

The AquaCare System for a perfect Sea Water Aquarium



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Image: G. Baginsky

Introduction

The way, described in this article, is not the only one to create a perfect sea water aquarium! There are many road maps to install a coral tank and to maintain it. We originate in our opinion and after our fancy. We are convinced in this way because it is clear (simple but efficient technique), nearly everyone can work with it (easy maintenance) and you can arrange an optical aesthetic coral reef with many fishes that can be fed very opulently.



In the 80th is was impossible to keep hard corals and to breed them.

Image: AquaCare

Every sea water aquarist must be conscious about the fact that this hobby cost a lot of money and time. The investment as well as the current expenses are much more than in the fresh water section. The method "start small and get larger" is only suitable with fresh water tanks. There you can start with a small cold water tank, then expanding with a heater to a tropical fish tank. Afterwards you install a carbon dioxide fertilizer and a professional lighting to support the growth of the plants.

In sea water aquaria, especially in coral tanks, this method will not work in the normal case.

Animals needs special conditions to water quality, light and currents. If one of these factors is o.k. nearly always the biological system collapses. There are some animals that will survive the worst conditions, especially animals from the lagoons, but it makes no sense to experiment how bad the conditions could be that some animals will survive. If animals suffer the animal-rights activists are right that they want to forbid the keeping of coral animals. It should be the top directive to keep coral animals as good as possible.

In the sea water range many questions are still open. Therefore the discussion between aquarists, shops, zoos, animal-rights activists, producer of aquaristic stuff, corals farms, fish catchers and people within the diving tourist branch should is very important.

We hope that you can get some useful advices from AquaCare. Your response will be welcome.

The tank

Key words: the bigger the better, depth effect, costs, material Size

The size of a tropical coral reef tank cannot be too large. There is the rule: the larger the aquarium the more stable the water quality and biology equilibrium.

The size depends normally only on the space, the stability of the installation surface (static) and of course on

the purse. Please mind that the volume (in liters) of the tank multiplied with 1.5 is approximately the weight (in kg) of the whole system. A aquarium with 500 liters volume is around 750 kg. Please ask the homeowner, architect or stress analyst if the installation surface is suitable for the projected aquarium. The aquarium furniture must be constructed for the weight, too.



Large glass tanks are glued on site.

Image: AquaCare

In good sea water shops you will get beneficial advices. But unfortunately there are many charlatans in this branch, too. AquaCare as a producer of branded articles has many experiences in systems that cannot run properly. For example: nano aquaria cannot run as a stand alone system. Only if a backup aquarium (normal aquarium) exists a nano tank can survive. To practise sea water aquaria smaller than 200 to 300 liters it is

very complicated and this should be done only by specialists.



A well running aquarium smaller than ca. 300 liters is very complicated to start up. Image: AquaCare

Depth

Important for planning a aquarium system is the depth (not the height) of the tank. An empty sea water tanks looks very big. But if it is filled with sea water it seems to be much smaller. This effect is caused by the very large refractive index. If you must take care to the maximum volume it makes more sense to enlarge the depth instead of the length or height. In tanks with a large depth very nice three-dimensional reef constructions comes true. The decoration in aquaria with small depth looks often like brickwork – the three-dimensional effect is missing.



The three-dimensional effect is very important for a good looking sea water tank. This is only possible with a large depth of the tank. Image: AquaCare

Current expenses

During planning a sea water tank the running costs should not be waived. Before ordering a tank the current expenses should be calculated. Especially the energy costs can overtake the aquarist. For calculating the energy costs look at the identification plates of the electrical devices, multiply the power consumption (in watt) with the daily running time: lightning factor 5-10 hours per day; filter system 24 hours per day; current pumps 12 to 24 hours per day; chillers only at summer time apart from tropical locations. Add all numbers, divide the sum with 1000 and you get the daily kWh. Multiply the kWh with the price you must pay to the power plant. Multiply the costs with 7 or 30 to receive the weekly or monthly energy costs.

The current expenses consists of other factors, too. Do not forget the costs for food, care products, sea salt, water and of course the animals (but animals should be more an investment that a running cost – our aim is to keep them for a long, long time).

But you must add to the energy costs some others, too: food, care products, sea salt, water and animals (in perfect running systems the animal costs are low but some animals should be completed regularly because of their short natural life time).



Energy saving pumps are important to reduce running costs. Image: AquaCare

Materials

Small and medium tanks are normally made of glass. This material is cheap, very rigid and has good optical properties. Glass-tanks has a life time of about 10 to 15 years. After it the glass gets to brittle and can break and the silicone seams gets porous. A good aquarium insurance is a must with this hobby. Even small water leaks can cause large damages. Some aquaria clubs offers inexpensive insurances, too. – The silicone seams

should be made of black aquarium silicone. Do not use the cheap silicone of do-it-yourself stores. This quality is normally not made for extreme forces that occurs at aquarium glasses. Remember: 100 liters of aquarium water weights 103 kg! Do not use bright silicone, because some algae can grow between silicone seam and glass. With the time these algae will destroy the adsorptive layer. Large silicone seams should be covered with thin glass stripes. Some animals can eat the silicone seams and destabilizes it.



For edge-versions and round surfaces Perspex glass aquaria are excellent. Image: AquaCare

The slight green colour of normal glass does not play a role at fresh water aquaria and small sea water aquaria. But if the glasses gets thicker (please look at an edge of a glass plate) the colouring of it starts to disturb the optical impression of the coral reef landscape. Especially the colour of fluorescent animals fades. Therefore glass grades are developed that contains any green colour. But this white-glass is more expensive. On that score it make sense to take the white-glass only for that sides you are looking through – normally the front glass and maybe one or two side glasses. – All glass plates must be grinded. Not only to prevent injuries but also to stabilizes the glass. Not grinded glass will break more easy than grinded glass. The quality of glass differs and so the prices differs, too. We recommend the best quality because if the glass is cracking normally all animals will die. You will loose a lot of money – apart from the non-material value of the animals. Insurances will only take the accrued damages not the reacquisition of the animals.



