Two Year Summary of the
Tohono O’odham Community College—EPA ecoAmbassador Project

Recycling Glass into a New Green Building Material

David Stone

For two years we have been working on our glass recycling project. We gather discarded bottles from the desert, bring them back to the solid waste facility, and run them through a glass crusher. The fine and coarse cullet is then separated and stored in stalls. Excess cullet is put on piles in the back of the yard. The actual recycling involves using the cullet as aggregate for building products. We do not use Portland cement, which during manufacture is a source of CO₂ that contributes to global warming. Instead, we use steel dust, which is another solid waste that is typically not recycled but our process makes good use of it. The glass cullet and the steel dust are mixed with minor ingredients that promote iron corrosion (rusting) and carbonate formation. Then water is added to make a wet paste that is similar in consistency to ordinary concrete. It can be poured and troweled like concrete to make the same kind of products. Finally, we expose the mix to carbon dioxide gas, which diffuses into it and reacts with iron to form iron carbonate. This mineral keeps growing for about a week into a solid matrix that binds all the glass together. The result is a hard, durable material that is as strong as concrete but greener because it is truly carbon negative and is composed almost completely of recycled wastes.

Our bottles come from drinking sites along the dirt roads out in the desert. We get people from other Tohono O’odham agencies and the communities involved for the bottle pickups. For example, we have had groups from adult detention pick up bottles with us as part of their court-mandated community service. We have also had the employees of the Tohono O’odham Environmental Protection Office out there with us. They know the locations of illegal dump sites that have lots of glass and have organized community clean ups that have brought in many thousands of discarded bottles. They have also held contests among schools, community groups, and other teams to see who could bring in the most glass and other litter.

Bottle pickups are held along roads in the desert. Bags, buckets, tubs, and wheelbarrows are filled with bottles by hand and then brought to pickup trucks or large roll-off containers.
The need to connect with the communities and their children has been consistently emphasized by the project’s longest serving participant, Richard Pablo. He started as a student intern two years ago and now is the Project Assistant. His special concern is with the social benefits of the project and puts all aspects of the process including the technical concepts in a cultural context. For example, he worries that the very sight of all the beer bottles lying around sends a subconscious message to the kids about the acceptance of drinking and worse, that the sacred land itself can be used as a dump. He says, “every bottle we leave laying there is like a sign always saying to the kids that it is okay to drink and it is okay to add your bottles to everyone else’s. These bottles are teachers! They teach a bad life. And they are everywhere. They send a different message to the kids and undo all the good lessons we want them to learn.”

At some sites there are many thousands of bottles that have accumulated over decades and it takes a dozen workers several days to clean up just one acre.

Fortunately, there is something we can do about this. The bottles can be picked up and in the act of doing so the Nation’s children and others can learn more positive lessons. For those who are young and have not yet started to drink (some start before 10 years of age) it can hopefully build a stronger resistance to the coming peer pressure. For those who have drunk from and discarded liquor bottles the act of picking them up can be a form of ritual that offers a means of making retribution and therefore re-establishes a sense of balance. It can perhaps be called a form of therapy. Pauline N., who has participated in the glass pickups, once remarked, “I can’t believe I’m out here picking up my bottles, the same bottles I drank from and threw down here 27 years ago! Everyone who drank here should come back and pick up their own bottles. Your bottles are here waiting for you. They’ll be here forever marking your spot until you pick them up.”
Almost all of the bottles on the Tohono O’odham Nation are brown, quart-sized beer bottles known locally as “Q’s” and have been discarded over many years at “party sites.”

But just picking up the bottles is not enough. It’s not enough for real recycling and not enough to undo the destruction that alcoholism causes on the Nation. The bottles need to be converted into something beneficial to complete the transformation process and turn a negative into a positive. Through this project we have transformed the discarded bottles into a green building material that in turn has been used to make a variety of products including tiles, pavers, and blocks as well as bigger structures such as benches, sidewalks, slabs, and walls. The process starts with crushing the bottles into cullet, which immediately transforms the waste into a product that has some value. Cullet is most commonly recycled as a feedstock for the production of new glass since it substantially reduces the energy requirement when using raw materials like sand. It also has other uses such as ground cover and as a filtering medium in sewage treatment facilities. We use it as aggregate in a building material in place of the usual sand and gravel.

From discarded bottles collected in the desert to piles of cullet being stored for future use at the solid waste facility. The glass crusher puts out three different grades, a grit of 1/8” and less, a pea gravel-like size of 1/2” or less, and bigger chunks. In the background are the finer grades and in the foreground are coarser chunks. All will be used for various applications.
On the left are 4” x 8” x 16” adobe-like blocks made from the fine crushed glass and steel dust. On the right are 18” square pavers made with a coarser glass cullet.

We made a bench of the recycled glass and steel dust while trapping CO₂—”sitting down on carbon!” Former head of the EPA Lisa Jackson tries out our sidewalk made of the same mix—”stepping down on global warming!”

The largest structure we have built with the mixture of crushed glass and steel dust is a material storage system. It is a series of open, three-sided stalls made with free-standing walls on a flat slab for easily filling and emptying.

A set of walls on a slab was made of the same recycled materials that later was stored in it—crushed glass and steel dust.
The material storage system we constructed includes an 8x28’ slab six inches thick and nine 3x7’ retaining walls one foot thick at the base. This overall structure required over 30,000 pounds of recycled materials with approximately 18,000 pounds of glass aggregate from discarded bottles collected by hand out in the desert. (The average bottle weighs a little over one pound.)

On the above left is a perforated pipe for delivering CO$_2$ to the slab during the hardening stage.

The glass aggregate-steel dust mix can be poured and troweled like ordinary concrete.

The free-standing walls were cast between two plywood forms and each contain a zig-zag length of perforated pipe that feeds the CO$_2$ into the material. A coarse glass aggregate is used for the pour and then a finer sand-like mix is troweled on like stucco to give the walls a smoother surface.
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http://www.epa.gov/ecoambassadors/tribal/

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