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Aquarium Management: A Scientific Guide to Ornamental Fish Keeping



Paramita Banerjee Sawant
Debajit Sarma
Vikas Kumar Ujjania

Division of Aquaculture
ICAR- Central Institute of Fisheries Education, Mumbai

INTRODUCTION

Aquarium tanks constitute the fundamental infrastructure for ornamental fishkeeping, research, education, and commercial aquaculture. An aquarium is a controlled artificial aquatic ecosystem designed to maintain aquatic organisms under conditions that closely simulate their natural environment. The fabrication of aquarium tanks is therefore not merely a craft-based activity, but an applied interdisciplinary process integrating principles of physics, material science, aquatic biology, and environmental engineering. Properly fabricated aquariums ensure structural stability, water-tightness, optimal water quality, and long-term safety for both aquatic organisms and users.

The rapid expansion of the ornamental fish industry and the increasing use of aquariums for aesthetic, therapeutic, and educational purposes have amplified the need for scientifically sound fabrication techniques. Water exerts continuous hydrostatic pressure on aquarium walls, and this pressure increases proportionally with water depth and tank dimensions. Consequently, inappropriate material selection, insufficient glass thickness, or poor sealing techniques can lead to structural deformation, leakage, or catastrophic tank failure. Such failures not only result in economic losses but also cause severe stress or mortality in aquatic organisms.

Glass remains the most commonly used material for aquarium construction due to its high transparency, chemical inertness, resistance to corrosion, and compatibility with aquatic environments. Modern aquariums predominantly employ frameless, all-glass designs bonded using silicone rubber sealants. Silicone sealants provide excellent adhesion, flexibility, and long-term resistance to water and temperature fluctuations, making them ideal for maintaining leak-proof joints. The thickness of glass panels and the requirement for structural reinforcements such as cross braces or beading are determined by tank size, water volume, and design specifications.

Precision in measurement and fabrication is a critical determinant of aquarium durability. Accurate calculation of glass dimensions, particularly the side panels and base, ensures uniform stress distribution and structural



integrity. In larger aquariums, additional design modifications are necessary to counteract outward bulging caused by water pressure. Furthermore, ergonomic considerations such as placement height, lighting integration, and accessibility for maintenance play an important role in the functional efficiency of aquarium systems.

In addition to the tank structure, the successful operation of an aquarium depends on the integration of essential accessories including aeration devices, filtration systems, heaters, lighting units, and protective hoods. Together, these components maintain water quality, oxygen levels, temperature stability, and biological balance. Therefore, scientific understanding of aquarium fabrication and setup is essential for sustaining healthy aquatic ecosystems and ensuring the long-term success of ornamental fish culture systems



FABRICATION OF AQUARIUM TANK: A SCIENTIFIC AND ACADEMIC OVERVIEW

An aquarium tank represents a controlled, artificial aquatic ecosystem designed to house aquatic organisms under simulated natural conditions. From a scientific and engineering perspective, aquarium fabrication involves integrating structural stability, hydrodynamic safety, aesthetic appeal, and long-term reliability. Proper fabrication is essential to ensure the safety of aquatic organisms, the durability of the tank, and optimal water quality.

Structural Considerations in Aquarium Fabrication

The fabrication of an aquarium tank must account for three fundamental factors:

(i) aesthetic design, (ii) size and shape of the tank, and (iii) total volume of water.

As water exerts hydrostatic pressure on the tank walls, structural integrity becomes increasingly important with larger tanks and deeper water. Improper design or inadequate material selection can result in leakage, deformation, or catastrophic failure of the tank.

Glass as a Structural Material

Glass is the most widely used material for aquarium fabrication due to its transparency, chemical inertness, and corrosion resistance. The thickness of glass required for aquarium construction is directly related to the dimensions of the tank, particularly the height of the water column. Larger tanks require thicker glass panels to withstand internal pressure and prevent bending or cracking.

Recommended Glass Thickness Based on Tank Size

Tank Size (L × B × H in feet)	Glass Thickness (mm)
2 × 1 × 2	4
3 × 1 × 2	6
4 × 1 × 2	8



$3 \times 2 \times 2$	10
$4 \times 2 \times 2$	10
$5 \times 2 \times 2$	12
$6 \times 2 \times 2$	12
$7 \times 2 \times 2$	12

This graded increase in thickness ensures structural safety and longevity of the aquarium tank.