For big tanks (here Tropicarium in Budapest, Hungary) Perspex glass is a must - the disadvantages of glass are too much.

Image: AquaCare

Large and very large aquaria - starting with about 1,000 liters - are built on site of professional aquaria constructors. There are many different systems to create large aquaria. Often only the front glass is made of glass; the others sides are made of covered wood, concrete, FPR (fibre glass reinforced plastics), see ADEY & LOVELAND 1991).

Perspex glass (Perspex) is an optical attractive material: the colours of the animals looks better, the refracting index is similar to that of water and reduces distortions drastically, and scratches can be polished out.

For very large aquaria - show aquaria - Perspex glass is the materials with the best option. The disadvantage is the maintenance and the costs. You can clean the glass only with special sheets or scrapers. The danger to cause scratches is very high. Only one little stone between the cleaning sheet and the Perspex glass causes deep scratches. - Aquaria totally made of Perspex glass are very long-lasting because this material will not embrittle like normal glass and they are not glued with silicone seams. .



Room divider are a good alternative to standard size aquaria.

Image: AquaCare

Cover lids

If possible do not use cover lids for your sea water tank. A cover lid reduces the light for the animals and hinders the gas exchange of the water system. The missing heat exchange in summer can destroy the coral reef within hours.

Electrical structure

Key words: residual-current circuit-breaker, divided electric circuits, non-confusing structure



The electrical structure of aquaria is often like a tangle of cables with life-threatening character. We cannot point out to much that many units should only be mounted by qualified personnel only. The combination sea water and electrical power is too dangerous. Every year people are dying because the installed not the right units like residual-current circuit-breaker or they have installed them not properly.

To achieve maximum safety all installed electrical units should connected with a residual-current circuit-breaker. This unit switches off all plugged units if small currents are flowing the wrong way. If currents are flowing through a person the unit switches off the power within fraction of a second and the probability to survive rises extremely.

But the animals should be protected, too. It makes no sense to install a residual-current circuit-breaker and it shuts down all systems in case of a mistake and all the animals die because the whole life support system (LSS) is not working. Normally the mistakes occur if no one is at home. A sea water tank will ruin very fast if any pump is running. After some hours the first animals are dying - depending on the installed technique.

We recommend following structure: connect the aquarium at minimum two intrinsically safe circuits. That means minimum two fuses and two residual-current circuit-breakers. The residual-current circuit-breakers should have a lower trigger limit than the main residual-current circuit-breaker of the apartment. Connect the first circuit with the life support system (main pump, skimmer, filters, heaters) and the second system with the pumps for creating currents inside of the tank and the lights. All other secondary systems like level controls, chalk mixer, chalk reactors, etc. can be allotted to both circuits. If you need a chiller it should be connected to the same circuit as the lights. Regulating systems should have an own fuse with a short response time. In case of an short-circuit only this unit fails and not all units of the same

circuit. - The signification of this electrical structure is that minimum one pump for water currents (oxygen supply) and one heat source is working if one circuit fails. Every stable working aquarium can compensate the failure of e.g. the lights or the LSS. If the LSS fails you get with the other circuit some heat into the tank by the light and some oxygen with the water current pumps. Without water currents and below 20°C the tropical reef animals will die very quickly.



The whole technique especially the electric structure must be constructed safely and clearly.

Image: AquaCare

Every hobby aquarist should take care that all cables are laid clearly and all plugs are labelled carefully. Normally an aquarium has a lot of LSS-units and secondary systems. Without order very fast mistakes are made and the wrong system is working. Especially holiday replacements are not able to solve problems if they see a jumble of cables plugs and valve. With exacted described units it is possible to solve the most problems via telephone support.

Filters, skimmer - Life Support System (LSS)

Key words: skimmer, bio-filter, living rocks, de-nitrification system, LSS



It is possible to build the whole technique below the aquarium in a safe and clear way.

Image: AquaCare

We know this chapter is a tricky subject. If two mariphilic people (obsessed sea water aquarists) are discussing there are minimum 3½ opin-

ions concerning the life support system (LSS). Our recommendation is: the skimmer is the most important filter of the LSS. You can renounce to bio-filters is living rocks are in the tank. With skimmer and living rocks very stable system are possible. Living rocks should not be put into the filter system – therefore they are too expensive. Inside of the tank they have the same function and you can use them perfectly to create an artificial reef structure.



There are many skimmers in the market. They must not be very large. With the right know-how even small skimmers are effective and you can install them below the aquarium. Image: AquaCareFlotor ACF1000V-060

There are many different skimmers in the market. To decide what type is the best is nearly impossible (see “quality features of skimmers”, too). The only way to test is a real system connected with all skimmers. The skimmer that produces foam in the end is the winner.

There are very different types with very different affectivity. The first group is the same direction flow system: water and air are flowing in the same direction. These group is not very effective. The second group is the counter flow system: water and air are flowing in reverse directions. The third group are all special systems as rotation skimmers, diffusion skimmers, contact skimmers, downstream skimmer, floating flow systems, power skimmer – every often the designations are only fantasy.

Pay attention to following points: the skimmer should be quiet, you must maintain it very easily and it must run stable. The smaller the produced air bubbles and the longer the contact time between air and water the better

the system. If you must decide please look at running system before. You can see working skimmers at clubs, aquaristic shops and friends with an sea water tank.

