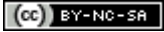
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Instructables

A Practical Zeer Pot (evaporative Cooler / Non-electrical Refrigerator)

By [Berkana](#) in [OutsideCamping](#)

Introduction: A Practical Zeer Pot (evaporative Cooler / Non-electrical Refrigerator)



A zeer pot is an evaporative cooler used in rural Africa and the Middle East to keep vegetables fresh. They consist of two terra cotta pots, one nested inside the other, with the gap between them filled with wet sand. The sand serves as a thermal mass that helps keep the pot cold once it has cooled down, and acts as a wick to spread the moisture up the walls of the pot. When placed in a shaded, breezy location, the evaporation of water off the outer surface chills the pot. If you have a good breeze, or a fan powered by a solar panel blowing the pot, the pot can get quite cold. Imagine that chill you get when you step out of a pool when the wind is blowing. Now imagine that wet wind chill going on all day. That's what the pot feels with a constant breeze.

Unless the air is very dry and the pot is exposed to a constant breeze, they generally do not become as cold as a refrigerator, but they will keep vegetables fresh for a couple of weeks. If you do have cool dry air and a constant stiff breeze, the interior of a zeer pot can chill down to around 40°F.

Think of it as an open-cycle refrigerator. Conventional refrigerators evaporate a refrigerant in a closed circuit to absorb heat from their interiors, then compress the refrigerant vapor in the coils in back to condense it and to expel heat. The zeer pot simply uses water as its refrigerant, and leaves the condensation to nature.

Zeer pots were re-discovered and popularized in the early 2000s by the Nigerian teacher Mohammed Bah Abba. By manufacturing and mass distributing zeer pots to the poor, he was able to bring refrigeration to tens of thousands of impoverished farmers and home makers, [enabling them to extend the usable life of their produce from days to weeks](#). For his efforts [Bah Abba was awarded the Rolex Award](#) for bringing life-changing technology to people in need.

In the under-developed parts of Africa and the Middle East, zeer pots use [custom made pots prepared by local potters](#). Here in the developed world, we need to settle for pre-made pots from the hardware store. There are some drawbacks, but also some advantages afforded by these limitations, as you will see.

What makes this zeer pot practical?

There are other zeer pot instructables out there, but this one is optimized for practicality. If the capacity is too small, the cooling capacity too low, or if it an eyesore or is annoying to use nobody would want to use it. This zeer pot uses a large glass pot lid, has an interior basket divider, and sits on a rolling cart. It even has a layer of decorative pebbles over the sand to make it look pretty. The terra cotta pot legs hold the pot off the rolling cart with enough clearance to let the bottom surface contribute to evaporation; this adds about 10%-15% more evaporative surface. The inner pot is bolted down so that it doesn't float up when you charge the pot with water. Nearly everything I used in this project was purchased at a hardware store, and it can be made in a few hours, plus a day to let the sealants cure.

I will be building a zeer pot array for [A Place for Sustainable Living](#) in Oakland (California) based on this design. The goal is to use an array of zeer pots to displace the use of at least one of their refrigerators. The design shown here is the outcome of my experimentation with making zeer pots for them.

(Be sure to read all the notes to all of the photos. Many important details are listed there.)

Parts list with prices

Prices are rounded to the nearest dollar. (I must admit, this is by no means the inexpensive original African zeer pot, which cost \$2 to make. You're going to spend well over a hundred dollars on this design. This one is for people are intentionally going out of their way to go off grid or to pursue sustainable options.)

Items are mostly from Orchard Supply Hardware (Berkeley, CA). The pot lid was from [Kukje market](#) (Daly City, CA), and the sandwich basket was from [Web Restaurant Store](#).