Role of Silicon Sealant in Aquarium Fabrication

Modern aquariums are predominantly **all-glass tanks bonded using silicon rubber sealant**, eliminating the need for metal frames. Silicon sealant provides high adhesive strength, elasticity, and water-tight sealing. Its flexibility allows it to withstand minor stresses from water pressure and temperature variations without cracking. For effective sealing, the sealant must be applied continuously and bubble-free to prevent leakage.

Design Modifications for Large Aquariums

For tanks up to **3 × 1 × 2 feet**, additional reinforcement is generally not required. However, aquariums larger than this dimension require **structural reinforcements** such as:

- **Cross belts** on the upper portion of the tank (for tanks above 3 × 1 × 2 feet up to 4 × 2 × 2 feet)
- **Beading and cross links** of approximately two inches in width for tanks larger than 4 × 2 × 2 feet

These reinforcements distribute stress evenly and prevent outward bulging of glass panels under water pressure. Recent advancements have also led to the availability of imported **modular aquarium tanks**, which offer standardised designs with enhanced safety features.

Dimensional Accuracy and Fabrication Precision

Accurate measurement is a critical component of aquarium fabrication. Special attention must be given to the width of side glass panels. The width



of side panes should be calculated by deducting **twice the thickness of the selected glass** from the width of the base glass. This ensures a perfect fit and uniform load distribution across all joints.

Aquarium fabrication is considered an applied skill or craft that can be mastered with limited practical exposure; however, scientific understanding of structural mechanics significantly enhances fabrication quality and reliability.

Placement Height and Viewing Ergonomics

For optimal viewing comfort in indoor environments such as living rooms, aquariums are ideally placed at approximately 2.5 feet off **the ground**. This height allows comfortable viewing from both sitting and standing positions while maintaining ease of maintenance.

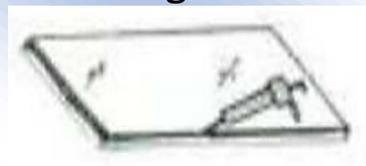
Hood and Lighting Integration

The aquarium hood serves both functional and aesthetic purposes. It is typically constructed using plywood, wood, or similar materials and is designed to support lighting systems and feeding access. Proper placement of the aquarium relative to windows is essential; moderate exposure to natural light promotes plant growth, whereas excessive light encourages algal proliferation, negatively affecting visual appeal and water quality.

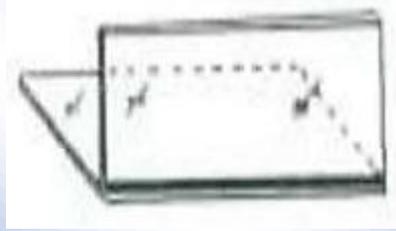
Electrical safety and accessibility are also key considerations, and provision of plug points near the aquarium is recommended.

Aquarium Making Steps

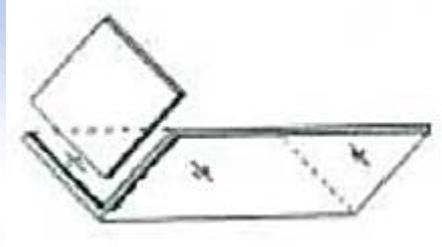
Step 1: Measurement and Cutting of Glass Panels



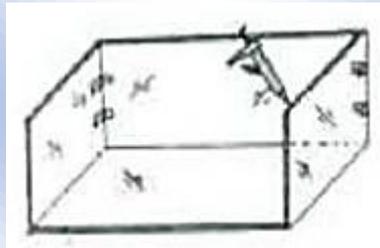
Step 2: Placement of Base Glass on Level Surface



