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The design and construction of Aquaria

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Abstract

This paper discusses the design and construction of aquaria, pointing out that finance, size/weight, shape/position and materials are basic architectural facts to consider in aquaria building. The industry of ornamental fisheries has provided the government and individuals of many countries entertainment, employment, income and health benefits. Thus, concludes that despite the problem of finance, space and maintenance encountered by hobbyists, specialists and teams, it awareness and exploitation should be encouraged considering the opportunities that lie in exploiting the niche.

Keywords: Aquaria, Finance, Size, Material, Maintenance, Ornamental fishes

1. Introduction

The Aquarium is an artificial pool for keeping life aquatic animals and plants for ornamental, research and breeding purposes. The idea of keeping fish in glass aquariums originated after 300 BC when glass was invented. During the Ming dynasty (1368 - 1643), the Chinese were entertained with goldfishes kept in earthen and glass vessels. In 1833 it was demonstrated by the British Association for the Advancement of Science that aquatic plants absorbed carbon dioxides and emitted oxygen thereby benefiting the fish which led to the development of modern-style aquaria. Today, many homes and public arenas have aquaria made not only of glass but also of Perspex or Plexiglas ^[1]. The inventions of heaters and thermostats, aerators and biodisc have allowed more exotic fishes to be kept. The aquarium also has in it gravel, sand and rocks, which provide an artificial favorable environment to aid fish and plants survival as well add to the aquarium scenic beauty of environment.

A 18 gallon rectangular tank aquarium of size 60 x 30 x 38 cm is the most suitable size for home ^[2]. The building of aquaria either for ornamental, research and breeding purposes has provided many beneficial values, and today, without a professional's touch, many have been able to create and manage their own aquaria and earn from it like the entertainment industry have done. Today the design and construction of aquaria has to do with the building of aquaria of high safety and economic values with quality materials in accordance with recognized standards and individual taste.

2. Types of Aquarium

a. Home aquaria: They are generally made for keeping small sized indigenous or exotic fishes for decorative purposes in offices, hotels, shops, etc. when they are constructed in schools or colleges their main purpose is for study or research.

b. Public Aquaria: They are created in places of public exhibition and they have an advantage of affording the space for many larger and more exotic species. They add to the aesthetic and entertainment value of these places.

2.1 Major Aquarium Accessories

a. Composts: An aquarium composts is the gravel (small stones and pebbles or a mixture of these with sand) placed at the bottom of the tank in which plants can be grown. If a decorative aquarium is to be set up the composts used should be that which is generally available with the aquarium dealer. Composts must be washed well before use.

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- b. Lighting arrangement:** The light bulb(s) of about 25w (240v) are fixed attached to the cover of the aquarium. The bulb (s) are either 'clear' or 'pearl'. The fluorescent tube can also be used in preference to ordinary light bulbs.
- c. Thermometers:** The Thermometer of aquarium water is very important especially for tropical fishes. Aquarium fishes need optimum temperature to prevent biological oxygen demand and susceptibility to diseases. The Thermometer is magnate to the glass surface inside the aquarium and can be read through the transparent glass or Perspex.
- d. Heater-stats (Heaters with thermostats):** in a tropical aquarium the temperature should be maintained within the range of 65 °F-85 °F (18-29 °C) depending upon the species. A heater aids in controlling the temperature of the aquarium by raising it to the desired temperature range, regulated by its thermostat. This instrument is partly submerged or fully immersed in the aquarium.
- e. Air pumps:** The aquarium air pump is made up of air tubes and joints, controller and a power source. Air pumps are used in aquarium to force air into the tank (aeration). Air is forced by the means of a small-size hose through a small porous stone (diffuser). The steam of bubbles formed agitates the surface of the tank-water allowing better exchange of carbon dioxide and oxygen, through the entire system.
- f. Aquarium covers:** They are used to prevent fishes from jumping out, keep out dust, reduce heat loss and evaporation and hold light bulbs or tube; it may take the form of a plain glass sheet, plywood or metal-hood.
- g. Filters:** Filters the magic jet power filter is used to maintain good quality water in an aquarium. This device filters water mechanically, chemical and biologically. Other types of filters commonly used by aquarist are: Box filters, sponge/foam filters, under gravel filters and reverse flow filters.

2.2 Aquarium Contents

- a. Aquarium Fishes:** Generally aquarium fishes are small-sized and brightly colored with characteristic Makings, bands, spots etc. most of them are hardy and can survive and breed well in the Confinement, while others are delicate and require proper attention and care. They are Beautiful, attractive and entertaining by nature.