- 18" **unglazed** terra cotta pot— \$30 @ Orchard Supply Hardware
- 14" terra cotta pot—\$15 @ Orchard Supply Hardware
- terra cotta pot feet, quantity: 7— \$1.79 each, so about \$13 @ Orchard Supply Hardware
- heavy duty planter caddy with five casters—\$30 @ Orchard Supply Hardware
- 50 lbs of sand; the finer the better, pre-washed — \$6 @ Orchard Supply Hardware
- 4" long 1/2" bolt
- 2" washers for a 1/2" bolt, quantity: 5
- jamb nuts for 1/2" bolt, quantity: 4
- Refrigerator thermometer: \$8 @ Orchard Supply Hardware
- Silicone Sealant—\$5 @ Orchard Supply Hardware
- 13.5" glass pot lid — \$8 @ Kukje Market (Korean markets usually have these; wherever you are, if there's a korean market or housewares shop, you're in luck.)
- sandpaper
- 12" diameter sandwich basket— \$7 at [Web Restaurant Store](#)
- 8" eyelet or hook bolt and a pair of nuts and washers— about \$6 @ Orchard Supply Hardware

Note: won't work as well in high humidity

If you live in a hot and humid area, the zeer pot probably won't work well; high humidity results in much less evaporative cooling. (However, a friend of mine who used a zeer pot to cool water in a humid part of Africa tells me that even with the humidity, it worked surprisingly well, so this is not definitive.)

Note: direct sunlight will cancel out all cooling effects

On the day I was doing the zeer pot seminar at the Place for Sustainable Living, we accidentally left one in direct sunlight. The amount of heat imparted by the sun totally overwhelmed the evaporative cooling effect. The cooling is supposed to come strictly from wind-induced evaporation, not from evaporation due to sun exposure. Sun exposure causes evaporation by imparting heat; wind exposure causes evaporation by lifting away water molecules, which carries away heat proportional to the heat it takes to evaporate the quantity of water carried away. If you do build a zeer pot, make sure you keep it in the shade for best effect.

Note: outer pot must be *unglazed* clay or terra cotta

At the hardware store, I saw a lot of fake terra cotta pots made of orange plastic. These are not usable for the outer pot of the zeer pot; the zeer pot cools by wind evaporating water that has been wicked through the outer surface. Plastic fake terra cotta is not porous, and will not work as an evaporative surface.

Glazed terra cotta pots also don't work for the outer pot. The inner pot doesn't necessarily have to be made of unglazed terra cotta, but the outer pot must be unglazed because glazed pots won't wick moisture to the outer surface for evaporation.

Note: many medium sized zeer pots work better than one giant zeer pot

The ability of a zeer pot to cool its content depends on the *surface area to volume ratio*. As you make the zeer pot larger, the volume will increase proportional to the cube of the linear dimensions, but the surface area only increases proportional to the square of the linear dimensions. Because the volume increases much faster than the surface area, one huge zeer pot will actually perform much worse than several smaller zeer pots. The size of the zeer pot in this instructable is about as large as you can make them while having a practical rate of cooling. You can always make them smaller; making them larger is not likely to give you reasonable performance. If you are serious about going off-grid, you would do better to make several zeer pots of this size than to make one huge zeer pot.

Step 1: Prepare the Central Bolt, Bolt Shut the Hole on the Outer Pot



(Be sure to view all of the photos above; much of the explanation is contained in the photo notes.)

In this practical zeer pot design, we have a limitation that I turned into an opportunity. The terra cotta pots that we have access to have holes in the bottom for drainage; these need to be plugged so sand and water don't drain out the outer pot, nor into the inner pot. I have found that it is insufficient to merely plug the holes; zeer pots also have another annoying problem where the inner pot will try to float up as you wet the sand in the space between the pots. In order to solve both of these problems, I use a 4" long 1/2 diameter bolt, and a bunch of nuts and broad washers and a bit of silicone sealant to seal the holes in both pots. The secondary benefit of this is that the inner pot can't float up because it is bolted to the same bolt that seals the outer pot. This way, you can be generous with charging the sand with water without worrying about the inner pot floating up.

The first thing you need to do is to put a pair of broad washers on your bolt, put some silicone sealant on the threads, and tighten them down with a nut. Then, seal around the nut with more sealant.

While the sealant is curing, use your sanding block to remove the clay burr around the hole of both pots. Be sure to sand off the burr both on the inside and the outside of the hole until the washer can lay flat against the pot. If you do not remove the burr, water will leak past the hole.