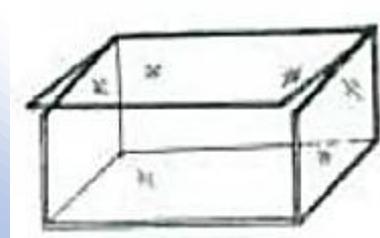
Step 3: Application of Silicone Sealant



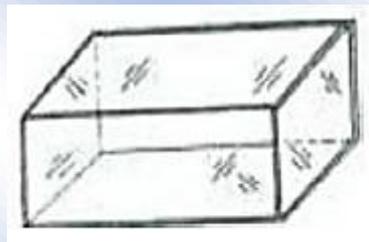
Step 4: Fixing of Side and Back Glass Panels



Step 5: Installation of Front Glass and Joint Sealing



Step 6: Curing, Finishing and Leak Testing



Scientific Importance of Fabrication Quality

High-quality fabrication directly influences:



- Prevention of water leakage
- Stability of water quality parameters
- Safety of aquatic organisms
- Long-term operational efficiency

A poorly fabricated tank can lead to structural failure, water loss, and disruption of the biological balance within the aquarium ecosystem.



AQUARIUM ACCESSORIES AND EQUIPMENT FOR SMALL-SCALE UNITS

Glass and Fibre Glass Tanks

Aquarium tanks used in small-scale units are commonly constructed using sheet glass, float glass, or transparent fiberglass. These tanks are generally placed on sturdy stands made of wood or metal to support the total weight of water, substrate, and accessories. To prevent contamination by dust and foreign particles, tanks are usually fitted with a hood that also serves as a protective lid.



Hood (Tank Cover)

The hood or tank cover is an essential accessory that protects the aquarium from external contamination and prevents fish from escaping. Hoods are typically made from glass, wood, or tin plates. In addition to providing protection, the hood supports lighting fixtures and feeding arrangements, thereby integrating both functional and aesthetic roles.



Aquarium Stand

An aquarium stand is required to securely hold the tank in place. It must be structurally strong and stable enough to support the aquarium system, including water, substrate, décor, and equipment. Stands are commonly fabricated from wood or metal and should be placed on level surfaces to avoid uneven stress on the tank.



Lighting Systems

Artificial lighting is essential for maintaining a healthy aquarium ecosystem, particularly in planted aquariums. Aquarium lights are installed inside the hood to provide uniform illumination. Proper lighting supports photosynthesis in aquatic plants and enhances the colouration and behaviour of ornamental fish. Common lighting sources include fluorescent tubes, mercury-vapour lamps, and metal-halide lamps. Excessive or direct sunlight should be avoided, as it increases water temperature and promotes algal blooms. Typically, illumination for 10–15 hours per day is considered adequate, with low-wattage lamps (e.g., 10 W for a 5 L tank) being sufficient for small aquariums.



Heaters

Temperature regulation is a critical factor in ornamental fish culture, particularly in cooler regions or during winter seasons. Immersion heaters equipped with adjustable thermostats are commonly used to maintain optimal water temperature, ensuring thermal stability and preventing stress-related diseases in tropical ornamental fishes.



Aeration Devices

Aeration is vital for maintaining dissolved oxygen levels in aquarium water. Air pumps are widely used in ornamental tanks to facilitate oxygenation and water circulation. These pumps are connected to air tubes, flow regulators, and air stones. Air stones help in breaking air into fine bubbles, increasing the surface area for gas exchange and thereby enhancing oxygen dissolution efficiency.



Filtration Systems

Filtration is essential for maintaining water clarity and removing metabolic wastes. Both mechanical and biological filtration systems are commonly employed in ornamental aquariums. Frequently used filters include under-gravel filters, box filters, poly-U filters, and power filters. Biofilters operate on the principle of nitrification, wherein beneficial bacteria convert toxic ammonia and nitrite into less harmful nitrate. In institutional or advanced aquarium setups, biofilters integrated with sump and overhead tanks are used to improve filtration efficiency and reduce maintenance frequency. Filtration systems are therefore indispensable and include:

- A. **Mechanical Filtration:** Removes suspended particulate matter using filter pads of varying pore sizes.
- B. **Chemical Filtration:** Employs activated carbon to adsorb dissolved organic compounds, residual medications, and discoloration (not recommended for planted aquaria).



