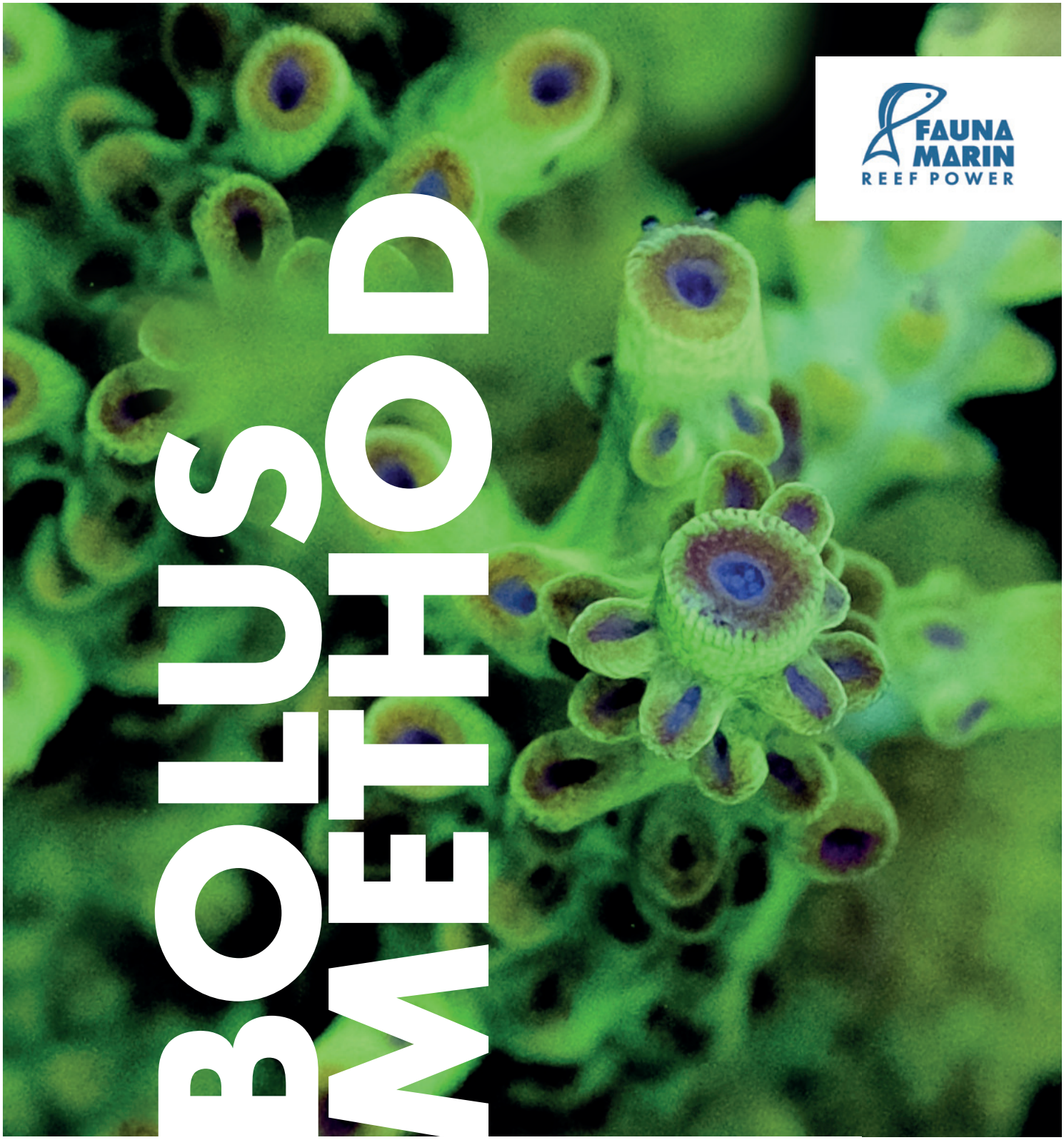
