The Quality of a skimmer

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Comparing the efficiency of different skimmer is a very difficult and expensive enterprise. A total ranking is only possible if you connect all to be tested skimmers at one reef system. The skimmer, that will produce foam at the end of the experiment, is the winner. It will steal all the others the skimmable substances. Unfortunately there is any comparison possible because there are too many skimmers on the market and the branch is too small to take these enormous costs.

Dreamlike sea water aquaria will hardly exists without a skimmer. Foto: AquaCare.

There are only some rules to make a picture of the skimmer. The more positive characteristics a skimmer has the better the system. But it is impossible to say who is the winner, if you try to compare very different skimmers: e.g. a short anti-way principle air wood driven skimmer built off Plexiglas against a high same way principle venturi driven skimmer made off PVC.

Dimensions of a skimmer

The higher the skimmer (with the same principle and the same bubble producing system) the better the efficiency. This rule is true up to about 2 meters. Beyond this 2 m it is not possible to increase the efficiency with longer tubes. The opposite can happen. The following explanation will help: a small air bubble pressed at the bottom of a very long skimmer becomes bigger on its way to the top because the water pressure decreases. Bigger bubbles with the same volume (calculated to normal pressure) have a smaller surface. But the Surface is very important for the efficiency (see below).

The gas change is better in higher systems: more oxygen will go in and more CO_2 will go out. In higher skimmers the contact time is longer because of the longer way from the bottom to the top. The contact time is another main factor for a good performance (see below).

Down draft skimmers must have a minimum height of 1 meter, better more than 1 meter. Otherwise the efficiency of the gas bubble creating system is too bad.

Size of the air bubbles

Air bubbles should have diameter below 1 mm to create a large surface for adsorbing and gas change processes. Picture: AquaCare ACF3000V-170 with injector at 35‰ salinity, 15°C, matured water of a reef aquarium, bubble size: average smaller than 0.7 mm.

The volume of the gas bubble affects the surface between water and air (see principle of skimming). The bigger the surface with the same volume the more effective the skimming. It is very complicated to measure the size of a bubble. And it is nearly impossible for an aquarist to compare the bubbles in two different systems.

There are only some rules for creating different sizes of bubbles:

Venturi = injector:
the higher the pressure at the injector the smaller the bubbles.

Air stone:
the smaller the pores of the mate-

rial, the lower the air pressure the better the gas bubbles.

Down draft system:
the higher the column, the higher the water pressure in the incoming tube, the smaller the trickling material the better the bubbles.

Dispergator:
the bigger the rotor, the higher the rotation frequency, the smaller the structure of the rotor the better the bubbles.

The opinion of AquaCare is: a new air stone made of a good wood quality creates at the start of its work better gas bubbles than a small injector. Depending on the operation time the efficiency of the air stone becomes worse; the efficiency of a good injector will be stable. At bigger skimmers with an injector working pressure of minimum 10 m (1-2 bar, 15-30 psi, see AquaCareFlotor ACF6000V and higher) there is no difference in the bubble quality between a new and good air stone.

Contact time: air - water

The skimming process bases on the physical rule of adsorption. The process is very slow and demands a long contact time between a gas bubble and the water column. You can arrange the efficiency of the different skimming techniques in following scale with increasing performance:

Same way reaction - counter flow system - suspended flow (see principle of skimming)

As seen above the height of a skimmer affects the contact time, too. But how can you measure the average contact time of the bubble? We do not know a scientific method to measure it. But you can get a rough overview with a simple experiment. Stop the air input of a skimmer working at a real system (aquarium) at once and look at the water / air column (stop the air pump; keep the air inlet closed). The time until any bubble is seen in the main tube has to be stopped. The longer this time the longer the contact time of the system.

If you stop the air input you will vary the water flow and other currents will occur in the skimmer, because the energy you need for sucking the air with an injector of dispergator is used for more water flow. But although this effect affects the experiment the result is the best you can get.

Air and water volume

The most asked question is the air volume of a skimmer. It is true that more air volume will create more surface. But also important is the question: how long will the air stay in the water? The longer the air is in the water (the longer the contact time) the less air is used to fill a skimmer tube with the optimum water-air-mixture.

With flow meter (e.g. with floats) it is possible to measure water and air volume. Picture: AquaCare.