Examples of some aquarium fishes

- i. Gold fish (*Carassius auratus*)
- ii. Guppy (*Poecilia reticulata*)
- iii. Tiger Barb (*Barbus tetrazona*)
- iv. Gourami (*Colisa sp.*)
- v. Siamese fighting fish (*Betta splendens*)
- vi. Baluari (*Nemacheilus aureus*)
- vii. Bitterling (*Rhodeus sp.*)
- viii. Minnows or Carps [Koi] (*Cyprinus carpio*)
- ix. Zebra fish (*Brachydanio rerio*)
- x. Angel fish (*Pterophyllum scalare*)
- xi. Mosquitoes- fish (*Gambusia sp.*)
- xii. Harlequin fish (*Rasbora heteromorpha*)
- xiii. Beacon fish (*Hemigrammus sp.*)
- xiv. Argentine pearlfish (*Cynolebias nigripinnis*)
- xv. Swordtail (*Xiphophorus helleri*)
- xvi. Black molly (*Poecilia mexicana*)
- xvii. Snake-head [Murrels] (*Channa gachua*)
- xviii. Jewel fish (*Hemichromis sp.*)

- xix. X-Ray fish (*Pristella sp.*)
 - xx. Tilapia (*Tilapia mossambica*)
- (Source: Esther, 1998. Pandey and Shukla, 2005) [3, 4].

b. Aquarium Plants

Aquarium plants add science beauty and oxygen availability in the aquarium.

1. Rooted:

- i. *Vallisneria spiralis*
- ii. *Hydrilla sp.*
- iii. *Potamogeton sp.*
- iv. *Cryptocoryne sp.*
- v. *Sagittaria sp.*

2. Submerged Floating:

- i. *Ceratophyllum sp.*
- ii. *Myriophyllum sp.*
- iii. *Limnophila sp.*
- iv. *Hygrophila sp.*
- v. *Cabomba sp.*

3. Free Floating:

- i. *Lemna sp.*
- ii. *Pistia sp.*
- iii. *Salvinia sp.*
- iv. *Riccia sp.*

(Source: Gupta and Gupta, 2006) [2]

c. Food Items

Examples of food items in the aquarium are:

- *Tubifex* (Blood worm)
- *Daphnia* (Water flea)
- *Cyclops* (One – eyed giant)
- *Chironomus sp.*
- Mosquito larva
- Phytoplankton
- Algae
- Plants, etc.

However, of great use to aquarist are the commercially prepared dried foods. E.g. the pelleted maintenance ration and the lump holiday feed.

There are other aquaria contents that are created artificially that can also be added to the aquarium to increase it scenic beauty e.g. plastic plants, nutty boy, house wheel, toy fish, shell, tortoise, hungry duck, toy frogs, etc. and can be purchased from an aquarium dealer.

3. The Basics of Aquarium Designing

An aquarium system cannot be constructed or operated better than its initial design. In designing, you find out, gather information, ruminant and discern all facts, ideas, methods and attitudes as to utilize the most appropriate, best available materials and technology. In designing you aim aesthetically and functionally the sights and sounds from your aquarium and the basic facts to consider in aquarium designing are:

3.1 Finance: Cost considerations for construction and maintenance should be part of your design plan.

3.2 Size and Weight: Size is determined by the intended site and weight which cannot be overlooked as it entails the type of stand to be constructed.

According to Esther (1998) in choosing aquarium size, the fish requirements should be considered as there are some fishes which live in small pools and are much more at home in aquariums of about 30cm wide. Standard aquarium sizes usually range from 18" x 10" x 10" (45 x 25 x 25 cm), 60 x 30 x 30 cm (Pandey and Shukla, 2005. Esther, 1998) [4, 3].

Table 1: Some standard aquarium sizes approximate furnished volume and weight of water and glass thickness.

S/N	Aquarium size (In inches)		Volume		Glass thickness (mm)
	Length	Width	Depth	Imperial gallons	
1	18	10	10	6	4
2	24	12	12	12	6
3	36	12	15	20	10
4	48	12	15	30	12
5	60	18	18	70	12(minimum)
6	72	18	18	80	15(minimum)

(Sources: Pandey and Shukla, 2005) [4]

3.3 Shape and Position: Originally, there were only the rectangular aquariums but today there are unlimited numbers of possible shapes: square, triangle, column-shaped, pyramid-shaped, etc. and not every fish can be kept in every type of aquarium.

The position where the aquarium is to be kept is of importance as certain fish species will not tolerate the slamming of doors. The aquarium should be kept in a decorative and safe position, away from direct sunlight to avoid algal bloom.