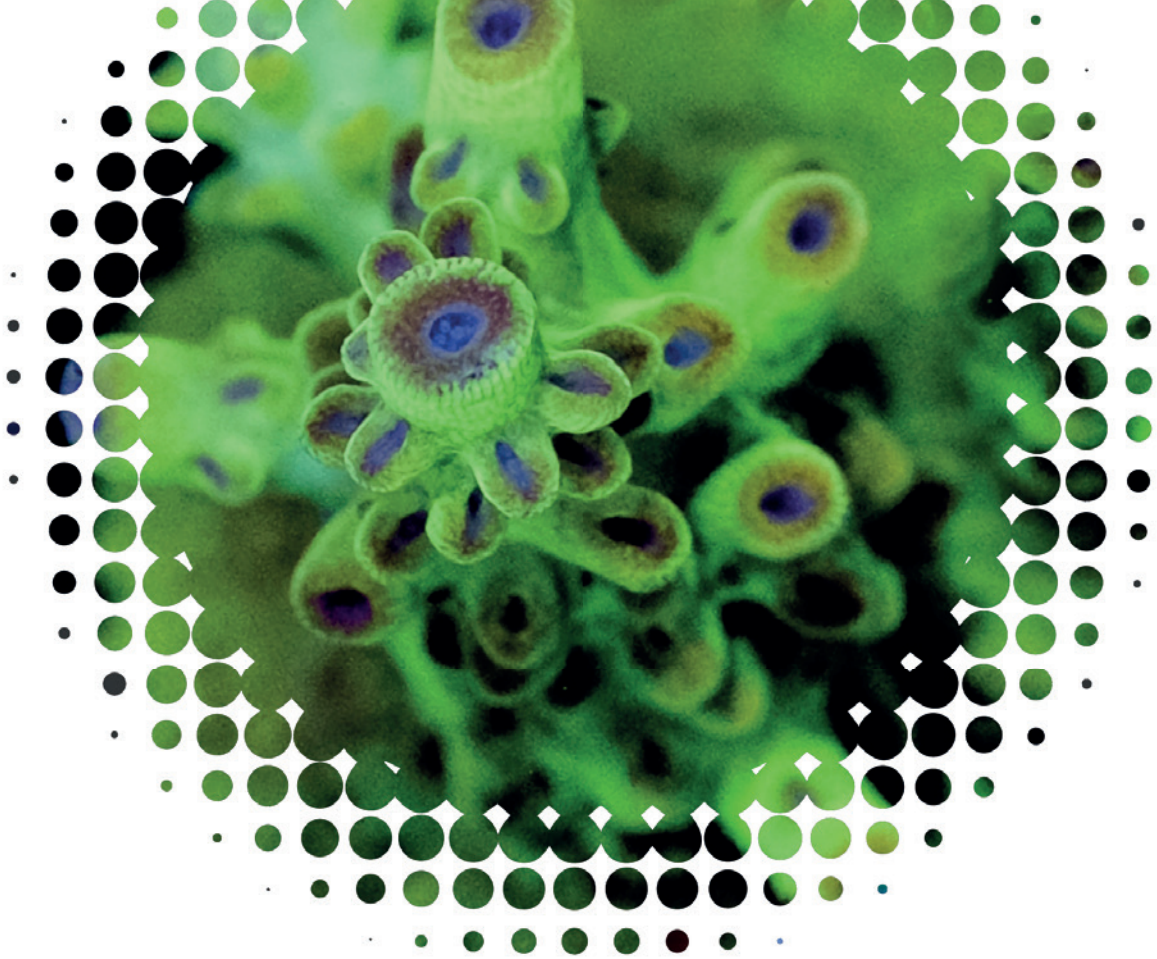


