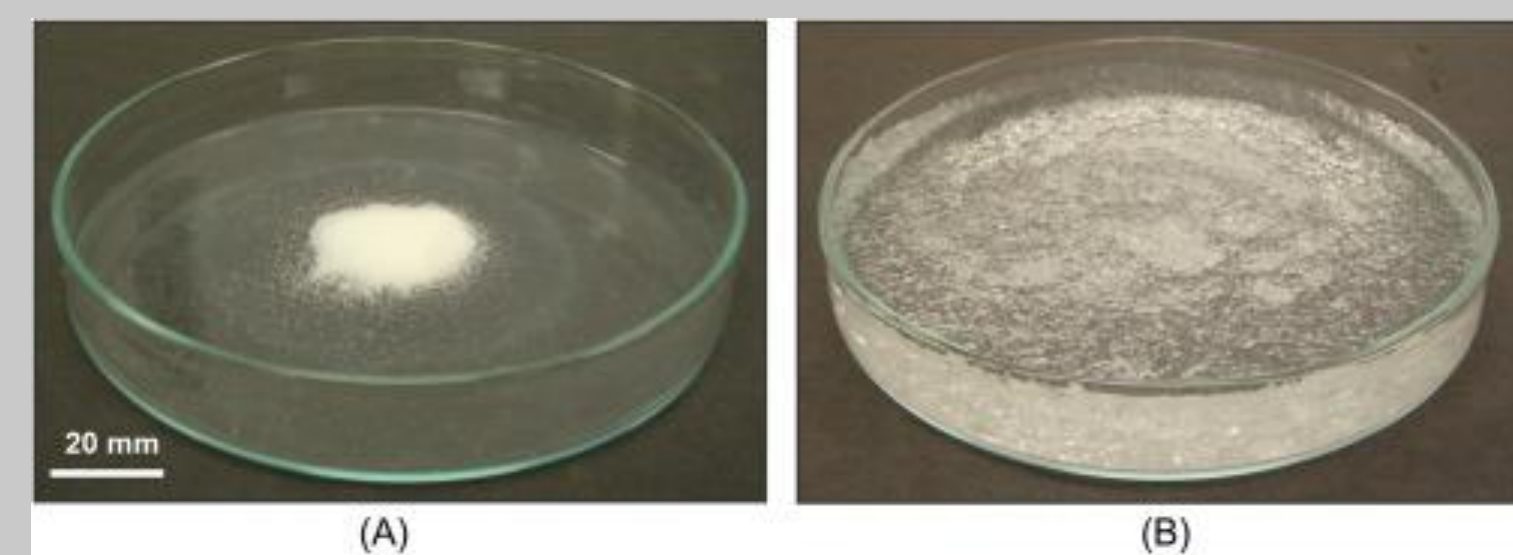


Fig 1: Shows (a) the dry SAP before any water has been added and (b) the SAP after hydration while it still remains a solid. (Source 1)

Prior Research:

- The spread of heat was mapped in prior experiments, resulting in a desired SAP thickness of 1.5 cm.
- Work was focused on roofs but has transitioned to personal shelters

Absorption Testing:

Test Purpose and Design:

- Determine how much of each type of water is needed to produce different pouch thicknesses.
- Each pouch was filled with SAP and hydrated with water in increments of 50mL. Thickness was measured after each addition of water.