The second question is the water volume. In general you can read in books and papers that a skimmer needs 1 to 1.5 times aquarium volume of per hour. This is a very rough value, because the efficiency is not mentioned with these numbers. The more effective a skimmer the less water is necessary for the skimmer. For AquaCareFlotors the number is about 0.7 times the aquarium volume per hour. A more effective skimmers works better with a lower water flow than a ineffective skimmer with a high volume. To compare skimmers only with numbers is very difficult or impossible.

The size of the aquarium is important, too: smaller tanks should be cleaned more that bigger tanks. Smaller aquariums a more unstable in biology, chemistry and physics, and are normally more occupied with more fish per liter. Bigger tanks has more open water than smaller tanks. So the small tanks should be cleaned more intensive than bigger tanks.

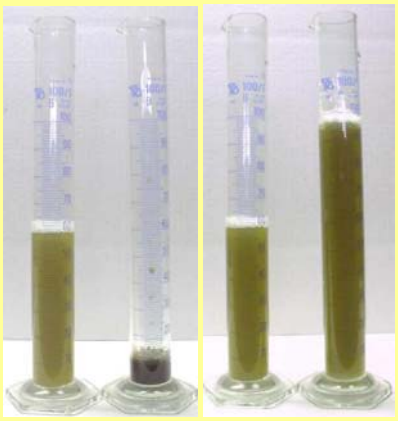
You can make many mistakes in installing the skimmer. It is important that the skimmer gets the water as fast as possible from the tank. If the skimmer is not installed directly at the tank and gets its water from a filter tank it is important to have a high flow through the filter system: 5 times the aquarium per hour or more is a safe number. Otherwise the skimmer cleans the water in the filter tank very good but gets too less dirty water from the aquarium. There is a competition between skimmer in the filter tank and biology in the aquarium. So the skimmers has to get enough dirty water.

You must care that the cleaned water will not be sucked from the skimmer again: this hydraulic short cut lowers the total efficiency of the skimmer. Unfortunately you will find this effect at some "professional" made filter tanks.

Produced flotate

You will find many opinions about volume and consistence of the flotate produced by a skimmer. In most cases only the produced volume is discussed. The as important as the volume is the concentration of dirty stuff. An objective number is volume ´ concentration. So 200 ml of a highly concentrated flotate can contain more dirt that 2 liters of a less concentrated fluid (see experiment below). Normally a darker flotate contains more dirt than a very pale water. If you try to compare different flotates you must dilute the darker flotate to the same color of the clear fluid. If you have a photometer you can dilute more exactly. It is important that the fluid is homogeneous and that the sample come from equal systems. For example: the flotate of an arctic or antarctic

system is very white and not brown or black; tanks with a algae problem have a green colour.



sample A+B diluted sample B

Experiment:
two skimmers at the same aquarium in the same time were producing flotate:

skimmer A 59 ml, skimmer B (darker flotate) only 9 ml.

Skimmer A produced 6-7 time more flotate.

The darker flotate (skimmer B), was diluted to the same colour. The flotate of skimmer B must be diluted to 98 ml. So skimmer B has a 1.7 times higher efficiency compared to skimmer A. Skimmer B produces foam nearly 11 times more concentrated.

Conclusion:
it is not possible to compare different skimmer only with the produced volume of flotate. Only if both samples has the same colour (the darker one has to be diluted) the efficiency is obviously.

Should a skimmer cup have a drain or not? At very big skimmers the question is easy to answer. Because of the size and mass you must drain the flotate before you are able to take the cup from the skimmer away from cleaning. At smaller systems a cup drain tempts the aquarist not to clean the cup and the main foam producing devices. A dirty skimmer has a much lower efficiency than a well cleaned one.

Air and water ways (turbulences)

If a skimmer is in action you will see some more advantages or disadvantages. If you can see through the main tube of a skimmer although at high loads, the concentration of bubbles is too less. This is wasted space! Reasons are too less air volume and / or a low contact time.

In the upper part of a skimmer (surface between water column and normal foam) huge turbulence will hinder the creating of foam. Skimmers with waves and currents in this parts are not good. The fresh created foam will be destroyed at once in the area. Only at very high organic loads the skimmer will produce protein foam. But the aim of a skimmer should be to clean as good as possible. If a skimmer is bad you can feed less - and a good feeding is important for fish development and health.

One tip to reduce currents and waves in the skimmer is to reduce the incoming water. At skimmers with the principle of Jülich (see AquaCareFlotor) the water flow must be very exact to reach maximum skimming effect. AquaCareFlotors are calculated in that way that the recommended pumps should be reduced a little bit. It sounds silly, but with the time the pumps will have lower power and in the incoming tubes organisms will grow and reduce the water flow. If this happens you only have to open the ball valve to get the right water flow. So the intervals for total cleaning are very long.