FAUNA MARIN
REEF POWER

HOW TO USE

BOLUS METHOD

TECHNOLOGY FOR ORGANIZING THE FAUNA MARIN BALLING LIGHT DOSING AND LIGHTING SCHEDULE.

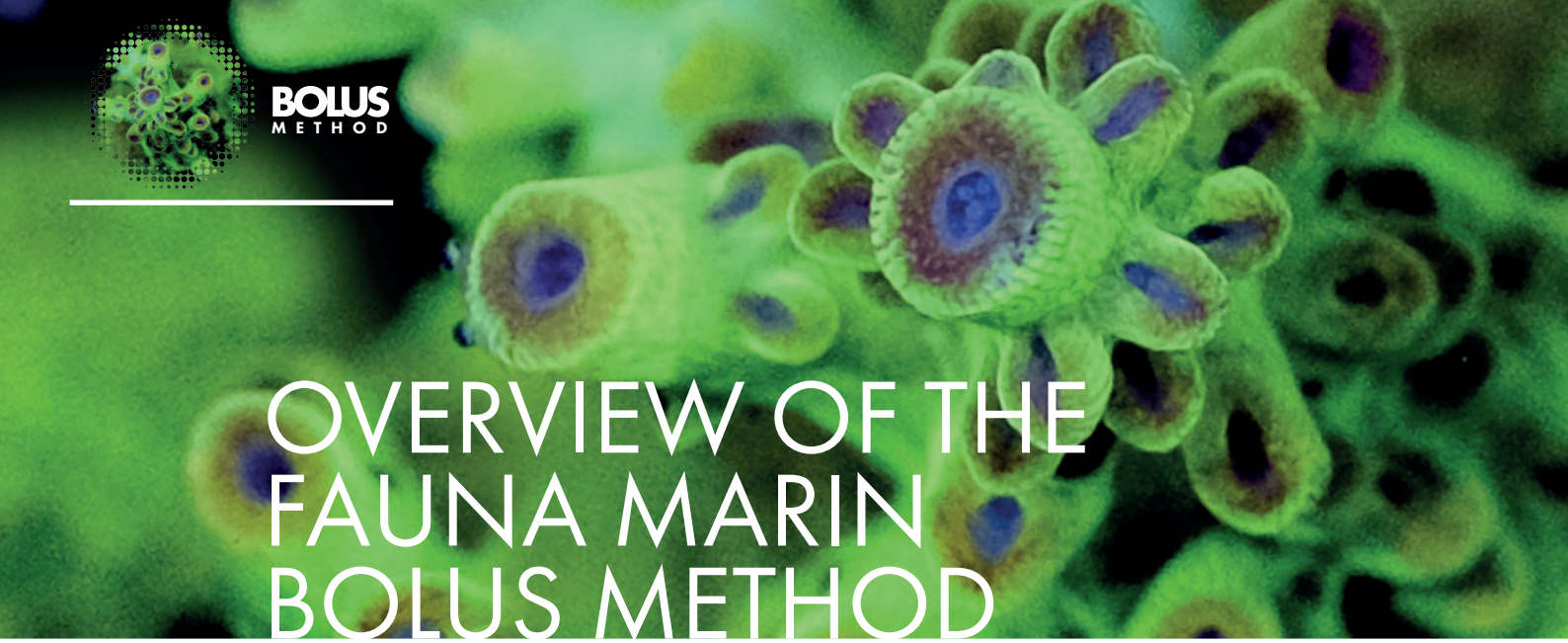


BOLUS METHOD

IMPORTANT!

The information contained in this document applies exclusively to the use of Fauna Marin Balling-Light products. The implementation of this method with the use of products other than Fauna Marin Balling Light or the use of products in addition to the Balling Light product (e.g., limewater) can damage your aquarium and endanger its inhabitants.

In medicine, a bolus (from Latin bolus, meaning „ball“) is the administration of a larger quantity of a medication, drug, or other compound within a specific period, typically 1–30 minutes, to elevate the concentration to an effective level.