Now, it is time to seal the hole in the outer pot. This works best with an assistant helping you. Lay the pot on its side, and put some silicone sealant on the clay around the hole both the inside and outside the pot; insert the shank of the bolt through the hole, and have your assistant thread on a washer and bolt it down from the other side. Wipe up any sealant that squeezes out around the washer. Then smear sealant around the nut and bolt to prevent water from leaking out around the threads.

Step 2: Prepare the Washer on the Bolt to Seal the Inner Pot



Turn the outer pot upright, and rest it on pot feet on your rolling pot cart. Put three pot feet into the pot near the bolt, and thread another washer onto the bolt such that when you put your washer down on the nut, the top level of the washer is just a tiny bit higher than the top of the pot feet. The washer must not have its upper surface lower than the upper surface of the pot feet; if it does, the inner pot will rest on the pot feet, and won't have its hole pinched tightly by washers from above and below.

Add a little bit of sand to the outer pot; you want just enough to fill the places that will be hard to get to once the inner pot is in place. Be sure there isn't sand on the washer or pot feet; the sand may prevent the inner pot from sitting flat on the washer, and will prevent a good seal. If you decide to dampen the sand to make it more easily shapable, do so **BEFORE** you put it into the pot, and add water using a spray bottle only until the sand has the consistency of brown sugar. Any more, and the sand sticks to everything.

Once the washer is in place, seal the threads with silicone, and thread on the nut that holds the washer in place. Put some silicone on the washer so that it will seal against the bottom of the inner pot, and rest the inner pot on that washer. Then put some sealant around the hole on the inside, add another washer to the bolt, and pinch it down with a nut. Seal the threads and the gap around the nut with silicone, and wipe up any silicone that squishes out around the washer.

(Unfortunately, I don't have a picture of the last step where we tightened down another washer to pinch down the inner pot.)

Variation: inner pot nested an inch lower

In the photos above, I show the pot legs used as spacers positioned upright. You can also position them laying on their sides so that the inner pot sits about an inch lower. (If you do this, be sure to use sand paper or a file to remove the clay burrs from the side edges of the pot feet, or else the inner pot won't sit properly on these spacers. Also, you can use a shorter bolt; I don't know precisely how much shorter, but probably about an inch shorter.) You can see from some of the photos in the other steps that the inner pot's upper lip sits about an inch above the later of decorative rocks. While this affords a little bit more evaporative surface, it also means the inner pot's upper edge is not surrounded by as much thermal mass as it could. Having the inner pot nested a little bit deeper also means you can use a couple of quarts less sand, which will also make the completed zeer pot just a bit lighter.

The next zeer pot I build will be this variation.

Note: Be sure the pot feet are close to the central bolt

I made a couple of mistakes in the pictures which show damp sand in the pot. Firstly, I put too much water in, and the sand started to stick to everything, which was a real hassle. Secondly, the pot feet were too spread out, and I had to move them back toward the central bolt. The reason you must have the pot feet close to the center is that the bottom of the inner pot actually has a raised perimeter. (This slightly raised perimeter can be seen in the photo from the prior step which shows me sanding the burr away from the hole.) If the pot feet end up contacting the raised perimeter, the part of the pot right around the hole won't touch the washer that you matched to the height of the pot feet, and you won't get a good seal around the hole of the inner pot.

