

The Appropriate Technology Collaborative

Low Cost Insulation Project Report 2015

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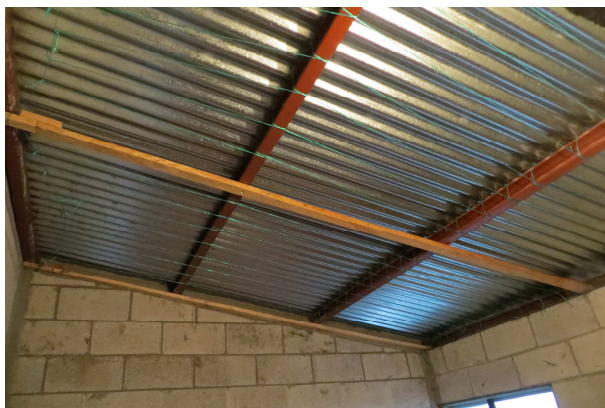
The Appropriate Technology Collaborative

Inventing Affordable Insulation with an Indigenous Guatemalan Family

Monika Goforth, ATC Guatemala Program Director



Appropriate Technology is a simple, low-cost system that is replicable by any person with a basic, primary education. Given the wastefulness of our economic system, I also add the use of recycled and/or sustainable natural resources to my definition. The mission of our project was to invent and implement a low-cost, sustainable and replicable solution to insulate concrete and tin-roofed homes in the extreme highlands of Guatemala.



**Bare Steel "Lamina" Roof With Twine
Bags**



Making Insulation From Recycled Corn



Installation of Insulation



Finishing Touches

Nueva Santa Catarina Ixahuacan (NSCI) is a small indigenous community that lost their traditional homes (made of adobe or mud) to a landslide over 10 years ago. International development funds went to a quick rebuild of the small town using concrete and tin to provide basic shelter. Years later, doctors are finding severe illnesses in the community and argue that the severe cold – inescapable even indoors – has been weakening the immune systems of the young and old. This town is known to have snow and frequent frosts over the winter, during our week-long stay in early May, the team experienced 3 hailstorms and a constant chill. Our personal experience with the cold (and desperately huddling over our host mother's cookfire) was a constant motivator to succeed in our project.



Celebrating the New Warm Roof and Insulated Window

Prior to arrival in NSCI, the team of four engineering students from Michigan State University ran tests on various materials to study the effectiveness of insulation materials available in the developing world. In Guatemala, John Barrie and I referred to their findings and sourced out recycled corn sacks at the bustling city market in Xela. The seller of these sacks was an old indigenous woman whose stall was packed to the ceiling with ‘bags of bags’ - selling us 300 *costales* at 2 *Quezales* each – that’s about 25 cents a bag. Of course, these bags can be easily collected for free from wholesalers, but for the purpose of our project, time was of essence.

Also important in an insulation project is aesthetics. Nobody wants to look up and see bare insulation in their home. We decided to use traditional handmade reed-mats to cover the corn sacks, offering one more layer of insulation with a natural, sustainable resource that is locally available and affordable.

Up in Nueva Santa Catarina Ixhuacan, the team of students and I introduced ourselves to Manuel and Juana, a middle-aged couple who work together in a family weaving business. The best room in the house was dedicated to their giant wooden loom, of which Juana coordinates the design and Manuel weaves as instructed. Juana speaks almost no Spanish, and does not know how to read or write. But she was clear and opinionated about the aesthetics of our project, and often poked her head in the door to ask what we were doing and why. Her husband, Manuel, translated from my Spanish to Quiche and she would nod in approval or give a blank face if we had more work to do before we reached her satisfaction. Manuel was raised by his grandmother. At age 14 his grandmother passed away and Manuel dropped out of school to work in various jobs. It turns out carpentry was one of them, as Manuel came to the rescue through the course of our project.

This leads us to the most magical moments of our insulation project. Manuel and Juana, welcoming hosts as ever, started the first day by offering us a hot cornmeal drink called *atole*, a welcome treat after a chilly day of sealing up the holes in their wall. The next day, they helped us fold the 300 corn sacks while we asked each other questions – how did Juana and Manuel meet? At what age do people get married in the United States? What about divorce? It was a rich moment of cultural exchange from both sides.