The water coming from the aquarium should flow first through the skimmer and then through other systems like bio-filters etc.. The skimmer should do the main work. All substances that the skimmer will not take out are degraded by bacteria in the bio-filter systems.

The material in bio-filters – if necessary – should be very coarse. The water must flow very easily through the material – even after some years. Fine material will plug very fast and the biological activity is lost. The best bio-filter material are big trickle filter ball made of plastic. Fine substances as gravel, activated carbon, sinter materials, lava rocks are not long-time stable. The porous materials will plug very fast and reduces the ORP (oxidation reduction potential = Redox) of the aquarium water and consume the alkalinity (carbonate hardness). These negative effects occur after some months or years and therewith it is very difficult to see these filters as the reason for declining water parameters.



Fluidised bed filters are the most effective bio-filters. Image: AquaCare Fluidised Bed Reactor FBR110-60

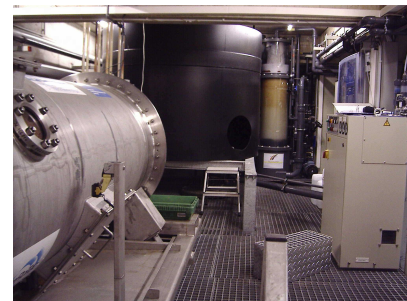
Please wash plastic bio-balls very carefully with hot water before installing them in the filter. Plastic bio-balls are made with injection moulding machines and often some waxes are added during production. Waxes and oils can disturb the function of a skimmer for many hours.

Aquaria with less or non living rocks or with many fishes or if ammonia and nitrite are detectable even after the start-up time can be equipped with fluidised bed filters. These fil-

ters are the most effective bio-filters and they cannot plug with the time.

Living rocks: see below.

With a good skimmer and living rocks inside of the tank (Berlin system) it is normally easy to establish a stable and long-lasting reef system. But it will only work a long time without troubles if only less fish is kept.



De-nitrification system (RBR) with connected bacteria elimination (ACF30.000VC) at the dolphin tank in Duisburg, Germany. Image: AquaCare

In our opinion the special constructed de-nitrification filters (nitrate filters) driven with organic substances like alcohol, sugar, „deni-balls“, organic acids are not safe for small hobby reef aquaria. We have seen many systems that are destroyed by wrong running nitrate filters.



Experimental de-nitrifying system at a temperature of 0°C in the Polar Research Center in Bremerhaven, Germany Image: AquaCare

In low concentration nitrate is important for reef aquaria. If the nitrate concentration is rising over 20 mg/l (ppm) and a regularly water change does not effect the concentration you should install a safe nitrate eliminating system.

Algae-filters, deep sand beds (DSB) and JAUBERT-systems are an alternative. They will work without control, but the effectiveness is not or hardly adjustable.

It is very important that de-nitrification filters have an internal circulation. The water inside of the filter should move constantly and so the ORP inside of the filters is at all places equal. Filters with organic

feeding must have an ORP control. Without this device you cannot control the ORP. With very low feed flow or too much feeding the ORP get too negative and hydrogen sulphide



Hydrogen sulphide – smelling like rotting eggs - is toxic. If you smell it is already in toxic concentrations.

If a de-nitrifying filter has a too high feed flow or a too less feeding nitrite can be formed.

Hydrogen sulphide and nitrite can cause big problems in the coral reef system. Therefore the outlet water of a nitrate filter should flow directly into a skimmer. Especially if the skimmer is driven with ozone



(attention ozone is toxic, too) nitrite oxidizes to nitrate and hydrogen sulphide to sulphate.

The relatively new nitrate filters based on sulphur material are more easy to handle. If the nitrate concentration is above 20-25 mg/l you can connect this filter type. You need not to feed this filter type. The specialized bacteria are living from sulphur and reduced nitrate to gaseous nitrogen (not toxic). Pay attention that the nitrate concentration will not fall below 5 mg/l. Otherwise some invertebrates especially sensitive hard corals will starve to death. In hobby aquaria corals get too less plankton to satisfy their nitrogen-needs. So they need a little bit nitrate!



De-nitrifying filters with sulphur granules are available for large aquaria, too.
Image: AquaCare

Water currents / pumps

Key words: water currents, pumps, interval control, water cycle.

Many sea water aquarists hopelessly underestimate the role of water currents. Nearly all kept reef animals

needs good water currents to prosper. Our recommendation: every hour the tank volume should be pumped 10 times or more.

Varying flows are especially good to hinder dirt corners – the animals are growing faster and they get a more natural shape.

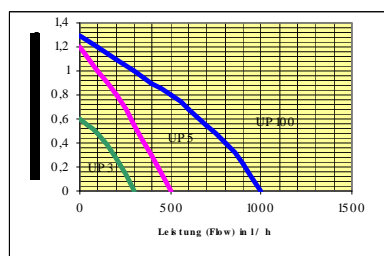
Pumps with its motors over the water surface (called “Turbelle”) emit less heat into the water than water cooled pumps that are mostly driven totally submersed. Especially in summer times or if an aquarium is driven in warm climates without an air condition this fact is very important. Every watt installed inside of the water is one watt heat that must be get out of the tank at warm room temperatures (over 22°C).

Submersible pumps (mostly driven with synchronous motors) cannot be controlled by speed controllers, with “Turbelle” or other pumps with asynchronous motors in combination with speed controllers you can realized complex current patterns.

In very large tanks (about 1,000 liters) is makes sense to install the pumps outside of the tank. With one or two pumps (for redundant work) and several outlets it is possible to create diversified currents. With built-in automatically actuated ball valves or butterfly valve it is feasible to vary the currents with timers of random controls.