Step 3: Sand Down the Inner Pot If Pot Lid Won't Fit

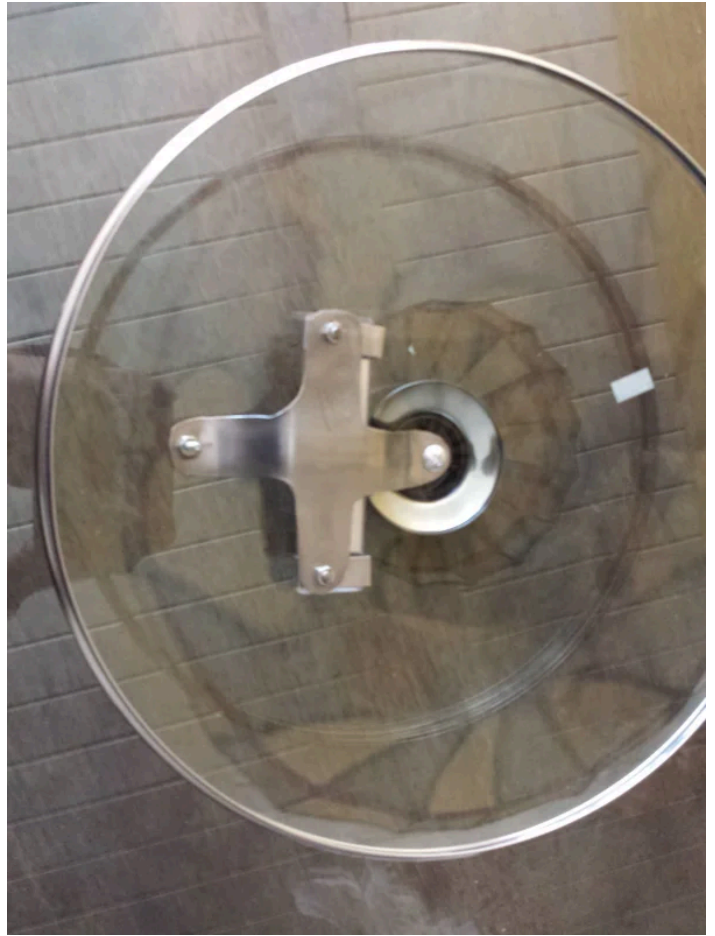


When you buy your inner pot, you should bring your pot lid to find one that fits well. However, please be aware that terra cotta is an imperfect material, and the pots will not likely be perfectly round. Because of this, you should use some sand paper to sand the inner pot's upper lip to make the lid fit.

Try to get the lid to fit as well as you can, and note where it contacts the terra cotta. Mark those areas either with pencil or perhaps with chalk. Use the sand paper to sand away the contacting areas, and keep doing this until the lid fits right. In our case, it took several hours of very careful checking and sanding to get the two zeer pots to fit their lids well.

Wipe up or vacuum up all the terra cotta dust before continuing.

Step 4: Optional, for the Sheet Metal Blackbelts: Add a Thermometer.



If you really want your zeer pot to have that extra nice touch, get a piece of sheet metal, and cut out a bracket to mount your refrigerator thermometer. You'll need a bolt and nut that fits the vent hole of your lid to lock down one end of the bracket; the other end will thread through the same screw that holds the handle onto the pot lid.

With the thermometer mounted on the lid, you can tell the temperature at a glance. Since the warmest air in the zeer pot rises to the top, you'll know that the temperature inside will be cooler than what the thermometer indicates.

Step 5: Fill the Gap With Sand, Add Water, and Top With Decorative Rocks



Firstly, adjust the four pot feet on your rolling platform at this time so that they are evenly distributed. Once the sand is in and the pot is wet, the zeer pot will be very heavy.

Use a funnel to add sand. You will likely end up using all 50 pounds of sand. Add more if needed; we ended up adding a couple of quarts of extra sand you want about 1/2 inch of a gutter going all the way around, which you will fill with decorative rocks **after** you wet it all down.

Before adding water, let all the sealant on the bolts and washers cure for at least 3 hours, or overnight for best results.

Add water one quart at a time; the sand will settle, and you will probably need to add a bit more sand when the pot is saturated. When the sand is saturated, you can add the decorative rocks, and perhaps a bit more water. The rocks are not just for looks; when you re-wet your pot, the rocks dissipate the water that you're pouring into the gutter so that the stream of water doesn't cut a pit into the sand.

Once the pots have their sand saturated with water, the pot will darken from water wicking through the terra cotta. Put the pot in a breezy area for the initial cool down. A breeze is absolutely necessary; it simply will not cool down enough without it.

A decorative trim is one of those things that sets this zeer pot apart; people are more inclined to use beautiful things. A zeer pot that looks really nice is not going to be something you're embarrassed to use.

