Building an Insulated Cover for a Tire Waterer

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Using a construction tire as a water trough is a common practice among beef producers because it is low-cost, holds a large volume of water, and can serve multiple animals at once (Figure 1). However, the large surface area makes the water more prone to freezing, which adds to the drudgery of farming in winter (Figure 2). Waterers located near a barn may have access to electricity to power a heating element, but remote locations often lack convenient 120-volt power. Livestock producers in these areas need practical, viable, and cost-effective options to reduce the freezing potential of water troughs. This publication describes management practices and options to reduce freezing of tire waterers or open water troughs in remote locations.

Figure 1. An insulated cover protects the majority of this tire waterer, while still providing livestock access to drinking water.

Figure 2. A beef producer chopping ice to allow livestock to obtain water.

Weather Data

The coldest month in Kentucky is January. Typically, the coldest days are associated with a cold front that passes within a few days. Historical weather data for Kentucky indicate that there are approximately six days that may create temperatures low enough to cause freezing. Although, livestock producers should prepare for weather extremes and an increase in the number of days below freezing.

Basic Insulation and Thermal Conductivity

Understanding insulation and thermal conductivity principles is crucial for selecting appropriate materials for constructing an insulative cover. The goal is to use materials with low thermal conductivity to minimize heat transfer or loss and to improve energy efficiency.

Insulation refers to the process of using materials or techniques to reduce the transfer of heat or energy between objects or areas that are at different temperatures. This is accomplished by impeding the movement of heat through a barrier that minimizes heat loss or gain.

Thermal conductivity is a physical property of materials that describes their ability to conduct heat. The higher the thermal conductivity value, the more efficient a material is at conducting heat. For example, materials with low thermal conductivity like foam sheeting and plastics, are good insulators because they resist the flow of heat. On the other hand, metals have high thermal conductivity, making them good conductors.

The benefit of using a construction tire as a trough is the thick rubber tread. Rubber is generally ten times more insulative than concrete (Figure 3). This is because concrete is a poor insulator. Placing concrete in the center hub to seal the tire allows some ground heat to transfer to the water due concrete's poor insulation properties, but not enough heat will be transferred in winter to prevent water from freezing.

Figure 3. A cross-section of a tire waterer.

Preventing livestock drinking water from freezing is the main goal of a livestock producer. Luckily, water has some unique physical and chemical properties. For instance, water acts as a good heat storage material, protecting against large temperature fluctuations in outdoor environments. Pound for pound, water can store more heat than any commonly available material.

One way to utilize the insulative properties of water is to provide the maximum volume held by a trough. Construction techniques can affect the water volume, maintenance schedule, and thermal dynamic properties. For example, Figure 3 shows a drain placed in the hub that is elevated above the base. This design does not allow all the water to drain when cleaning and may create a hygiene issue. One option is to fill the sidewall with concrete, raising the base elevation and providing better drainage. However, this design feature displaces water, an excellent insulator, with concrete, a poor one.

The surface area of the trough is where the greatest heat loss occurs (Figures 2 and 3). The probability of freezing increases in locations that do not receive winter sun or are exposed to wind, which accelerates evaporative cooling. Experience and observations by livestock producers have shown that temperatures in the low 20s (°F) over several days are required to form ice across the surface of a tire waterer. Reducing the surface area reduces heat loss and the potential for freezing.

Designing the Insulative Cover

There are several ways to cover a tire trough. The designs described in this publication aim to improve performance and reduce maintenance. Each design has certain advantages and disadvantages compared with the others.

Designing a cover for a tire water trough is complicated by the following conditions:

- It must withstand harsh weather conditions.
- It must also be durable enough for an agricultural and livestock environment.
- It must be non-toxic.

Designs that meet these conditions require construction materials chosen to resist outdoor exposure, moisture, and corrosion. Durability must account for the size and strength of livestock pushing against the unit, how it will be anchored, and how it will be moved and stored. Only non-toxic materials should be used and fabrication should consider that livestock will explore and put anything within reach into their mouth.