In very large tanks (more than 10,000 liters) is makes sense to install wave generators additional to some less pumps.

The water circulation between tank and filters system should be dimensioned not too small. The pump(s) should lift the aquarium volume five times per hour.



Pump diagram of three different pumps. For example a pump should pump the water from the filter system to the tank and the difference between the two water surfaces amounts 1 meter. Go into the diagram to 1 meter (vertical scale) and mark a horizontal line. At the points of intersections mark a vertical line and read off the value at the horizontal scale. You see: the smallest pump cannot pump one meter, the

second one pumps only 100 liters per hour, the strongest one pumps 300 liters per hour.

For dimensioning the pump you must look into the pump flow diagram. If you do not have this diagram you can create it by yourself: take the maximum point (maximum flow and maximum pressure = height) and join them with a line. With this provisional flow diagram you can read off the really flow.

But take care this is only the maximum water flow in your system. Normally the flow resistance will lower the result.

It is very important that the pumps are sea water resistant. The damage of a corroded or burned out pump can be considerable. In some case a total disaster can occur.

Pumps of other fields of application (e.g. heater pumps) are normally not suitable for sea water. The water touched materials should be resistant against acids and chloride. Stainless steel corrodes in sea water. The best and safest pumps are magnetic coupled plastic pumps.

Piping

Key word: hoses, soft-PVC, silicone, PVC-U, push fit fittings

Hoses are normally the worst kind to transport water in sea water tanks. Most of the hoses are made of soft-PVC (PVC = polyvinyl chloride). This material is flexible but with the time the softeners are diffuses out of the PVC. Some of these substances like phthalates are carcinogenic. The hoses become hard and may slip off from the connector if slightly moves, e.g. pump vibrations, occur. If the softeners causes problems in the sea water tank is not known. Soft-PVC hoses are suitable for transporting air. But they should not get contact to water.

Silicone is very good for sea water tanks. Normally it is made without softeners and is therefore permanently elastic. But gases can permeate through silicone. So you cannot use it for CO₂ supplies (you will lose CO₂) or for “Kalkwasser” (CO₂ is diffusing into the “Kalkwasser” and creates lime). And silicone is not pressure resistant, except types with textile or steel reinforcements. If you decouple a pump from the tubing with silicone you must take care, if the silicone hose walls are thick

enough or the pump has not too much pressure.



A clearly build tubing made of PVC is a supposition for safe and long-time operation without flooding the living room
Image: AquaCare

For sea water tanks the best system is a PVC-U tubing. This PVC type contains any softeners - the type PVC-C is not suitable. The tubing is easily made: you can saw the tubes with a handsaw; there are a lot of different fittings (Tees, elbows, bends, reducing bushes, and many, many more); PVC is easy to glue. PVC-U is pressure resistant: on the fittings the maximum pressure at room temperature is marked as PNx – PN16 = 16 bar, PN10 = 10 bar. Normally PN10 is more than enough. But after gluing the tubes with the fittings you cannot unfasten them again. The glue is very fast binding. If you must disconnect some aggregates regularly, e.g. pumps, filters for cleaning, the best way is to use unions (if you can stop the water flow at another place) or ball valves (if the water flow must stop at the pump or filter).

The best way to create a professional tubing is to make a good design before. If you have not worked with PVC before contact a specialist (some of the aquarium shop dealers are skilled). It is very important to pay attention to the users instruction of the glue.

If you want to make a tubing only for tests, may be if you want to see if the systems works, it is possible to connect fittings and tubes with Teflon tape. But this method is not for ever.

For small experimental tanks a tubing with push fit fittings is very useful. You can unfix these fittings many times and they are absolutely tight

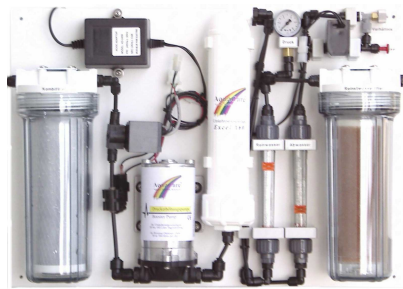
and protected against unintentional unfasten. The push fit system is very good for creating the fresh water supply, e.g. reverse osmosis units, storage tanks, sea water mixing tanks or air supply.

Water treatment: from tap water to aquarium water

Key words: reverse osmosis R.O., ion exchange resin, activated carbon filters

In industrial areas or areas with an intensive agriculture tape water is normally not good enough to use it for sea water tank. Substances like nitrate, silicid acid, residuals for pesticides and medicines are able to destroy the sensitive biological equilibrium of the sea water aquarium.

The most known method is the reverse osmosis (R.O.) technique. Others are ion exchangers and activated carbon. More information are below.

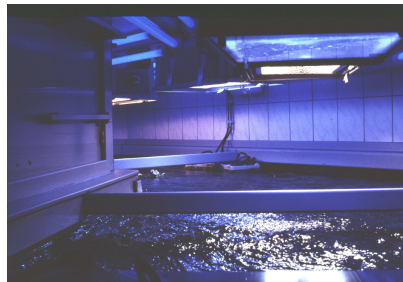


Reverse Osmosis units are custom-made for special purposes. Simple units are a mass product.
Image: AquaCare

Lighting

Key words: fluorescent tubes, mercury-vapor lamp (MV), metal halide lamps, T5, LED, halogen emitters, illuminance, Kelvin number, light spectrum

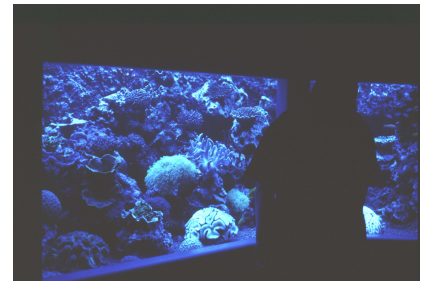
You can find many discussions about the best light and you can hear a lot of technical terms that overextend beginners with this hobby.