A



B



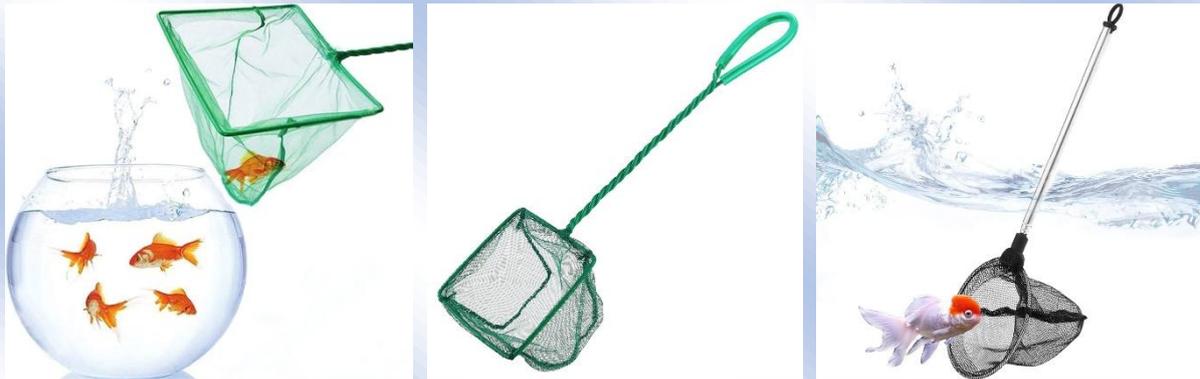
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- C. **Biological Filtration:** Utilizes nitrifying bacteria (*Nitrosomonas* and *Nitrobacter*) to convert toxic ammonia into less harmful nitrate, ensuring a stable and non-toxic environment.



Hand Nets

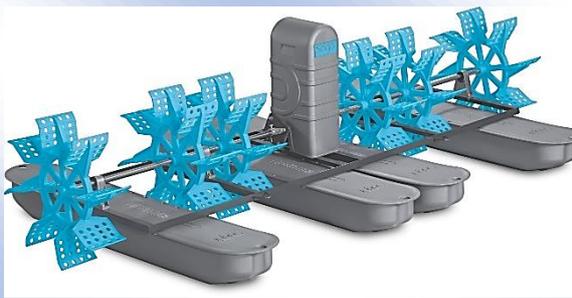
Hand nets are indispensable tools for handling ornamental fish safely during stocking, transfer, or maintenance operations. Nets made of mosquito netting, velon screen, or bolting silk are commonly used. For handling brood stock, velon screen nets (No. 30–40) are preferred, as they minimise physical injury and stress to the fish.



AQUARIUM ACCESSORIES AND EQUIPMENT FOR LARGE-SCALE UNITS

Aeration Devices for Mass Rearing Systems

In large-scale ornamental fish culture, particularly in pond-based systems, aeration becomes increasingly critical at higher stocking densities. Aeration devices used include surface aerators, diffuser aerators, and turbine aerators. Paddle wheel aerators, a type of surface aerator, are widely used due to their efficiency and affordability. Aspirator-type aerators are effective for oxygenating deeper water columns and pond bottoms, especially when culture depth exceeds two meters. Gravity-based aeration systems, such as splash boards and raceways, may also be employed to enhance oxygenation.



Pumps and Pipeline Systems

Pumps are essential components in large-scale ornamental fish farms for water supply, circulation, exchange, and emergency operations. The use of underground water sources is preferred to avoid introducing weed fish and predators commonly associated with natural water bodies. Pumps facilitate periodic flushing, water exchange under high-density culture conditions, and maintenance of optimal water quality. An efficient



pipeline network ensures smooth water movement across different culture units.

Transportation and Supporting Equipment

Transportation of brood stock and ornamental fish seed requires specialised equipment to ensure survival during transit. Fish are commonly transported in tins and polythene bags. Oxygen cylinders fitted with pressure gauges are essential for oxygenating transport water. For breeding and hatching operations, hapas made of gada cloth, bolting silk, or velon screen are widely utilized.



Feed and Live Food Production Units

Commercial ornamental fish farms require dedicated units for feed and live food production. Cement tanks and FRP tanks are commonly used for culturing live food organisms. For prepared feed production, equipment such as mixers, grinders, steamers, pelletizers, and dryers is required. Advanced farms producing single-cell algal cultures for larval feeding require specialised facilities, including controlled illumination, air-conditioned culture rooms, sterilisation equipment such as autoclaves, and culture containers.



