Rainwater Harvesting: Comparing Storage Solutions

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Storage tanks, usually the most expensive component of the rainwater harvesting system, come in a wide variety of sizes and types. When deciding on the type of tank to use, the main factors to consider include where you live and your budget. When choosing the size of storage tank or cistern, consider several variables: rainwater supply (local precipitation), demand, projected length of dry spells without rain, catchment surface area, aesthetics, personal preference, and of course, your budget.

A myriad of variations on storage tanks and cisterns have been used over the centuries and in different geographical regions: earthenware cisterns in India, large pottery containers in Africa, above-ground vinyl-lined swimming pools in Hawaii, concrete or brick cisterns in the central United States, and, in Texas and Colorado, galvanized steel tanks and site-built stone-and-mortar cisterns.

Tanks can be above or below ground. Factors such as soil, outside temperature ranges, and cost should be used to determine whether a tank is placed above or below ground. Some tanks are suited for above-ground placement (i.e. vinyl-lined swimming pools), where others can be used both above and below ground (i.e. polyethylene). Some types of tanks are built to be buried (i.e. polyethylene tanks designed for burial).

Consequently, understanding all the information about the options available is critical to making a good decision about the type of tank to purchase, since it should prove to be something you live with for a long time. Below is a general overview of the various tank types to choose from and some of their characteristics.

Fiberglass

Fiberglass tanks are light-weight, reasonably priced, and long lasting. They are built in standard capacities from small 50 gallon barrels to much larger 15,000 gallon tanks and are available in both vertical cylinder and low-horizontal cylinder configurations. Smaller fiberglass tanks (i.e. under 1,000 gallons) are expensive for their size, so polyethylene might be preferred. Tanks for potable use need to have a USDA-approved food-grade resin lining and the tank should be opaque to inhibit algae growth. The durability of fiberglass tanks has been thoroughly tested and proven to last for years and can be easily repaired. The fittings on fiberglass tanks are an integral part of the tank, eliminating one common potential problem - leaking fittings.

Polyethylene

Polyethylene tanks are probably the most common type of tank being sold today and are readily available at most farm, ranch supply, and large landscape retailers. They vary greatly in size, shape, and color, and can be used above or below ground.

However, most of the tanks stocked by farm and garden supply houses are usually for above-ground installations. For buried installation, specially designed and reinforced tanks are necessary to withstand soil expansion and contraction. polyethylene tanks are comparatively inexpensive, lightweight, and long-lasting and are available in capacities from small 50 gallon barrels to large 10,000 gallon tanks. They are lighter in weight than other types of tanks, including fiberglass, and consequently, are cheaper and easier to transport.

Polyethylene tanks tend not retain paint well, so use pre-painted (i.e. pigmented) tanks manufactured with opaque plastic. Black and dark colored tanks will absorb heat and thus, should be shaded or buried. The fittings of these tanks are aftermarket modifications and are easy to plumb. However, the fittings are not always tight, and should be checked for leakage occasionally.

In-ground polyethylene

In-ground polyethylene tanks are more costly for two reasons: the cost of excavation and the cost of a more heavily reinforced tank.

The latter is required if the tank is to be buried more than two feet deep. Burying a tank in soil with high clay content is not recommended because of the expansion and contraction cycles of clay.

For below ground installation, the walls of poly tanks must be manufactured thicker, and sometimes, an interior bracing structure must be added.

Swimming Pools

Above ground swimming pools are commonly used in Hawaii for rainwater catchment; and although used throughout the islands, they are not a good rainwater catchment solution. A few of the issues related to these pools as a storage device are: 1) The pool liner typically only goes up to the lip of the pool and slips into the pool. 2) Liners are not food grade quality and may in fact be made to retard bacterial growth in the pool and can be toxic. 3) Large diameters of these pools are not easily covered and therefore it is difficult to keep out debris and animals.

However, swimming pools are very inexpensive, readily available and an easy to install solution. If this is the only option available then take the following precautions: 1) Make sure the liner is approved by the Food and Drug Administration (i.e. not the standard liner but one made for storing and holding water). 2) Plan to have a support system (i.e. a post in the middle of the pool) to hold up the cover so it does not sag into the water. 3) Make sure the cover can be firmly attached to the top of the pool to keep out unwanted guests and debris.

Wood

For personal aesthetic appeal, a wood tank is sometimes a desirable choice. Wood tanks, similar to water towers at railroad depots, were historically made of redwood. However, modern wood tanks are usually of pine, cedar, or cypress wrapped with steel tension cables. Wood tanks are lined with plastic to increase longevity. For potable use, a food-grade liner should be used.

Redwood, as a tank material, has a great reputation for being durable and attractive. It contains no resins and has high levels of tannin, a natural preservative resistant to insects and decay. It is also a good insulator, keeping the water cooler in the summer and protects it from freezing the winter.

These tanks are available in capacities from small 700 gallon tanks to very large 37,000 gallon tanks, and are usually site-built by skilled technicians. As with metal tanks, they can be dismantled and moved to a different location, if required. These tanks are for above-ground use and not for use in dry, hot climates.

Redwood is very attractive, but it is expensive and not readily available. Pine is commonly used and although it does not have some of the characteristics of redwood, it is readily available and less expensive.

Metal

As with wood, galvanized sheet metal tanks can also be an attractive option. They are available in sizes that range from small tanks of 150 gallons to medium-sized 2,500 gallon tanks, and are lightweight and easy to relocate if required. Most tanks are corrugated galvanized steel dipped in hot zinc to improve corrosion resistance. These tanks should be lined with a food-grade liner, usually polyethylene or PVC, or coated on the inside with epoxy paint. The paint or liner will extend the life of the metal and, if being used for potable water, must be FDA and NSF approved for potability.