It is very important to fix the lighting in that way that you can easily maintain the systems.
Image: AquaCare

There is one rule: the more the water depth the more the power of the lamps. In general hard corals need

more light than soft corals, e.g. mushrooms, button polyps and others. But normally these kinds will grow faster and more colourful if they get much light, too, and the tank gets more faster a physical and biological equilibrium. The reason for this is, that more photosynthesis of the zooxanthellae will get out more nutrients and will produce more oxygen.



With blue lighting at the beginning and at the end of a light period animals appear totally in another way. Especially fluorescent colours look beautiful.
Image: AquaCare

For the main lighting metal halide lamps are the best choice, especially with large water depths. Never use mercury-vapor lamps (MV) because the spectrum of these lamps are totally inapplicable. Metal halides are made with 70, 150, 250, 400, 1000, 2000, and 3000 watts. The power should be chosen depending on the water depths and the table is only a recommendation. But the rule: the more light the better should be minded. The lower the lighting the higher the risk to get no chance to start the artificial mini-reef.

Water depths of the aquarium	Power of the metal halide lamp
lower than 30 cm	70 W
30 - 40 cm	150 W
40 - 50 cm	250 W
50 - 70 cm	400 W
70 - 100 cm	1000 W
100 - 200 cm	2000 W
more than 200 cm	3000 W

The required power of LED lights is strongly dependent on their efficiency. As a rough guide, half the power of HQI can be given. In case of large water depths, lens systems must ensure that sufficient light reaches the bottom.

A too small lighting cannot be equalized by a longer light period! The numbers of the lights depends on the size of the aquarium. With minimum 1 watt metal halide per liter water

normally a tank is very good illuminated.

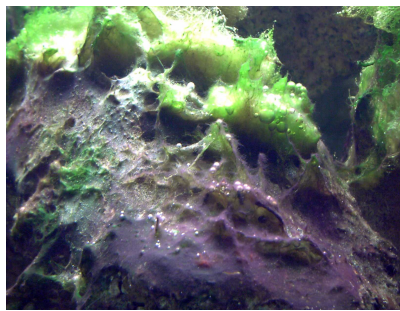
The length of the light period with metal halides should be between 8 and 10 hours – during the starting phase shorter to prevent the risk of the mass algae growth. Which light colour is the best? This depends on the taste of the aquarist. The daylight bulbs are very bright, the 10,000 Kelvin or 20,000 Kelvin bulbs are much darker – not only for our eyes.

As an alternative the T5 fluorescent tubes conquer the lighting scene. They need low energy at high illuminance levels near to that of metal halide lamps. The advantages are low investment, low replacement costs and a long life up to 5 years for a tube. The disadvantages are a “boring” light effect because the typical flickering effect of the waves at the bottom is missing and because of the very even radiation it is very difficult to illuminate deep water aquariums. To have the flickering effect with T5 tubes you can install one or more halogen or LED spot lights.

To illuminate the tank before and after the main lighting period normally fluorescent tube, e.g. T5, are used. Especially blue tubes attenuate the transition between night and day. Fluorescing animals mediate a totally other impression. The transition time should be about 1 hour before and 1 hour after the main illuminating time.

A night light or a moon simulation is necessary if the aquarium stands in a totally dark room. Especially new fishes get panic if the tank is totally dark. They have no time to find a hiding-place and in their panic the jump out of the tank. Of course the tenacity for jumping out is species specific.

Modern LED lights show great differences in quality. Also the control of the color channels is so diverse that the beginner should really only use the basic settings. The currently popular extremely blue aquariums have no advantage for the corals, on the contrary: if too much white light is missing, there can be deficiency symptoms.



The wrong lighting or too old bulbs support the growth of undesirable blue-green algae. And if these bacteria settled down in a tank it is normally very complicated to get them out again. They can secrete toxic substances and overgrow invertebrates.

Image: AquaCare

Living rocks

Key words: origin, quality, function

The introduction of living rocks was a great benefit in the modern reef aquaristic. Living rocks are fragments of natural reefs and they contain a lot of different organisms like bacteria, algae, protozoa, worms and nearly all phyla of the animals. Larvae of corals can grow to mature animals and some aquarist was wondering what animals are in the tank without buying them. But more important than the surprise is the armada of micro-organisms. Bacteria, protozoa, small feather duster worms and sponges are very efficient filter units. They provide important processes like nitrification, de-nitrification, degradation of organic substances and filtering out particles and swimming phase of many parasites.



Living rocks allow not only a realistic impression of a natural reef. They are the best living filter system and they produce a lot of small organisms that are important for many fishes. Especially small tanks get very stable with living rocks.

Image: AquaCare

The optical impression with living rocks allows to create a nearly natural reef in a small tank.

But there are disadvantages of living rocks, too. Not only useful organisms are introduced into the home reef. Animals like mantis shrimp, toxic bristle worms and others may cause some problems. But normally it is possible to solve these problems and the advantages of living rocks prevail.



Some blind passengers of living rocks are not welcome. Like this crab they can cause some trouble.

Image: AquaCare

Living rocks should smell like „ocean“. Never buy rotten smelling rocks – and may they be ever so cheap. The information of some unscrupulous dealers to flush them very carefully will not provide good working living rocks. Bad rocks secrete a lot of nitrate, phosphate and other harmful substances.

Pay attention to the fact that living rocks are transported like fishes and corals. And so the price of each kg is very high. Very cheap living rocks come not from tropical reefs or have a very bad quality (wrong transport, wrong storing) – so it is better to refrain from a purchase. See living rocks with their high costs as the best and most easiest biological filter system you can get for your money.