Note: if you are using beach sand, wash the sand to remove salt

If you decide to use beach sand to fill your zeer pot, be sure you wash the sand in a couple of changes of water to purge it of salt. Salt will contribute to the mineral build up on the terra cotta that

lessens the cooling effectiveness of the zeer pot.

Note: water will likely pool in the inner pot after saturation

Do not be alarmed if some water pools up inside your inner pot during the initial cool-down after you saturate it with water. Use a sponge to soak it up and wring the sponge over the decorative pebbles to return the water to the sand.

If water accumulates inside quickly, you probably have a leak, which is a whole different problem. If your inner pot is cracked, you will need to replace it. If your washers and nuts are not well sealed, you will need to let the whole thing dry out, and re-seal the entire thing, leaving at least a few hours for the sealant to cure.

Step 6: Add a Handle to the Inner Basket



Get your eyelet bolt, and a pair of nuts and washers, and bolt it onto the sandwich basket as close to the middle as you can. The basket should be pinched tight between two washers. This inner basket gives you an extra platform to put stuff on, and is one of those features that makes this zeer pot practical compared to some of the other "first world" hardware store zeer pots you may have seen.

Insert the basket into the zeer pot, and put the lid on. Adjust the eyelet bolt such that it is as high as possible without touching the glass lid. You want the eyelet bolt to be useful as a handle even if the basket is filled with fruit or other items.

Step 7: Root Cellar Variant, and Important Notes About Usage and Limitations of the Zeer Pot

You should moisten the zeer pot with a quart of water three times a day. If you store your water in the zeer pot, or have a dedicated water chilling pot, you will have the best results, since the water you add will be cold already, and won't increase the temperature of the pot.

Root cellar variant

One neat variant for keeping root vegetables and scallions fresh is to build your zeer pot, and to fill the inner pot half way up with damp sand. Then, bury your carrots and beets in the sand to store them. Damp sand will keep your root vegetables as fresh as possible by keeping them alive. You will find that they remain crisp for longer this way. Also, if you have scallions, bury the root parts in damp sand to keep them fresh. This works even better than simply keeping them cold.

Please note:

- The zeer pot will eventually accumulate mineral build-up. Use hot water and a sponge, or perhaps a bit of lemon juice to dissolve away the minerals that crust up on the outside of the zeer pot.
- The zeer pot will not be as cold as a refrigerator; it will be cool, and it will keep your food cool, but it will not chill a hot container of food down to safe temperatures.
- The zeer pot **needs** a breeze to cool. If you have a good breeze all the time, or perhaps a small fan powered by a solar panel, the pot can get quite cold. Imagine that chill you get when you step out of a pool when the wind is blowing. Now imagine that going on all day. That's what the pot feels with a constant breeze.
- High humidity will result in reduced performance. However, a friend of mine who used a zeer pot in a hot humid part of Africa told me that it still worked "shockingly well", so it might just work. But keep it in the shade, with a breeze.
- Zeer pots actually perform better than refrigerators for many vegetables; vegetables wilt in the refrigerator because the condensation on the cooling tubes dries out the air. Refrigerators blow a lot of air over a little chilling surface that is really cold, causing the air to dry out. In contrast, the air in the zeer pot is chilled over a much larger surface that is only a little bit colder. This minimizes condensation; also, since the surface inside the pot will be moist terra cotta, the air inside will have as much moisture as possible, which keeps vegetables crisp in spite of not being as cold as a refrigerator.

The zeer pot is a greener option **only** if you use it according to the following rule:

- These things can evaporate a couple gallons of water a day if you have a good breeze, especially if the weather is dry and warm. If you multiply this water consumption by several zeer pots, this can be a considerable water consuming appliance. I don't intend to unleash upon the world a device that wastes water in lieu of using electricity, especially in California, where we are experiencing a drought; I expect that everyone who uses these zeer pots to use a bucket to catch the gallons of water that you would normally waste while waiting for the shower to warm up, and to recover this water for the zeer pot. That way, you're saving electricity without using any additional water. Or, go ultra-sustainable and use captured rain water.