Material Selection

The type of building materials suitable for this project are commonly used in aquatic systems such as boat docks. Ideally, the material would have the following characteristics:

- Be readily available.
- Provide structural support.
- Be durable and reusable.
- Resist rot and damage.
- Be easy to transport, construct, and repair.
- Be non-toxic.
- Provide insulative value.

- Be affordable.

Structural Building Materials

The issue is that no single construction material possesses all these characteristics. Some examples and characteristics of typical construction materials that might be used are provided below:

- **Wood** is light weight and typically less expensive than other construction materials. Working with wood can be accomplished using common tools and basic carpentry skills. However, untreated lumber will not hold up without being treated or painted. Conversely, pressure-treated lumber should not be used as it can leach toxic chemicals into drinking water. Marine-grade plywood is not considered lumber in this sense, as it is treated with oil rather than toxic chemicals. Preserving marine plywood requires sealing with an oil-based primer and an oil-based paint or stain.
- **Trex** is a wood and plastic composite decking material, made primarily made from equal parts reclaimed hardwood sawdust and recycled polyethylene plastic, such as grocery sacks. The benefit of this material is that the plastic protects the wood from moisture and insect damage. Embedded plastics also eliminate the need for costly and time-consuming sealing, staining, or replacing rotten boards, while the embedded wood provides stability and traction. However, Trex does not have the structural ability to span distances over one foot and is both heavy and expensive.
- **Galvanized metal** should not be used for drinking water purposes unless the material is coated or lined. Sealing with paint coatings is not recommended because coatings have difficulty adhering. Galvanized metal can leach zinc and or lead in water, which can cause heavy metal poisoning, so it is best to avoid the use of this material altogether.
- **Steel** is often the least expensive option for providing structural support to large components. However, rust and weight are potential problems with steel, and coatings are required to prevent corrosion, which increases cost.
- **Stainless steel** can withstand corrosion, but it is expensive, heavy, and can be difficult to cut.

- **Aluminum** is light weight, structurally stable, and non-corrosive. However, it is a conductor and when exposed to high-pH water aluminum can leach into the water.
- **Plastics** become brittle in the cold, which can cause breakage. In addition, plastics rarely hold up to the abuse livestock can inflict upon it.

Hardware

Any hardware used in the construction of the cover should be protected from corrosion. Examples of corrosion-resistant hardware include epoxy-coated deck screws or materials made from stainless steel (although low-grade stainless steel may still corrode).

Insulating Materials

Foam sheeting is the preferred insulating material for providing thermal insulation in an aquatic environment. Because livestock will eat foam insulation, it should be protected by placing it in interstitial voids of the structure or by covering it between construction materials such as plywood sheeting or decking.

Rubber is a good material to use in aquatic environments for the following reasons:

- Rubber repels water and does not absorb moisture, making it ideal for wet or submerged conditions.
- Rubber remains flexible over a wide range of temperatures, which is useful in applications where movement, expansion, or vibration may occur.
- Rubber's elasticity and compressibility make it excellent for forming watertight seals (e.g., gaskets, O-rings), which is crucial for preventing leaks.
- Unlike metal, rubber does not corrode, which extends the life of components exposed to water.
- Rubber has insulative properties.

Case Studies

Observations

The most useful design would be insulated covers that reduced the water opening by 75% (Figures 4 and 5). These designs were observed to be more manageable for producers. The cover consisted of a wooden frame fabricated using 2-by-4s and filled with four inches of foam board insulation. Three-quarter-inch plywood sheeting was used to cover the frame and insulation. Epoxy-coated deck screws were used to attach the frame and cover. The cover was then sealed with an elastomeric paint. A rubber skirt was attached to enclose the area under the cover where it interfaces with the opening.

Livestock benefited from a smaller opening, as their drinking activity could naturally keep it free of ice based on their consumption levels. A rule of thumb developed through management experience suggests that approximately 30 animals can maintain an ice-free opening when 75% of the surface is covered. An 18-to-24-inch opening is needed for large animals to angle their heads properly to drink. The width should be at least 24 inches wide. Furthermore, it is recommended that the overflow drainpipe remain visible and not obscured by the cover, allowing producers to easily monitor the overflow drain.