Increase of oxygen / decrease of carbon dioxide

A very important factor for reef aquaristics is the concentration of the different gases. With technique you must care of an oxygen saturation of 100% or more. Tropical fish and invertebrates are very sensitive against too low oxygen concentrations. It is possible to enrich the water with an oxygen reactor But skimmers are effective, too. With a good down stream skimmer you can produce 1 mg/l oxygen above saturation, with the principle of Jülich 2 mg/l (report of Research Center Jülich) are possible.

Lime reactors (here AquaCare *Turbo* Chalk Reactor size 5 with magnesium tube) enrich the water with carbon dioxide, that will lower the pH value by forming carbonic acid. Without a skimmer the risk of a pH fall exists. Picture: AquaCare.

Important, too, is the decrease or increase of carbon dioxide. In tanks without chalk reactor (CO_2 system) a skimmer takes in CO_2 to prevent total minimum of this gas and a too high pH value. In tanks with chalk reactor you get very fast problems if a skimmer is not connected with the system. The pH will fall below 7.0 and after a while a strong growth of algae will choking invertebrates. Even at chalk reactor models with a lower CO_2 input like the AquaCare *Turbo* Chalk Reactor the pH will fall in the aquarium, if a skimmer is not installed. If you try to compare two skimmers following experiment can be done instead of use an oxygen probe: if the first skimmer is mounted (and a chalk reactor is installed) look at the pH value (electronically measuring) for least 1 week. Write down the pH value every day at the same time. Then change the skimmer and look at the pH value for the next week, too. It is important to change nothing else! Compare the pH values. If the pH value of the first skimmer is above the values of the second skimmer, the first skimmer has a better gas exchange (more oxygen and less carbon dioxide if a chalk reactor is used).

Materials of a skimmer

To guarantee a long life the materials for a skimmer are important. Only materials suitable for sea water should be taken. If different material are welded or glued to-

gether, e.g. Plexiglas and PVC, with the time small cracks will appear and water or salt will go out of the skimmer. The cracks will appear much faster if the temperature will change in a wide range. Different materials should be put together with unions and flanges with the right o-ring. PVC-tubes that are welded at a main plexiglas (perspex) tube must be fixed e.g. at the wall to prevent the welding seam against the forces caused by the mass of the tube and the water in the tube. Main tube and contact tube should be transparent to control the bubbles size and quantity. Additionally you can see the currents and waves in the system. All other parts - except the cup - should be made of non-transparent materials. These parts will never be covered with algae that will grow if light reaches the skimmer.

Most skimmers for aquaristic purpose are made of PVC and Plexiglas. In the last time Plexiglas becomes more and more popular. Pure Plexiglas skimmers are very good looking, if the are fabricated well.

Components of AquaCareFlotor 1000V

But Plexiglas has some disadvantages: you will get very easy cracks and scratches (only a low proof stress, see table). If a Plexiglas skimmer is broken normally the aquarist is not able to repair it. If different types of Plexiglas are used it is very important that the skimmers are malleabled. Otherwise the seams will get cracks with the time. If you have a new skimmer you cannot see if the model is malleabled or not.

The better proof stressed PVC in grey or transparent is very rigid against shocks and other destroying forces. If a skimmer made of this material falls down it will normally not crack. And if a part of PVC is cracked an aquarist is able to fix it with PVC glue. AquaCare uses PVC for chalk reactors, nitrate filter, "Kalkwasser" mixer small skimmers up to size 3000 and above 16000. Only the main tube of the skimmers ACF6000 and ACF16000 is made of Plexiglas. The main tube is mounted to the other parts with flanges and o-rings.

You will find other materials at mass produced skimmers: ABS, PS and POM. All these materials have a high proof stress and are suitable for sea water. Only POM is not resistant against ozone.

Abbreviation	Name	Proof stress in %
SAN	styrol-acrylnitrile-co-polymerisate	2-6
PMMA	polymethylmethacrylate, "Plexiglas"	3,5-5
PS	Poly styren	4-25
PC	polycarbonat, "Macrolon"	12-60
ABS	acrylnitril-Butadien-Styrol	15-30
PVC-U	polyvinylchloride, hard (without softener)	15-40
POM	polyacetal	45-75
PA	polyamide	40-150
HDPE	polyethylene with high molecular weight	500-800
LDPE	polyethylene with low molecular weight	500-650
PP	polypropylene	500-1000

Tab.: Proof stress of some plastics at room temperature. Source: FH-Frankfurt-Verfahrenstechnik (http://www.fbv.fh-frankfurt.de); Goldmann (http://www.goldmann.de); http://chemie.fb2.fh-frankfurt.de/KUT/211KENNWE.htm

It is important that all parts are fabricated carefully by a well educated team. A skimmer that will fall in pieces after unpacking is not a good choice.