Next, the students installed the folded corn sacks over a network of string tied up along the slant of the ceiling. Several neighbors stopped by and asked about what we were doing. One young man asked detailed questions about the price of the corn sacks and said, “Huh, I could do this at *my* house.” And by the look on his face, I truly think he will.

The day after, Manuel worked closely with the students to resolve some installation issues – it seemed that no matter what we did, the reed-mats sagged! Frustrated and in despair, we started brainstorming other materials to use – but the expense! Manuel came into the room, jokingly commented on our sad faces, and announced that we can definitely install the reed-mats correctly and after lunch he would dedicate all his time to show us how. Within two hours of four people standing on various raised surfaces (including a table, an oil drum, a wooden ladder, a stool and fancy A-frame ladder) we tugged those mats in place while Manuel staple-gunned it all in. We celebrated with more *atole* from Juana. Manuel was our hero that day.

One more important detail needed to be done: window insulation. The thin window panes did not close tight, letting out any heat the ceiling insulation would keep down. The students came up with a brilliant simple design – quilting 3 layers of corn sacks between fabric, chosen and provided by Juana. A student, Teresa, and I were led up the hill to Juana’s sister’s house – another Teresa! The two Teresas and I worked on a pedal-powered Singer sewing machine to quilt the insulating curtains so that they would lay flat and tight onto the window in the evening and easily roll up for the daytime. They looked fantastic.



JC, Juana and Jeremy

Saturday rolled around and it was time for a goodbye party at Manuel and Juana's house. The guests were our host family from around the corner; the village spiritual leader, Don Victoriano; Juana's extended family; and various neighborhood women and children. Soft drinks and thank-you speeches were exchanged and we had the funniest group photo-shoot ever. Juana wanted a photo with the "American boys," then so did their daughters, Manuel wanted a photo with the girls, then with the boys... it went on and on with lots of laughter and funny poses. The week of working so closely with this family filled all our hearts. And feeling them respond with the same affection for us made all our work ever more fulfilling.

Technical Details by John Barrie:

We folded the costales over twice so that there were 8 layers of mesh between the roof and the inhabited space. The thickness varied slightly but averaged 2.5 inches. We overlapped the costales slightly when installing to create a continuous layer of insulation without gaps.

The plastic used to make costales is polypropylene (pp). It has a high burning temperature and is used in "green" building products due to pp's inert qualities. From the Albox Sustainable Products website: "Polypropylene is one of the most neutral plastics, containing only two elements: carbon (C) and hydrogen (H)" and "Polypropylene sheet is manufactured from propylene monomer, a relatively safe gas, which is a waste byproduct of the petroleum industry that used to be burned off into the atmosphere contributing to greenhouse gas emissions. As a consequence, the more polypropylene used in products helps in reducing greenhouse gas emissions."

We have compared the costale insulation side-by-side with fiberglass and we find that costale insulation performs about 5% better than fiberglass.

A sample Material Safety Data Sheet (MSDS) for polypropylene is attached for reference.

POLYPROPYLENE Material Safety Data Sheet



I. General Information		
Chemical Name & Synonyms Polypropylene	Trade Name & Synonyms Natural Homopolymer Polypropylene, O, P grade polypropylene.	
Chemical Family Homopolymer Polypropylene	Formula [Ch (ch3) ch2-]	
Proper DOT Shipping Name: N/A	DOT Hazard Classification: N/A	
II. Ingredients		
Principal Components	Percent	Threshold Limit Value (Units)
Polypropylene (9003-07-0)	>99%	10mg/m3 (total dust)
III. Physical Data		
Boiling Point (Deg. F.) N/A	Specific Gravity (H2O=1) .90-.91	
Vapor Pressure (mm Hg) N/A	Percent Volatile By Volume (%)	
Vapor Density (Air=1) N/A	Evaporation Rate (Air =1) N/A	
Solubility in Water Negligible	pH N/A	
Appearance & Odor Opaque, or white, solid, no odor		
IV. Fire & Explosion Hazard Data		
Flash Point (Test Method) >500F (260C)	Auto Ignition Temperature 735F (388C)	
Flammable Limits N/A	LEL N/A	UEL N/A
Extinguishing Media Water, Foam, Carbon Dioxide, Dry Chemical		
Special Fire Fighting Procedures Slow burning plastic that emits a dense black smoke. Firefighters should wear a self-contained breathing apparatus and protective clothing.		
Unusual Fire & Explosion Hazards Dust is flammable when finely divided (less than 200 mesh) and suspended in air. Combustion products may be hazardous.		