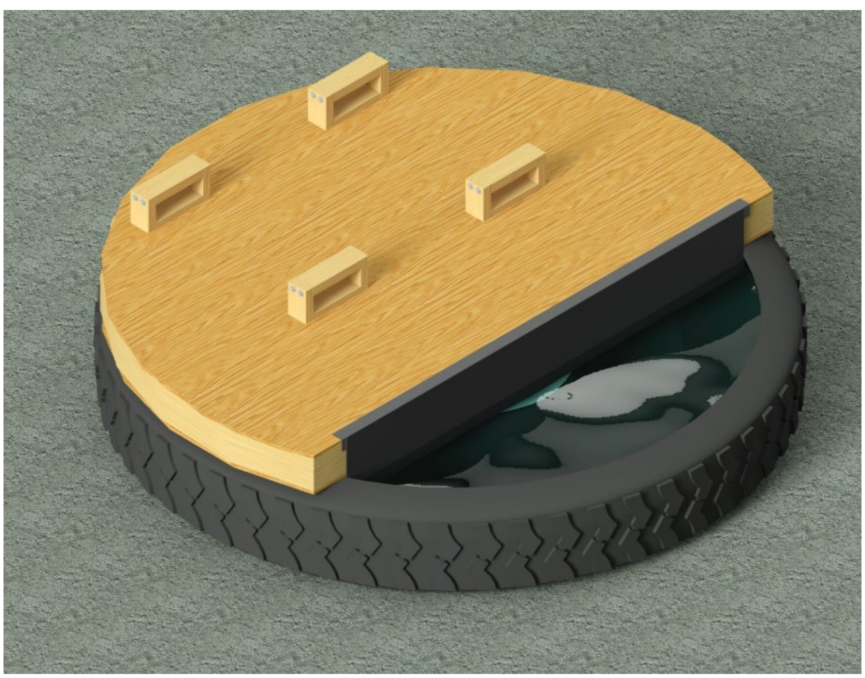

Figure 4. A rendering of a wooden insulated cover. Lifting pockets are used to facility moving and placement using a frontend loader.