OVERVIEW OF THE FAUNA MARIN BOLUS METHOD

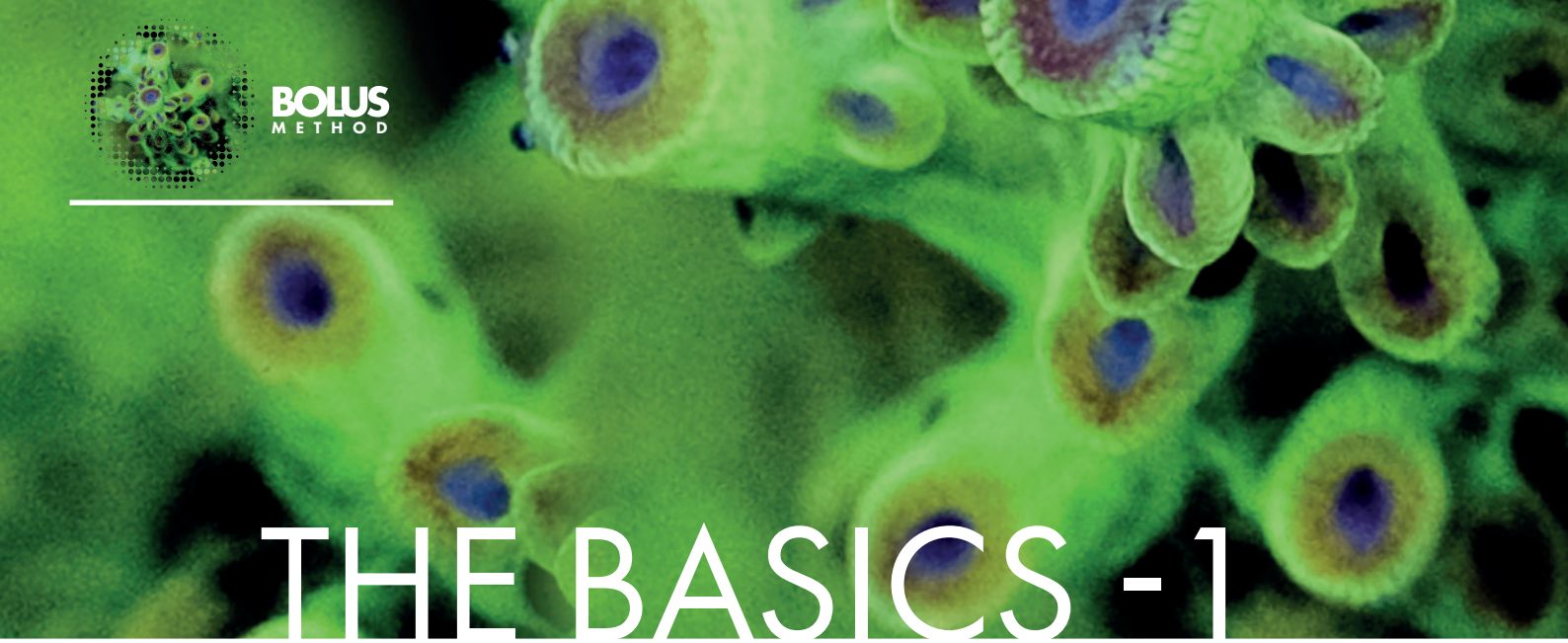
The Bolus Method is a technique of organizing your Fauna Marin Balling Light dosing and lighting schedule in order to improve coral growth, tank health and the long-term health of the aquarium.

The main principle is an 'alignment' of dosing and lighting to achieve maximum pH over the photoperiod by precise timing of a single daily dose of alkalinity that is co-ordinated with the start of your photoperiod. The Bolus method is an intelligent approach that harnesses natural processes to improve tank chemistry. We take advantage of the properties of Balling Light to maximum effect without the need for addition of chemicals that would cause long-term harm to the reef tank.

THE OBSERVED BENEFITS OF THIS METHOD WILL BE:

- pH improvement and coral growth rate
- availability of halogens for improved coral health
- maximize photosynthesis during the early stages of the photoperiod
- improve overall system stability
- eliminate/reduce detrimental precipitation and accumulation (the depot effect) that leads to long-term problems such as 'old tank syndrome
- make your tank more reliable and predictable

This method (co-developed by Frag Farm Ltd, UK and Fauna Marin, Germany) while appearing to be very simple and straightforward, has been formulated through a deep understanding of reef tank chemistry and how it relates to coral photosynthesis processes where we are inducing various natural chemical factors at a single point in time to excite the corals into a state of high activity. This is done without any detriment to the tank chemistry or the corals, it is simply organising all the factors that yield a positive result at the right time.



THE BASICS -1

The fundamentals of the Bolus method are to dose the entire daily requirement of Fauna Marin Balling Light alkalinity in a single dose 30 minutes before the start of the photoperiod; this single dose is known as the BOLUS.