POLYPROPYLENE Material Safety Data Sheet



V. Health Hazard Data

OSHA Permissible Exposure Limit	ACGIH Threshold Limit Value
15 mg/m ³ total dust, 5 mg/m ³ respirable dusts.	10 mg/m ³ total dust

Carcinogen - NTP Program	Carcinogen - IARC Program
NO	NO

Symptoms of Exposure
Polypropylene heated to 700 deg. F can irritate the respiratory tract.

Medical Conditions Aggravated By Exposure
None known, however, seek medical attention if constant irritation occurs. If thermal decomposition occurs, upper respiratory, eye, nose, and throat irritation may result.

Primary Route(s) of Entry
Inhalation of particulates.

Emergency First Aid
Molten material. If molten material comes in contact with the skin, cool under running water. Do not attempt to remove the molten material from the skin. Get medical attention.

VI. Reactivity Data

STABILITY	☐ Unstable	<u>Conditions To Avoid</u>
	☒ Stable	None Known
INCOMPATIBILITY		<u>Materials To Avoid</u>
Hazardous	☐ May Occur	Strong oxidizing agents.
Polymerization	☒ Will Not Occur	<u>Conditions To Avoid</u>
		None Known

Hazardous Decomposition Products: Carbon Monoxide, Carbon Dioxide, organic oxidation products, acrid smoke, and fumes.

VII. Environmental Protection Procedures

Spill Response...Sweep up for Disposal or reuse.

Waste Disposal Method...Incineration or landfill - dispose of in accordance with Federal, State and Local regulations.

VIII. Special Protection Information

Eye Protection	Skin Protection
Glasses with side shields.	Use insulated gloves when handling molten material.

Respiratory Protection (Specific Type) - NIOSH approved dust respirator recommended. If material is being burned wear an organic respirator.

Ventilation Recommended - Local ventilation in dusty conditions, or if thermal decomposition occurs.

Other Protection
Gloves and protective garments when handling molten material.

IX. Special Precautions

Hygienic Practices In Handling & Storage: Wash with soap and water.

Precautions For Repair & Maintenance Of Contaminated Equipment: Eliminate ignition sources.

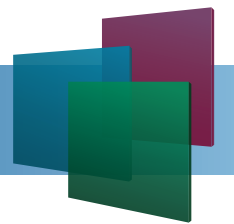
Other Precautions

Avoid excess breathing of vapors, fumes, or smoke that may be released during thermal processing. Store in a sprinkler protected warehouse. Natural Homopolymer Polypropylene will burn if ignited.

NFPA Code: Fire 1, Health 0, Reactivity 0

HMIS Code: Fire 1, Health 0, Reactivity 0

POLYPROPYLENE Material Safety Data Sheet



X. Regulatory Information

OSHA Status: Polypropylene is not considered hazardous under OHSA.

TSCA Inventory Status: All ingredients are listed.

CERCLA Reportable Quantity (RQ): None

SARA Title III:

Section 302/304.No extremely hazardous substances

Section 311/312.No reporting requirements although it is suggested that storage of >10,000 lbs of polypropylene in one facility should be listed on a Tier II report.

Section 313: No reporting requirements.

Hazard data contained herein was obtained from raw material suppliers. The information presented is believed to be factual, as it was derived from the works and opinions of persons believed to be qualified. However, no facts contained in the information are to be taken as a warranty, or representation, for which A&C Plastics Inc. bears legal responsibility. The user should review any recommendation in the specific context of the intended use to determine if they are appropriate.

N.A.= Not Applicable N.E.= Not Established