“Activated stones” are limestone fragments that are stored in the sea for a period of time in order to colonize them with microorganisms. “Activated rocks” are considered more sustainable, but usually cannot have the diversity of organisms as living rocks.



Only very large aquaria should be built without living rocks. The sediment load of living rocks is very high.

Image: AquaCare

With artificial reef building (reef ceramics), there is a risk of undesirable substances being released into the water from the raw materials or from the manufacturing process, e.g. heavy metals. The producer should have proper quality control; also, the artificial materials should be cleaned very thoroughly before use.

Aquaria with more than 1000 liters should be built without living rocks. To create a stable reef construction with living rocks is very complicated and the long term durability is not good. Because the drilling reef organisms are destabilizing the construction continuously. Very often large aquaria with living rocks are locking like a rubbish dump.

Chemistry: sea salt / supplements / chalk reactors

Key words: Chemistry, biology, sea salt mixtures, pollutants, supplements: trace elements, iodine, strontium, calcium, carbonate hardness (alkalinity), BALLING-Method, "Kalkwasser" by WILKENS, chalk reactor, Turbo Chalk Reactor

I will never put chemistry into my aquarium!

This attitude is wrong. In every aquarium are so many chemical reactions that you must call a tank correctly as "chemical reactor". All biological reactions are based on chemistry.

An artificial reef is never in a natural equilibrium. Always you must help to get the important parameters in the right values. We must increase or decrease the temperature, we must eliminate pollutants, we try to keep the pH and the salinity constant, and we must add essential substances like trace elements, calcium etc..

Normally the starting point is artificial sea water – only a very few aquarists can utilize natural sea water in a good quality. The best way to get good artificial water is to use reverse osmosis water (only with a good R.O. unit you are sure that any harmful substances are in the water) with a good branded sea salt. Useful information about the handling with sea water see below.



A good sea salt is the basis for good sea water. If the artificial sea water has some disadvantages it is very complicated or impossible to create an equilibrium.

Image: AquaCare

With the time harmful pollutants will concentrate in the aquarium water. Many of them you can eliminate with a good skimmer before bacteria are able to degrade them. Non-skimmable substances normally will be destroyed by bacteria and algae. Only some persistent substances won't be eliminated. If you do not change some water regularly they will enrich. About 10% water change per months make sense. With increasing organic loads you can raise it to 25%. The water change should be done very regularly e.g. every week 2.5% (total 10% per month) to ensure an even water quality every time.

Nutrients and other essential substances may be consumed very fast and it is nearly impossible to add them with the water change. The only way is to add them manually or automatically.

E.g. corals need considerable amounts of dissolved chalk. In sea water the dissolved chalk is present as calcium-ions and hydrogen carbonate ions. The coral absorbs both substances and creates hard lime stone for their skeleton. If too little dissolved chalk is in the water the corals stop to grow and will die with the time.

You can add dissolved chalk in different ways and combine them as you like.

1. Care products: there are solutions and powders on the market that can enhance calcium and hydrogen carbonate (carbonate hardness, alkalinity) – method introduced by BALLING. If you realize regularly only a small water change it is advised that you add sea salt without sodium chloride ("mineral salt").

2. With "Kalkwasser" – a solution of calcium hydroxide – you can add calcium ions. Additionally you raise the pH of the aquarium water. With a

"Kalkwasser" reactor or mixer it is easy to supply the "Kalkwasser".

3. A chalk reactor (lime stone reactor) is filled with substrate containing calcium carbonate (lime stone, coral gravels, Turbo granules). If carbon dioxide (CO₂) is added the material dissolves into calcium ions and hydrogen carbonate ions.

4. Only for specialized coral breeders the CO₂ injection method is helpful.



The Turbo Chalk Reactor of AquaCare produces safely dissolved calcium and carbonate hardness (alkalinity).

Image: AquaCare

Trace elements, iodine and strontium are absorbed by animals, too. With small amounts of water change and with some special animals that need plenty of these substances a lack will occur with the time. So you must dose artificial active agents to the aquarium. In some tanks the colour of the hard corals gets better if you dose Iron-II. In tanks with lots of red coralline algae and gorgonia magnesium should be added.

Fluids can be dosed automatically with dosing pumps.

Witch parameters / values must be monitored?

Key word: temperature, pH, carbonate hardness, salinity, density, electrical conductivity, ammonium / ammonia, nitrite, nitrate, phosphate, silicic acid, thinking in parameter

Because of the very fragile balance inside of a coral tank you must monitor some parameters and control them if necessary. *But: every modification should be done very carefully and slowly to prevent stress to the animals. Stress – in what kind however – can cause illness and death.*

Temperature:

The water temperature of a normal coral reef tank should be between 25 and 27°C. Below 20 and over 30°C will cause widespread deaths. Take action before the temperature in summer raises over 30°C – in summer you have sometime problems to get chillers or ventilators.

A heater – if necessary – should be protected twice: electronically working temperature control plus a bi-metal controlled heater. The electronic device should be adjusted to the nominal value (set point) the normal heater 2...3°C more. If the first controller fails you have the second step with the ordinary bimetal heater. But remember only in very cold rooms you need a heater. Normally you have the other problem: the aquarium is too hot: pumps, light and filters continuously bring heat into the system. Tropical sea water animals are living only in a small temperature range of about 10 K.