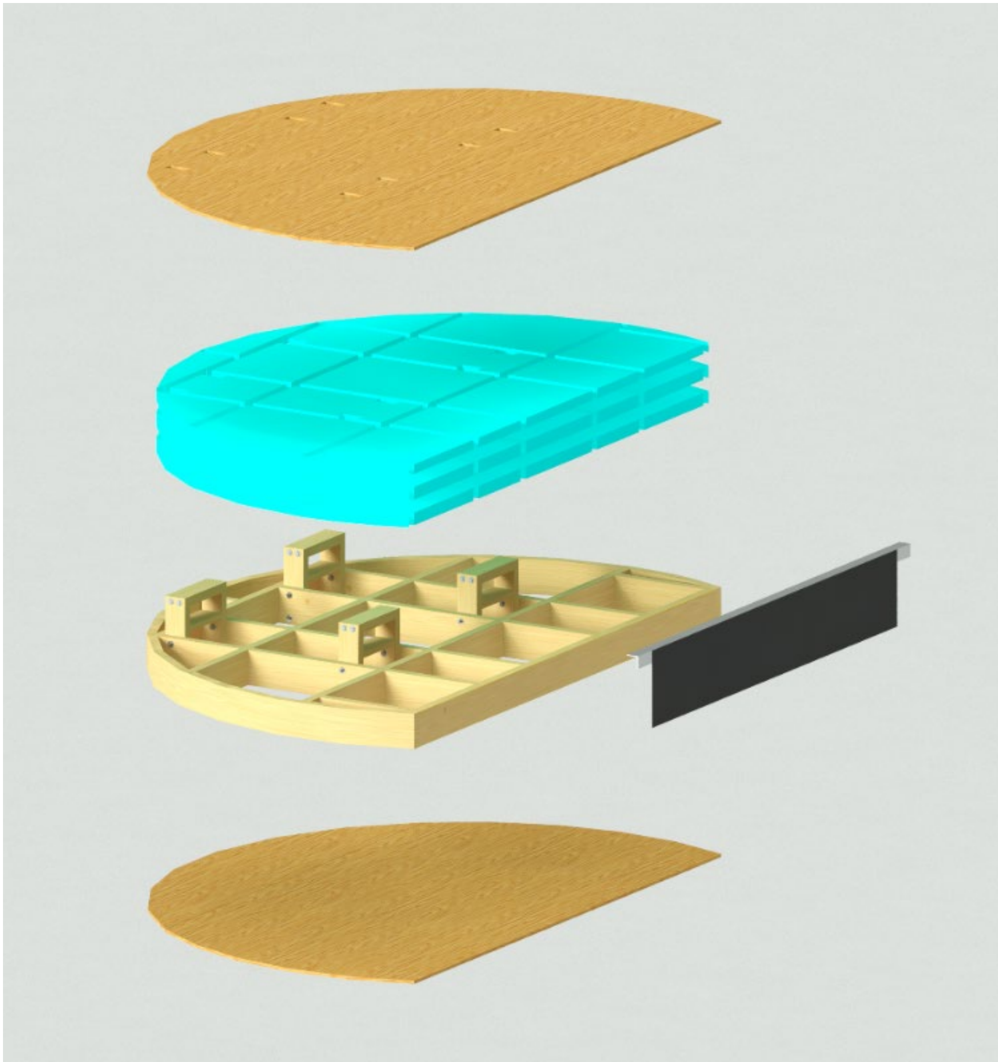

Figure 5. An exploded diagram of an insulated wooden cover.

The probability of a water trough freezing can be further reduced by the following management practices:

- Increasing the load or number of animals drinking from the water fountain. As animals drink, cold water is removed and replaced with warmer water, which has been insulated by the ground in the supply line. The greater the load, the lower the chance that the water will freeze.
- Lowering the water level in the trough can also reduce freezing potential. This practice shelters the water by allowing wind to flow over the rim, reducing the cooling of the surface water.

- Obstructing winds with snow fences, windbreaks, or trees can help. Existing buildings or structures may also change wind patterns across the surface of the trough and reduce the potential for freezing. Conversely, shading or obstructing sunlight in winter increases the likelihood and duration of freezing.
- Covering or protecting the trough to reduce the surface area and evaporative losses is one of the most effective practices. Common covers include plastic, wood, and rubber truck bed or stall mats. Insulating the cover with foam insulation further ensures that the water beneath stays insulated. Insulation is one of the most direct and effective ways to prevent a water trough from freezing.

Examples of Insulative Cover Designs: Learning by Trial and Error

A partial cover (more than two-thirds covered) was designed to reduce the surface area while still allowing animals access that may keep it open. The design also required that the drain remain visible (Figure 6). The cover consisted of a wooden frame fabricated using 2-by-4s and filled with 4 inches of foam board insulation. Three-quarter-inch plywood sheeting was used to cover the frame and insulation. The exposed surfaces were sealed with oil-based paint. A rubber skirt was attached to enclose the area under the cover where it interfaces with the opening using stainless steel screws and washers. The concept was to create an insulated air void to protect the float from ice and allow it to move freely.

The cover provided operator conveniences, such as a hinged door to inspect the float and threaded eyes to facilitate transport and placement (Figure 7). However, during the winter, the access door swelled from moisture and ceased to operate freely. Eventually, the eye screws pulled out. Every seam, screw hole, and crevasse were an opportunity for wood rot. It did not help that the surface of the cover was flat and not pitched to drain water. During the off season the cover was stored on an old porch. After two or three years, it was no longer functional (Figure 8). Failure was largely attributed to the wood not being properly covered with a waterproof sealant.

Figure 6. The first insulative cover design used a rubber dam that recessed into the water to seal the undercarriage.

Figure 7. The top cover provided conveniences like a hinged door to monitor the float. Threaded eyes were installed to facilitate lifting and placement.

Figure 8. The first cover design emphasized the importance of sealing wood construction.

Second Iteration

The second iteration was designed to cover half the surface area. Hinged side covers were considered as an option to open or close individual sides or fully close the cover to conserve heat (Figure 9). However, the hinged option required additional materials, money, and time, so it was omitted from the design.

Figure 9. An as designed image of the second cover iteration.