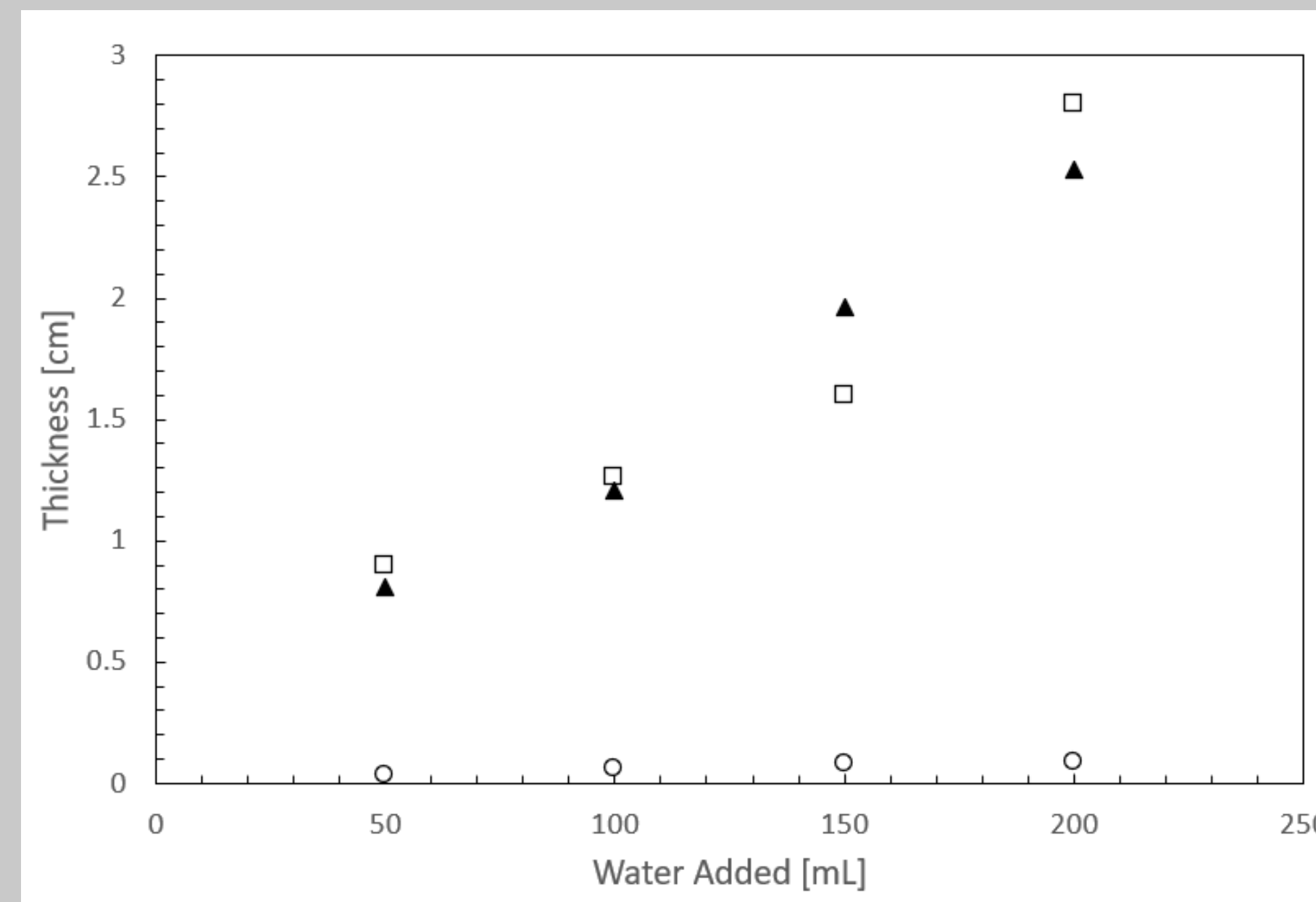


Fig 2: A graph showing the results of the absorption tests for three types of water. The three sets of data are for DI water (squares), tap water (triangles), and salt water (circles). All thicknesses were measured from the thickest part of the pouch.

Test Results:

About 125 mL of either tap water or DI water is needed to achieve a minimum thickness of 1.5 cm. Salt water (representing urine) proved to be an ineffective way to hydrate the pouch as most of the water was not absorbed by the SAP.

Current Market Standard:



Fig. 3: Current market standard price and usage (Source 2)

- Current shelters consist of a layer of aluminum foil backed by woven silica that functions as a fire repellent/heat barrier.