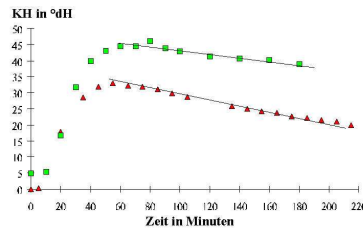
The pH-value:

This parameter decides if the water is acid or basic (alkaline). Values over 7 are basic, 7 is neutral (never acid nor basic) and values below 7 are acid. In sea water the pH should be between 8.0 and 8.5. Pay attention to the fact that the pH is in the morning lower than in the evening. Therefore you should measure only at the same time to get comparable results.

The carbonate hardness (alkalinity):

This value is the most important chemical parameter. The carbonate hardness influences directly the pH-value and so it is very important for the health of the animals. The KH-value should never be below 7°dH. You can raise the KH with different methods: AquaCare care product “KH-plus” at lower needs, “Triple Buffer” at higher needs or automatically with the *Turbo Chalk Reactor* (very big aquaria, hard coral tanks). The “Kalkwasser” is nearly not raising the KH.

The carbonate hardness is the most important parameter but unfortunately many aquarists are will not measure it. The results are terrible.



Course of the KH-value with the time; experiment with *Turbo Chalk Reactor* size 7 at a 13 m³-tank. Graphic: AquaCare

Salinity, density, conductivity:

The salinity specifies the salt content of sea water. This value is measured in “promill” or ppt (= part per thousand). Sea water should have a salinity of about 33...35‰. You can measure it very easily by using a refractometer. Other measured values are density (araeometer), specific weight or electrical conductivity (conductivity meter)



Refractometer are easy to handle and a safe alternative to araeometers. Image: AquaCare

If the salinity in the tank is too high you can take about 1% water out off the tank and refill it with reverse osmosis water – or if you have a automatically driven refill unit, the water will be replaced. If the salinity is too low you can fill up 1% sea water. If water evaporates the salinity will rise. If the salinity is still not in the right value wait one week and repeat the procedure.

Water will evaporate continuously, but the sea water will loose only water not the dissolved salts. So every day only reverses osmosis water must be added (except you will higher the salinity!). With automatic level switches or float valves you can fill up the tank without work. More information see below.

Pollutant resp. nutrients: ammonium / ammonia, nitrite, nitrate, phosphate, Silicate

Ammonium / ammonia is produced every time in the aquarium. It is very important that you cannot prove them in the water (except during the starting phase).

If you are able to detect ammonium / ammonia something is fundamentally wrong with your life support system (LSS) or with the currents inside of the tank. The aquarium technique should be redeveloped as soon as possible. The same is valid for nitrite. Ammonia and nitrite (exact: nitric acid) are toxic for all animals and can kill the whole live in your tank.

Nitrate and phosphate are metabolic end substances, that means: with the time they will enrich to harmful concentrations. The more you feed, the more fishes you have in the tank, the worse your technique and the less water change is made the faster nitrate concentrations will rise.

The optimal concentrations in a reef tank are 5...20 mg/l nitrate and 0.05...0.2 mg/l phosphate. If one or both parameters will grow over the upper limit you must take steps against the rising. But if you decrement the values below the lower limits you can get problems with your animals, too. Because both substances are important nutrients. If they are missing the animals feel not well. Therefore: if you install a nitrate filter or a phosphate column you must be sure that this technique is necessary. (more information see: nitrate – do I need a filter?)

Action	lowers nitrate	lowers phosphate
more water change	+	+
using phosphate-free and nitrate-free sea salt	+	+
phosphate-free and nitrate-free water for water change and refilling (R.O. technique)	+	+
feeding less (the better way: less fishes)	+	+
Check the food (nitrate, phosphate) and if these substances are available in high concentrations take better food	+	+
clean frozen food carefully by washing	-	+
feed small portions but very often	+	+

using phosphate-free material for chalk reactors	⊖	⊕
more currents in you aquarium	⊕	⊕
more lighting (animals are growing better and assimilate more phosphate and nitrate	⊕	⊕
using phosphate reducing means	⊖	⊕
using "Kalkwasser" (calcium hydroxide method)	⊖	⊕
using a nitrate filter	⊕	⊖
using living rocks with a good quality	⊕	⊖
using a more effective skimmer	⊕	⊕
More flow between filter system (LSS) and aquarium	⊕	⊕

Silicate or silicic acid is arriving you tank with the fresh water (refilling evaporated water, water for water change). In some areas the concentration of this substance in the tap water is extreme high. Even a reverse osmosis unit is not able to reduce the concentration below the harmless concentration. Additional a ultra pure water filters should be installed. If you stop the supply of silicate the concentration sinks and the unwanted diatoms vanish.

Measurement and control technology

Key words: analogue, digital, micro-processor, computer, modules, security, handling

Especially in Germany measuring technique and automation is very popular. This technique may reduce the work but hold many dangers. Some of the aquaristic technique is not working steadily. There is one rule:

measure as much as possible but control as less as possible.

The most important parameter to control is the **temperature**. The environmental condition (room temperature, humidity and therefore the chilling caused by evaporation) are too different to forego a controlling. But it is very important to safeguard the control against failing (see chapter "temperature").

The **lighting** should be controlled automatically. You can use simple timer of complex micro-processor controlled units. Even moon light simulations are possible. A failure of the light brings calamities only after many hours to some days. In that time the failure might be repaired.

All other parameters should not be controlled automatically. It only makes sense to create a emergency shutdown with some units:

The carbon dioxide supply of a chalk reactor (lime reactor) should be shut off if the pH of the aquarium water is

below e.g. 8.0. You can use a pH controller for this: the pH probe must be in the aquarium tank and the output of the controller triggers the solenoid in the CO₂ line. If you use an chalk mixer the feed water should stop if the pH is over 8.0.

It makes sense to shut down the automatically driven **level control** if the conductivity inside the aquarium falls below 30 ppt.



