Responsibility

Plastic tanks compare well to concrete in trout trial

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Lower costs, easy modification, transportability and reduced labor

Environmental regulations are resulting in reduced pollution limits for large fish hatcheries that can cause production reductions or even hatchery closures. This has led to more smaller, private fish farms providing fish for public stream stocking.

The U.S. state of West Virginia has many free-flowing groundwater sources from coal mines that can be used for biosecure, small-scale fish production. Economies of scale usually result in a higher cost of production for smaller producers, making it difficult to compete with larger operations.

In a study funded by the Northeast Regional Aquaculture Center, the authors used water from a small mine water discharge to determine if producers could reduce their costs by using a new patent-pending "U"-shaped plastic tank for fish production.

The potential advantages of the plastic tanks include lower purchase and installation costs, easy modification, transportability that allows resale value and reduced labor for cleaning. The costs of the new tank were compared to those for the precast and poured concrete raceway systems most commonly used for trout production.

U-shaped plastic tanks cost less to purchase, install and clean than flat-bottom concrete tanks of similar volume.

Tank comparison study

In November 2006, 10-cm-long rainbow trout fingerlings were stocked into 7,570-liter U-shaped tanks constructed with food-grade plastic and a similar-volume, flat-bottom concrete tank at two separate trout-rearing operations. Facilities at both locations had a history of normal trout growth.

Fish were fed a 42 percent-protein, 16 percent-fat commercial trout diet during the 31-week production cycle. Demand feeders were used at both sites. Nylon netting was used to deter aerial predators.

Average weight was measured at six-week intervals. Random samples of at least 50 fish were weighed with a commercial bench scale. As the trout approached marketable size, fin condition was recorded using a scale from zero (perfect) to 5 (over 90 percent missing or eroded) for each of the seven rayed fins. Each fish had a potential score of zero to 35.

Water quality data was monitored in the plastic tanks using a commercial instrument. Temperature, pH, oxygen and conductivity were recorded hourly. In the concrete system, a hand-held commercial oxygen meter was used to measure temperature and dissolved oxygen. Water samples from each site were analyzed by a certified analytical laboratory for anions and cations three times during the study.

The costs of purchasing, installing and cleaning the custom plastic tanks during the study were compared to the estimated costs of purchasing, installing and cleaning precast concrete tanks as well as poured concrete tanks. Businesses that specialize in building concrete tanks provided recent quotes for the cost estimates.

The labor costs for cleaning the plastic and concrete tanks were measured on five occasions during the last five months of the study. Annual labor demands for this task were estimated with this data.

Results

Critical water quality parameters remained stable at both sites for the most of the study. Water temperatures remained 11 to 15 degrees-C at both sites. Water analysis from both sites showed that all measured parameters were within the tolerance range of trout.

Water quality monitoring at each site showed the concrete tank had one low-oxygen event during the last week in May, which resulted in the precautionary removal of 400 trout (40 percent) from the system. The plastic tanks had two low-oxygen events in the lower tanks, one in May and one in June, due to the intrusion of a bear that diverted the water from the lower tanks. The upper two tanks were unaffected by this diversion of water.

Growth, fin condition and mortality data presented here are based on the average in the top two plastic tanks compared to the concrete tank. At the end of the study, average fish weight was based on a random sample of at least 50 fish from the approximately 1,000 fish stocked in each tank. The trout in the concrete tank showed better growth but also higher mortality than those in the plastic tanks (Table 1). There was no significant difference between the concrete and plastic tanks regarding the fin condition of the trout.

Hydrostatic water pressure pushed the solids that accumulated around the manifold into the off- solids removal pipe.

Miller, Growth, fin condition and mortality of trout, Table 1

Tank Type	Volume m^3	Trout weight gain (g)	Growth (g/day)	Fin Score (0-35)	Mortality (%)	Culture Days
Concrete	7.84	484	2.20	7.93	5.62	220
Plastic	7.57	382	1.75	8.08	3.96	219

Table 1. Growth, fin condition and mortality of trout in concrete and plastic tank systems.

A one-way analysis of variance was performed on the fin condition data using total fin condition scores. When the trout from the two plastic tanks were compared to the trout in the concrete tank, the procedure showed no significant ($\alpha < 0.05$) difference in fin erosion between the two trout populations.

Maintenance, cleaning costs

Assuming labor costs at U.S. $10/hour and cleaning occurs every five days, an average of five cleanings during the study resulted in 3.4 hours/tank/year for cleaning, or $34/tank annually. The average cleaning for the concrete tank required 6.75 minutes. This translated into 8.2 hours/tank/year or $82/tank/year (Table 2).

Miller, Cost comparison for 10 concrete and plastic tanks, Table 2

Tank Type	Cost (U.S. $)	Installation (U.S. $)	Cleaning (U.S. $)	Total (U.S. $)	Precast (%)
Precast concrete	45,8509	6,000	820	52,670	100
Poured concrete	33,110	4,000	820	37,930	72
HDPE plastic	24,507	3,000	340	27,847	53

Table 2. Cost comparison for 10 concrete and plastic tanks.

Although the manifold in the settling zone did not improve the solids retention in the plastic tank, it functioned very well by allowing hydrostatic water pressure to push the solids that accumulated around the manifold into the off-line solids removal pipe. Table 3 shows the various considerations used to compare the two tank materials.

Miller, Setup considerations, Table 3

Characteristics	Concrete Tank	Plastic Tank
Purchase cost	Higher	Lower
Tank weight	16.3 mt	344.7 kg
Site preparation cost	Higher	Lower
Vulnerability	Low	Moderate
Installation	Critical	Critical
Easy modification	No	Yes
Useful life	20 years	20 years
Waste removal	Slower	Faster
Flexibility	None	Some
Prod. volume (l)	7,570	7,570
Size restrictions	Customized	Maximum diameter 1.52 m
Outside use	No restrictions	51 cm set in ground
Inside use	No restrictions	HDPE cross bars
Resale/transfer	More difficult	Less difficult

Table 3. Setup considerations.

Versatile, cost-effective approach

The food-grade plastic tanks used in this research appear to be suitable for quarantine, fingerlings and grow-out in flow-through or recirculating systems. The development of improved screens and crowding systems can improve system performance.

These plastic tanks are presently limited to a maximum diameter of 1.5 meters. Concrete tanks can be made into nearly any size or shape. Although extremely resilient, the plastic tanks should be set into the ground 51 to 61 cm for stability. If used indoors on a hard floor, plastic feet can be added to stabilize the tanks.

The total cost of the plastic tank system was estimated to be approximately 53 percent of that for a precast concrete system and 72 percent of the cost for a poured concrete system with similar production volume.

The equipment and skills used to install the plastic tanks are more commonly available than for concrete tanks. The modular nature and durability of the tanks allows them to be easily moved and reset as needed.

The time required to clean the plastic tanks was 41 percent of that required to clean the flat-bottom concrete tanks. This was attributed to the design of the quiescent zone. Labor savings were estimated to be U.S. $9,600 over the expected 20-year life span of a 10-tank system.

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