SETTING UP OF AQUARIUM

Aquascaping, the process of setting up an aquarium, involves arranging physical and biological components to create a visually appealing, ecologically balanced system. Aquascaping serves two major purposes:

- (i) Enhancing aesthetic value, and
- (ii) Simulating a natural aquatic environment.

Selection of Location

The aquarium should be placed on a firm, level surface, away from direct sunlight, to prevent temperature rises and algal growth. Aquariums can be installed in homes, hospitals, hotels, restaurants, and public spaces, provided that structural stability and accessibility are ensured.

Steps Involved in Setting Up an Aquarium

Selection of a Suitable Location



Placement of Tank on a Firm Base



Installation of Under-Gravel Filter



Addition of Gravel (3–5 mm size)



Installation of Air Pump and Aeration System



Arrangement of Rocks and Decorative Structures



Filling the Tank with Water Carefully



Planting of Aquatic Plants



Placement of Cover Glass



Electrical Wiring for Lights and Filters



Installation of Hood and Lighting System



Conditioning of Aquarium



Introduction of Fishes

Key Components of Aquarium Setup

Under-gravel filter acts as a biological filter, where beneficial bacteria colonize gravel surfaces and convert ammonia and nitrite into nitrate.

Gravels of 3–5 mm size facilitate water circulation and provide anchorage for plant roots.

Rocks and décor are arranged to create natural landscapes; silicon sealant may be used to form caves, especially for cichlid species.

Ornamental Aquatic Plants are arranged with taller species at the back and sides, while shorter plants occupy the foreground. Aquatic plants play a crucial role in oxygen production, nutrient uptake, and habitat structuring. They are categorized as:

- Submerged plants (e.g., *Hydrilla*, *Vallisneria*)
- Emergent plants (e.g., *Nymphaea*, *Nelumbo*)
- Floating plants (e.g., *Pistia*, *Azolla*)



- Marginal plants (e.g., *Cryptocoryne*, *Echinodorus*)



Acclimatization and Introduction of Fishes

Fish selection should prioritise health, compatibility, uniform size, and active behaviour. Fishes must be free from visible disease symptoms and transported under oxygenated conditions. Gradual acclimatisation before release into the aquarium is essential to minimise stress.



Purchase of Healthy Fish



Floating Transport Bag in Aquarium Water



Temperature Equalization



Gradual Mixing of Tank Water into Bag



Acclimatization (15–30 minutes)



Transfer of Fishes Using Hand Net



Avoid Immediate Feeding

Stocking Density Guidelines

- **Tropical freshwater fishes:**

30 cm² surface area per 1 cm fish length

- **Cold water fishes:**

75 cm² surface area per 1 cm fish length

Surface area (length × breadth) of the tank is used to calculate stocking density to prevent overcrowding.

Aquarium Decoration

Decorative elements such as artificial ornaments, background panels, and aquatic plants significantly enhance the aesthetic value of aquaria. Beyond visual appeal, aquascaping plays a functional role by providing shelter and territorial boundaries, thereby reducing stress in aquatic organisms.



Additionally, well-designed aquascapes support biological balance by promoting natural behaviour, improving water quality, and contributing to overall ecosystem stability within the aquarium system.



Regular Maintenance

Regular maintenance of the aquarium is necessary for healthy fish growth. Fish should be fed once or twice daily, and air pumps and filters should be turned off during feeding. Electrical equipment such as aerators, heaters, and filters should be turned off once daily for about 30 minutes to prevent overheating. During winter, the heater must be checked regularly. Insecticides or chemical sprays should not be used near the aquarium. Ensure sufficient lighting and proper air supply at all times. Dead fish should be removed immediately, and aquarium glass should be cleaned using a magnetic cleaner. Always use chlorine-free water for refilling and water exchange





ICAR-CENTRAL INSTITUTE OF FISHERIES EDUCATION
(University under Sec. 3 of UGC Act 1956)
Panch Marg, Off Yari Road, Andheri (West), Mumbai – 40061