The AquaCare BasiTech control for Turbo Chalk Reactor.
Image: AquaCare

You can decide between analogue and digital controllers. If you want to have a remote control via computer or internet you need digital units.

Complete aquaristic computers are cheaper if you compare them with single units with a bus structure. But unfortunately if the computers fails all functions are not available and all important controlling functions are out of order.

It is important to pay attention to the safety guidelines.

Operator convenience is often disregarded. Please tests the unit at the aquaristic shop and ask for its functions. If you are sure that you can handle the system you can buy the unit. – The best measuring system is not worth a damn if you cannot operate with it.

We cannot repeat the most important principle enough:

Do not trust in a measuring unit! If a bad value is shown please control the measuring system first, before

you try to correct the value by adding chemical substances.

Normally a view into the tank shows more information if all animals are in good health. Especially with electrodes (pH, conductivity, ORP) mistakes will occur. Often aquarists have trust more in their measuring units than in their eyes with the consequence of a destroyed water chemistry and biology if the manipulate the good but wrong shown water value.

Chemical tests

Key words: guesstimate, drop tests, test strips, storing, photometer, standards.

In nearly every aquaristic discussion you can hear different "best values". But mostly the aquarists are unaware of the fact that the aquaristic measuring systems are extremely inaccurate. Drop tests and test strips are not more than a guesstimate. Serious manufacturers sign their tests with the word "half quantitative" – this means that the measured value is only a guide and not precise data. It is important to know the detection limit. If the lowest concentration of the test is for example 0.5 ppm phosphate you are not sure that you have phosphate in the water or not if the test shows zero! It is possible that you have 0.4 ppm phosphate and the test shows nothing. You are sure that you have any phosphate problem and the animals are dying by phosphate eutrophication. This example shows that the constructed test is not suitable for sea water (reef aquaristic).



Small one-parameter-photometer are a perfect way to measure important substances like phosphate and nitrate. These units are not really expensive. Image: Hanna

For a reef tank you must have a test that is able to measure below 0.5 ppm phosphate (e.g. 0.01 ppm).

If you are measuring at the upper limit of a test there is a trick: if you dilute the sample with distilled water before measuring (e.g. 1+1) and multiply the result with the diluting factor (e.g. $\times 2$) you have doubled the range – but you have doubled the inaccuracy, too.

To neglect the “human factor” while estimating the colour of colour test there are small photometers on the market. These units are measuring considerably better than drop test and test stripes – even if they use the same chemistry. Good shop owner have this photometers and they are testing your water for a little charge.

All tests are very sensitive against storing at the wrong conditions: temperature, humidity, light. If you store a test too long or under wrong conditions the results are doubtful. To check the test there are “standards” on the market. A standard is sea water with well defined concentrations of the test parameter.

The time table / event plan

Key words: overview, analysis, error analysis

In many books you can read about a time table to erect a reef aquarium system. But unfortunately there are different ways to start an aquarium, and if you are starting two aquaria with the same system you will see that they will develop in different ways. In our opinion a time table is not the best way. We suggest an event plan. If you follow this the probability is high to have success. The running-in time starts with some weeks to 1 or 2 years. Sometimes there are aquaria that never leave the running-in time: technical knowl-

edge, biological feeling or lack of care are the reasons.

1. Start-up and testing all systems

The first step is to build up the complete system and fill it with fresh water. All systems must be examined carefully: leakage, function, emergency conditions.

2. Filling with sea water and living rocks

Let out the fresh water and therewith rests of glues and dirt. Fill the system with sea water. If you work with used sea water the temperature should never fall below 20°C. Fill about 50% of the total volume. Take enough time to construct the artificial reef with living rocks. The construction should be stable and diverse. You can construct caves, gorges, reef columns, sand areas, etc.. Include enough space for the corals with their rocks – and the animals are growing! After the reef construction you can fill a small sand layer. Only if you want to keep animals that need big layers or if you want to erect an deep sand filter inside the tank you must take more material. If you have only a small sand layer do not use it behind the living rocks.

After this work fill up the tank completely with sea water. Put all the technique in operation – except the technique you need later.

The lighting should only run at half power: Switch on half of the lamps or reduce dimmable LED systems.

3. Rapid stocking of corals and other invertebrates.

To prevent cyanobacteria (blue green algae) and green algae from growing, it is important that invertebrates are introduced quickly. The more densely the colonization area is occupied, the less danger there is of undesirable bacteria and algae growing.

Carefully select the animals and determine the appropriate location in the aquarium. Note the sizes and the risk of nettle. Only buy animals that are in perfect condition. Half-dissolved animals are definitely not viable in the early stages. Be aware that some animals are poisonous. Handling should be done very carefully.

When stocking the aquarium, care should be taken to include some herbivorous animals (fish, snails) to prevent excessive green algae growth.

4. The fishes

If all invertebrates and the first introduced fishes are feeling well, you can choose other fishes. Increase the number of fish only step by step. And do not forget to feed them. Nearly all coral reef tanks fishes eat almost the whole day short portions (only predators are eating big portions infrequently). See below: how to feed animals?

Feed several times small portions. It make no sense to feed once a day a big portion (except freshly introduced shy fishes should be acclimated to the feeding procedure). After every increase of the population you must look if the fertilizing parameters nitrate and phosphate will not proliferate. If these substance are enriching you must install technique (larger skimmer, nitrate filter, phosphate adsorber) for eliminating the increase or you have to reduce the numbers of fish.

Please do not introduce too much fish into the system and reduce the food intake. Only good and diversified food is a guarantee for healthy, magnificent coloured fish that tolerate each other and are stable against diseases. Keep your fishes as a pair, in trios or small groups - like their natural needs. Most of the fishes are social – if they not starve!