These tanks are for above-ground use. Old or recycled tanks may contain lead and should be avoided. Brass and bronze fittings should not be connected directly to the tank as they will cause corrosion. Additionally, care should be taken when cleaning

these tanks, as a film develops naturally on the inside of the tank, which coats the tank and inhibits corrosion.

Concrete

The most versatile of tanks, concrete tanks can either be poured in place or prefabricated. They can be constructed above or below ground. They can be owner or contractor-built. Poured-in-place tanks can be very attractive and easily integrated into new construction. For example, the tank can be placed under a patio, or a basement. Concrete tanks, once poured, are considered permanent.

One unique advantage of poured concrete is that the concrete will over time decrease the corrosiveness of rainwater by leaching into the water. This advantage of concrete tanks results in a desirable taste imparted to the water by calcium in the concrete being dissolved in locations where there is slightly acidic rainwater. For potable systems, it is essential that the interior of the tank be plastered with a high-quality material approved for potable use.

Underground concrete tanks are prone to cracking and leaking, especially when in clay soil. Leaks can be easily repaired, although the tank may need to be drained to make the repair. If building the tank yourself, it is recommended to involve the expertise of a structural engineer to determine the size and spacing of reinforcing steel to match the structural loads of a poured-in-place concrete. A product that repairs leaks in concrete tanks, Xypex(TM), is now available and approved for potable use.

Ferrocement

Ferrocement is the term used to describe a steel and mortar composite material. These tanks can be above or below ground and can be done by contractors or homeowners. They were developed in third-world countries to be relatively low-cost and durable. They are listed separately from concrete, not just because of the materials used to construct them, but also because they have differing problems and advantages.

These tanks are typically built with concrete, but have multiple layers of wire mesh - typically chicken wire-wrapped around a light framework of rebar, embedded in the concrete. Walls can be as thin as 1" and still be strong. Consequently, it can cost less to build than a concrete-only tank. If buying a ferrocement tank, make sure it does not contain any toxic compounds in the concrete and that the wires are not visible on the inside of the tank.

Ferrocement, like concrete, will need maintenance and repair as cracks appear. It is important to ensure that the ferrocement mix does not contain any toxic components. Some sources recommend painting above-ground tanks white to reflect the sun's rays, reduce evaporation, and keep the water cool.

Stone & Mason

Hand made stone or mason tanks are not as common as they once were. Increasing labor costs, decreasing costs and increasing availability of other types of tanks has limited their use to areas where labor is very, very cheap (i.e. third-world countries) or where budget is not an issue.

The mass of the stone gives these tanks two distinct advantages: it keeps the water cool in hot climates and they can be very attractive. As with ferrocement tanks, care should be taken to make sure the mix does not contain toxic materials.

These tanks are custom-built, so they can be as large as designed. Most tanks are designed to be circular, since this shape is more structurally sound. These tanks, if properly constructed and maintained, will last for decades.

Plastered Tire Cistern

Another type of hand-made tanks are plastered tire cisterns. They were pioneered with the earthships in the Taos, New Mexico area and some have been in use for decades. They are simply a circle of buried tires with a wire mesh inside covered with plaster. Just like stone or cement cisterns, they will need periodic maintenance to repair cracks on the inside.

These tanks are meant to be buried and can be very economical for large tank sizes (i.e., 10,000+ gallons/37,900 liters), especially if owner-built. In earthships, tanks are typically built as an integral part of the home and can provide cooling in hot climates. In cooler climates, the tops and sides should be insulated to prevent cooling. Care should be taken in building a plastered tie cistern to ensure the wire mesh and tires are thoroughly covered with plaster.

As with stone and mason cisterns, these tanks are custom-built, so they can be as large as designed. They are typically designed to be circular, but since they are buried, they can be almost any shape. These tanks, if properly constructed and maintained, will last for decades.

Summary

A summary of cistern materials is below. Keep in mind that the tank is one of the most important components of the system, typically being the most expensive and the most permanent. Prices on each type of tank can vary widely depending on your locale, local labor costs, and the price of raw materials. Check with distributors and other rainwater harvesters in your area prior to making your final choice.

	Expected Life	Availability	Transportability	Expected Maint.	Build Your Own
Fiberglass	++	++	++	--	---
polyethylene	++	+++	+++	--	---
Below Ground polyethylene	+++	++	+++	--	---
Cement	++	+	---	++	+
Ferrocement	++	+	---	++	++
Plastered Tires	+++	-	---	++	++
Stone	+++	-	---	+	+
Wood	+	-	++	+	-

LEGEND: -- Low/No + High/Yes

General Guidelines

General guidelines for all tanks include:

- Before you start, conserve, conserve, conserve. Cutting your water usage will reduce the size of tank you need and save you money.
- Remember - water is very heavy. (i.e., 500 gallons weighs over 2 tons!)
- Make sure the tank is easy to access and maintain.
- Tank should be opaque or darker, either upon purchase or painted later, to inhibit algae growth.
- For potable systems, storage tanks must never have been used to store toxic materials.
- Tanks must be covered and vents screened to discourage mosquito breeding.
- Tanks used for potable systems must be accessible for cleaning.
- Install first-flush and screening devices prior to water reaching the tanks to keep it as fresh and clean as possible.
- Keep tops of tanks free of debris to make it harder for animals to reach the top of the tank.
- Buried tanks should be located in well-drained soil and location.
- Water weighs about 8 pounds per gallon so plan your pad, if any, before installing your tank.
- Plan where storage tank overflow should be piped or directed to. Keep it away from underneath your holding tank to prevent pad erosion and to keep animals away.