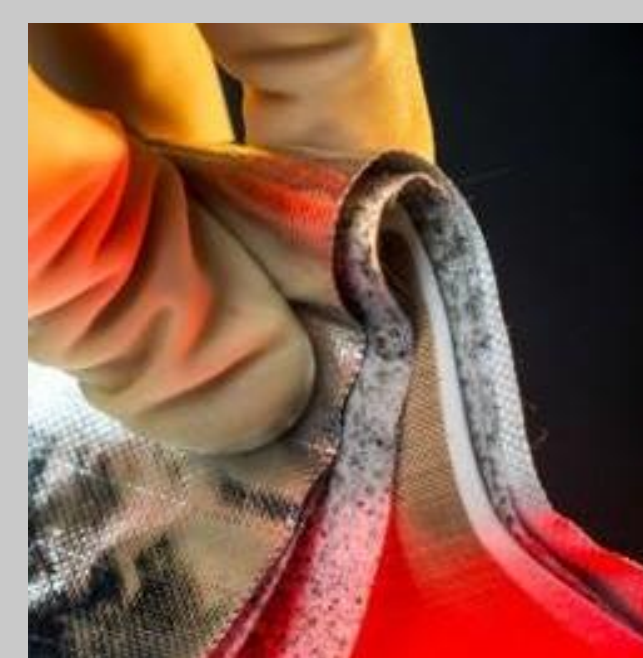


Fig 4: Layers of a current fire shelter. (Source 3)

New Shelter:

- SAP layer added to current standard of aluminum woven silica to enhance overall protection
- Addition of the SAP layer reduces heat influx by 97%

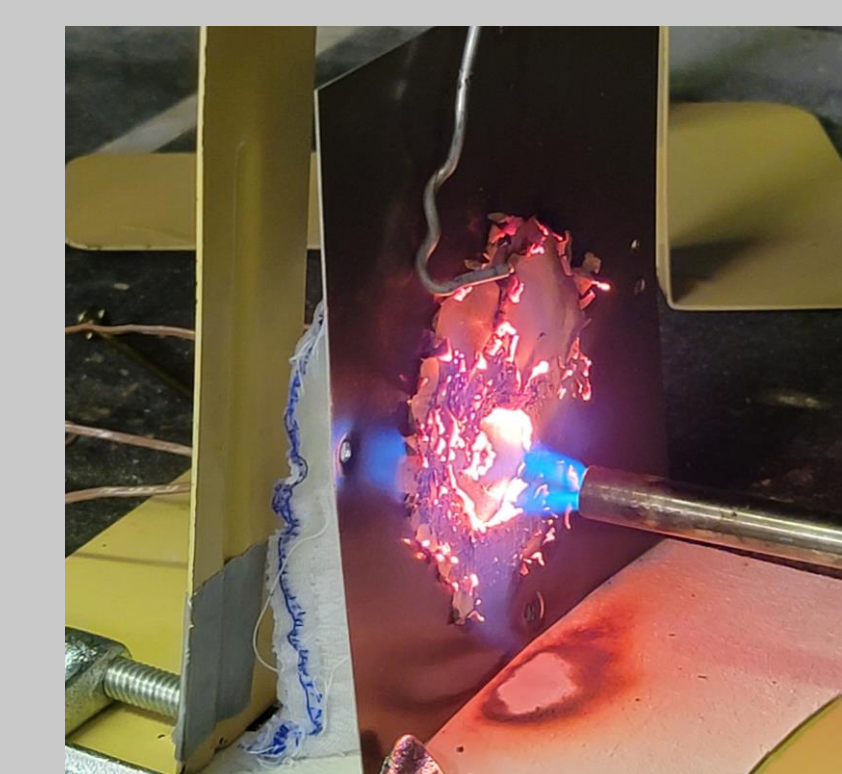


Fig. 5: Burn tests on a hydrated SAP pouch.