3.4 Material: The material mostly used is glass and is a better investment than the plastic tank as it last longer. The plastic is easily damaged, removing algae from the sides with razor blade or soft scourer always leaves ugly scratches. The E.W. Scripps DIY custom Aquarium Company in US recommends a glass with 3.8 safety factor. But, many DIYers thought that is a bit of overkill and recommends that to economize on construction, a glass of 2.92 safety factor can be used to achieve the same results. You can increase the safety factor of your glass tank by bracing it and using a stand that fully support the entire tank bottom using a Styrofoam or polystyrene pad between the aquarium tank and stand. However, the quality of glass is determined by individual manufacturer's method and technique of producing the glass. Tested sample of uniform manufacture have indicated that the tensile strength runs from 19.3 to 28.4MPa (Scripps DIY Networks, 2006) [5].

4. Aquaria Construction, Management and Benefits

4.1 Basic considerations in Aquaria construction

- Ensure accurate measurements
- Prepare the glass or plastic material
- Use the right adhesive and apply it correctly
- Install the glass so as to have continuous, bubble-free seams.

4.2 Procedure for constructing an aquaria tank

Materials: Glass, Hanger, adhesive (silicone gum), masking or duct tape

Steps to follow:

- Put your prepared glass pieces on a flat surface

- Collect one of the glass panes for the base and set it on a flat table and the other four (4) pieces place adjacent at sides
- Apply a bead of the adhesive round the edges of the bottom panel and at two side edges of the front and back panel with the aid of the hanger
- Run a continuous 1/4 inch bead with no gaps or bubbles
- Install the back glass panel on the bottom and the side panels are fixed inside the back and front panels.
- When all the panels have been set in place the silicone is smoothed out with the tip of your finger and the panel supported at the corners with a masking tape. Thus, the aquarium is constructed such that the two end pieces of glass fit inside of the back and front panes and the front, back and two side panes set on top of the bottom base pane of glass. The best bonding results are achieved by applying only as much silicone as you can within 3 to 5 minutes, because after this, the silicone tends to skin over and won't bond well to the glass.

4.3 Installing the aquarium tank

Steps to take:

- After testing for leakages, wipe out the tank using a clean, damp cloth and place it on its stand
- Cover the bottom with a layer of clean sand (about 2.5 cm thick)
- Add the aquarium gravel and smooth it out with the air wall tubes and hose covered
- Add various rocks on the bottom which enhance the aquarium and also give fish a place to hide
- Add the water by placing a small bowl on the gravel and pour the water into the bowl. Let it run over the sides, filling the tank without disturbing the gravel or rocks
- When the aquarium is full. Test the water with pH meter before adding live aquarium plants and fishes
- Float the fishes, which are still in oxygenated water-bags or containers from the store into the tanks
- Put the cover in place to prevent the fish from jumping out.

4.4 Management of Aquaria

a. Materials used for maintaining an aquarium:

Aquaria cover, light tubes, starter units, heaters and thermostats, air pumps, diffuser stones, filters, filter media, nets, scrapers/algae cleaner, spot cleaners, feeding ring, water testing kits, planting sticks, siphon tube, thermometer, aquarium glass cleaner, etc.

b. Aquarium Maintenance

- Feed morning and evening.
- Look for signs of illness.
- Check breeding behavior.
- Check water condition e.g. pH, temperature and alter accordingly
- Check and clean some of the aquarium accessories.
- Avoid over feeding to prevent disease occurrence.
- All unhealthy fishes noticed with disease signs should be collected for diagnose and treatment. Healthy fishes are fishes that feed well, and are active. Their eyes are bright and their gills pink. There are no skeletal deformities and the body cavity of the fish is not swollen or the belly hollow [2].

4.5 Benefits of Aquaria

- The aquarium is a source of employment and income for individuals/companies of different countries involved with its design, construction and distribution.
- Some aquaria fishes aid in the environment control of mosquitoes.
- It is used for research and decorative purposes as it aids study and adds to the scenic beauty of the environment.
- Aquarium viewing certainly reduces stress and subsequently lowers blood pressure as well as aids in controlling Alzheimer's disease as shown by a study in the 80's and a Purdue study in 2009.

5. Conclusion

Aquaria design and construction require expertise which few teams around the world are trying to provide. It has evolved into a niche industry of international recognition and standards though provided by those few teams involved. You can purchase or create your own aquatic garden with the basic knowledge of aquaria design, construction and proper management of the system.

Despite the difficulties of finance, space and maintenance involved, this industry serves as a source of employment and revenue to both the government of different countries and individuals/teams occupying this niche.

6. Recommendation

The government, private organizations and research institutions should collaborate to create aquarium awareness considering the benefits it can offer.

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