Maintenance

If you buy a skimmer you normally not looking to the maintenance. But this point is very important. Only system with easy maintenance will be maintained carefully and regularly. If the maintenance is difficult to handle the systems get dirty, the water quality gets worse and the animals have to pay the bill.

The best place for a skimmer is a dark place, to prevent algae growth in the transparent main tubes. Is the only way a bright place it is very clever to take a dark foil and wrap it around the transparent tube - after having done the exact adjustment. If you build in a skimmer take care of all parts you have to maintain like skimmer cup, ball valves, and air woods.

The skimmer cup should be take off very easily. Systems with many screw are not good. Bayonet catches are problematic, too, because most of these systems have a very small tang that can crack. Push systems without seal can stuck easily in the main tube after a while or salt comes out through this connection. To prevent salt or water leaking the connection between skimmer and cup must have a sealing like O-rings or gaskets. In our opinion big threats are a good solution, best are trapezoidal threats. But all

connections should be covered with silicone fat or Vaseline (do not use other fats! They can decrease the skimmer activity enormously) to prevent jamming.

Large trapezoidal threads will stand the rough conditions of daily routine – a laid-in o-ring seals simply and perfectly the skimmer cup from the main tube of a skimmer.
Picture: AquaCare.

The water pump should be connected with two ball valve except submersed pumps. If you have to clean the pump shut the pump and both ball valve. Then you can disconnect the pump with a minimum of water leakage. Especially in reef systems with a high concentration of calcium and carbonate hardness pumps get a chalk crust very fast and have to be cleaned.

Injectors (Venturi) should not be glued with the tubing. They can block with particles or salt - bad injectors get a chalk crust. If you want to clean an injector it is very easy if it has two unions. Otherwise it is nearly impossible to clean it. Very short injectors are not good because they have the wrong geometry - this types will block very fast with chalk!

Wooden airstones are a very old technique but effective. If you maintain them regularly they produces finer bubbles than venturi or dispergator.
Picture: AquaCare.

Wooden air stones must be changed regularly to ensure a good effectivity. You can hear from many "skilled" aquarists that an air stone works for several months. Wood is a natural product and decomposes in sea water very fast. Bacteria and dirt covers the surface quickly and blocks the gas bubbles. The bubbles get larger and the skimming effect decreases. In our experiences we have to change the air woods every 2-6 weeks. Because you must change the woods very often it is very important to make this in a very easy way. Air stones outside of a skimmer are very practical. - Air stones made of ceramic or other materials have normally bigger bubbles or a high working pressure. With this air stones you will loose the advantage of air stone driven skimmers. If you do not want to change the air stones regularly, please take another system like venturi.

Dispergators or diffusors are prone to wear. The specialized rotors have a short life time because the forces in dispergator pumps are very strong. The material cannot resist these forces a long time. The modified rotors are very expensive and will run under extreme conditions only some week. Axis and the bush of the rotor abrase very quickly and after a stop of the pump (e.g. a short lost of electricity) it will not start again by itself. The consequence have to pay the aquarium animals.

Down draft skimmers should be placed dark because you can clean the tubes not very easy. The inlet water should be filtered to prevent blocking of the trickling filter materials in these skimmers.

Overview

System	Advantages	Disadvantages
short skimmers compared to long skimmers	lower price; can be placed under the aquarium; easy to clean; lower energy consumption; can stand in the filter sump (you do not need a skimmer shut off)	lower efficiency
wooden air stones	new air stones forms brilliant bubbles (size and size range)	you need an extra air pump; air stones has to be changed regularly
venturi = injector	any maintenance (if you have a good construction)	you need a stronger water pump
dispergator = diffusor	low energy	high cost for spare parts; very loud
down draft skimmer	if the filter system is several meters below the aquarium (filter in the cellar) you save energy, because you can use the free fall of the water	large models are necessary; not easy to clean
Plexiglas	if constructed well; it looks fantastic	danger of cracks and scratches; you cannot repair by yourself
PVC, ABS	low danger of cracks; transparent a in-transparent material; you can fix cracks by yourself	transparent tube are not totally transparent (lightly milky)