The redesign involved removing the side doors and extending skirts into the water (Figure 10). The exposed surfaces were covered with rubberized flooring material. The “as-built” design is pictured in Figure 11. This design worked, but most of the time the cover was positioned to block prevailing winds while providing a large, single opening (Figure 12).

Figure 10. Design changes to figure U included removing the side doors and replacing them with skirts.

Figure 11. Construction screws were used to attach this fifty percent covered design that allows cattle to drink from two sides.

Figure 12. Most of the time, the cover was placed to the windward side to allow drinking and wind protection for the leeward side.

The producer found that covering most of the opening helped limit ice formation. Another iteration was constructed to further reduce the size of the opening (Figures 13 and 14). However, the opening was too small to accommodate the neck of bulls. The small opening also made the removal of ice difficult using a pitchfork.

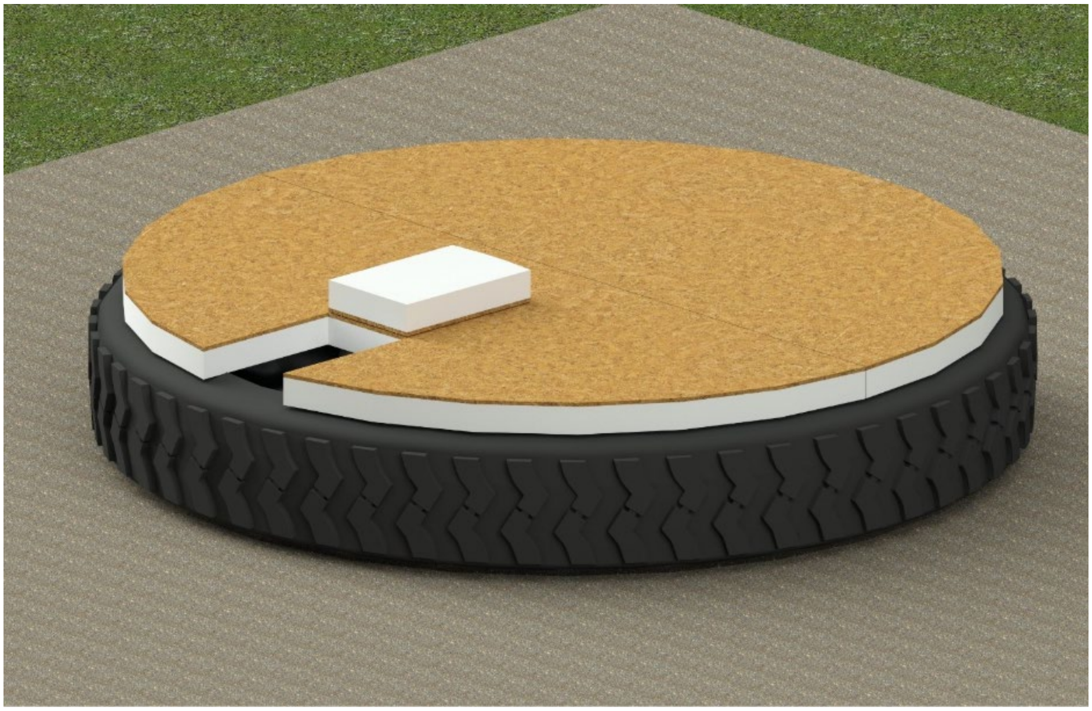

Figure 13. An image of a cover with a small opening for drinking that was too small for large males.

Figure 14. A group of stockers drinking from a covered tire water fountain.

Summary

Constructing a water trough using a construction tire is a popular practice among beef producers because of its low cost, large storage volume, and the ability to water multiple animals at one time. Obviously, reducing or eliminating freezing in winter increases the versatility of tire waterers. This publication describes several management practices and options to reduce freezing, which also improves performance and reduces maintenance. It also presents a useful insulated cover. Some designs allow a trough to be partially covered, split between two fields, or used on only one side. In addition, there are other management practices that can further reduce the potential for freezing.

References/Resources:

Yung, F. D., 1956. Heating drinking water for livestock. ASAE Journal Vol. 37, No. 6. pp-411-413.

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