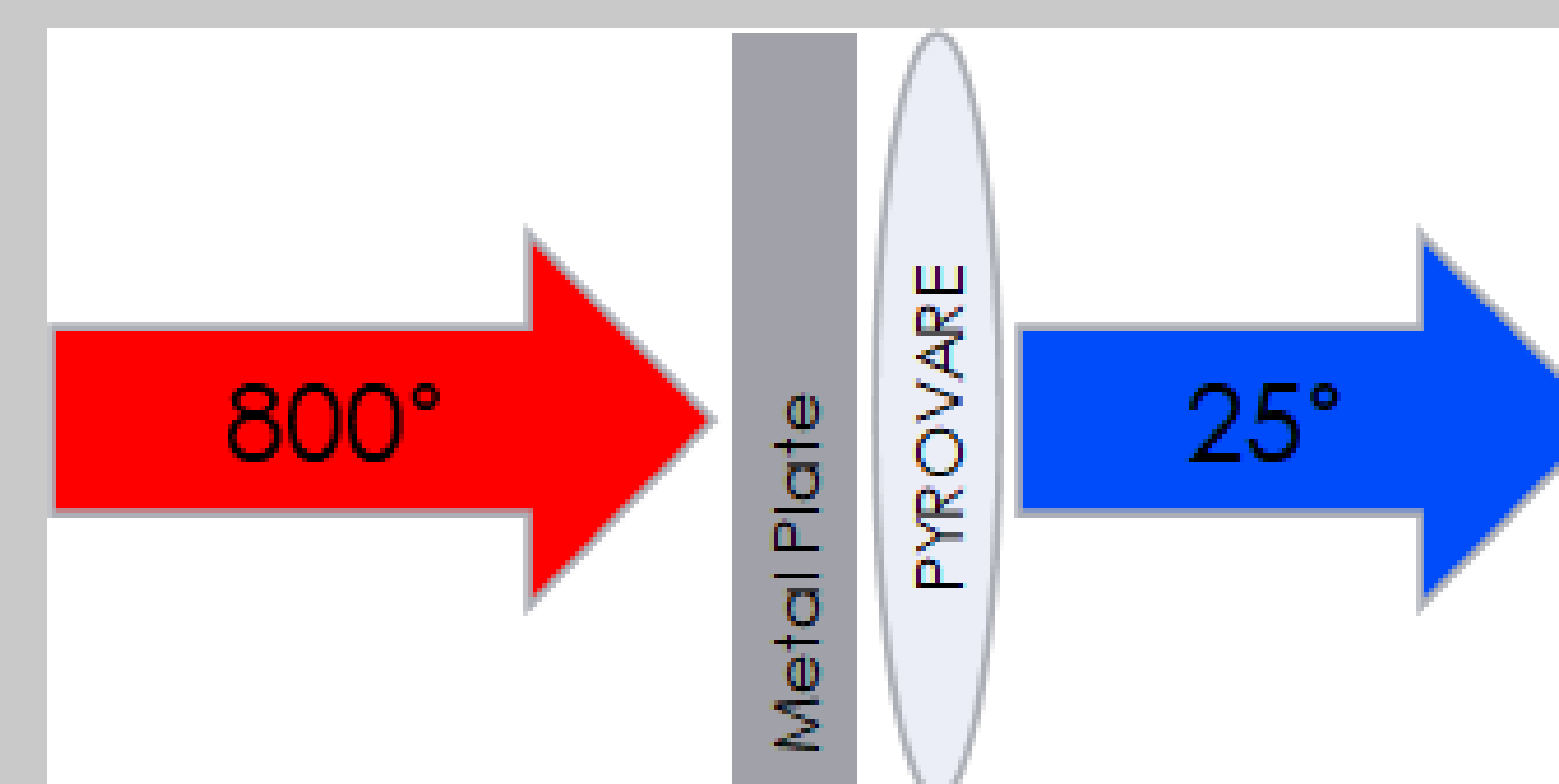


Fig 6: Shows a graphic of the heat test demonstrated in Fig 5.

Go to Market Strategy

This technology has the potential to save lives. The best course of action was determined to be starting a small business with a go to market strategy.

Phase	Use	Demographic
Phase 1	Small Scale Property & Personal Protection	Population living within high risk zones
Phase 2	Personal Protection	Outdoor Enthusiasts
Phase 3	Personal Protection	Ready-to-go shelters scattered throughout High Risk Zones for everyone and anyone caught in a forest fire

Literature Review:

- SAP technology has many different applications including:
 - Sprayed from a hose or fire extinguisher
 - Can be sprayed on trees and grease fires
 - Requires smaller/finer SAP – higher cost
- Different materials and techniques can be used in shelter construction
 - Outer layers can be both water permeable and fire resistant – higher cost

Future Work:

Thermal Protective Performance (TPP) is a common metric used to characterize fire-resistant materials

To compare SAP directly to other materials, future tests can be conducted with a copper calorimeter capable of measuring TPP

Citations:

- Wong, H. S. Concrete with superabsorbent polymer. <https://www.sciencedirect.com/science/article/pii/B9780081021811000174> (accessed May 20, 2021).
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- Vitug, E. Developing a more effective fire shelter. <https://www.nasa.gov/feature/developing-a-more-effective-fire-shelter> (accessed May 20, 2021).