The lights come on with little or no ramp (maximum 10 minutes) from zero to your maximum specified intensity for a limited time and ramp down to a 'normal' level within a fairly short space of time (between 30 minutes and 2 hours depending on your tank). This intense burst of light is important at the beginning of the photoperiod and works in conjunction with the Bolus to supercharge photosynthesis.

TO RUN THE BOLUS METHOD YOU WILL NEED:

- Fauna Marin Balling Light (Alkalinity, Calcium and Magnesium plus Balling Trace 1,2 and 3)
- A good quality doser, with at least 3 dosing heads, that can dose a reasonable quantity of liquid reliably and with consistent accuracy at a daily specified time
- Lighting of the correct spectrum with the ability to program the intensity and timing of the photoperiod. Ideally this should be set up to achieve PAR of 250-380 mmol/m2/s.
- We recommend using the light measuring device ITC PARwise for precise determination of PAR values.
  Link to the device: https://www.faunamarincorals.de/ITC-PARwise/22070V
- A powerful, well maintained protein skimmer that is sized appropriately for the reef tank.

Optional:

- A device for measuring and logging pH
- A method of automatically measuring alkalinity using an alkalinity testing machine.

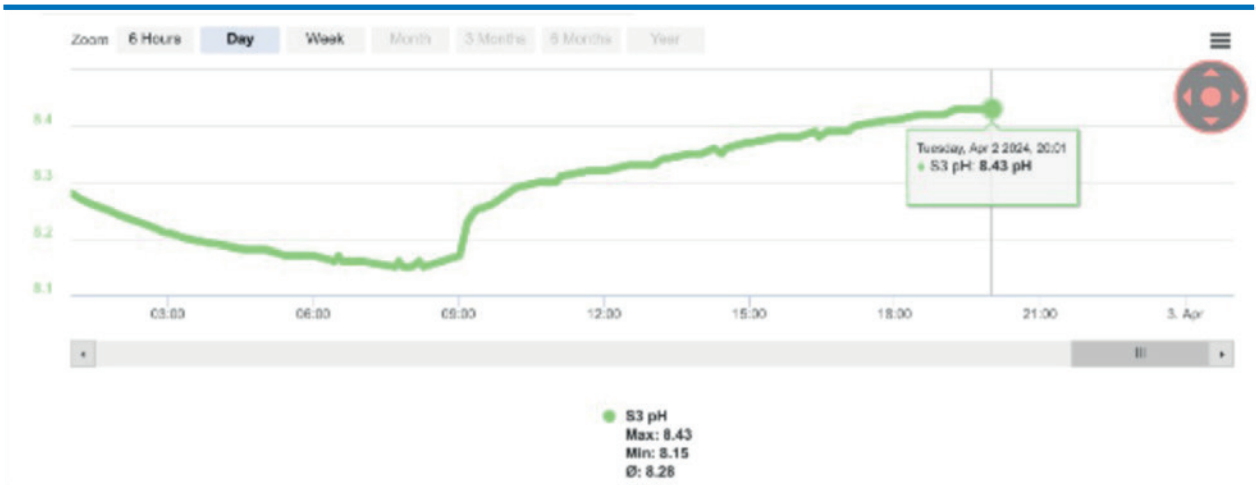
IMPORTANT:

It is important to state that no other dosing product should be used that would impact the carbonate/calcium system. This includes any other carbonate, formate or hydroxide-based additive or calcium reactors. For example, use of kalkwasser with this method would likely lead to disaster.

THE BASICS -2

It is a very simple concept. The aim is to have the pH of your tank as close to 8.2 as possible at the start of the photoperiod, this is a significant threshold where a number of processes within the coral start to work optimally and is the correct balance for both coral growth (calcium deposition) and photosynthesis (chemical energy production from light).

Using Fauna Marin Balling Light carbonate, it is possible to raise the pH substantially just before the start of the photoperiod by dosing the entire daily requirement in one dose, this is the Bolus. The timing is very important as there is a chemical re-balancing that can take between 10-30 minutes, this should be the delay between the Bolus dose and the start of the photoperiod.



As we see on the graph, the Bolus is dosed shortly before 9am. After a slight adjustment the pH rises rapidly to a point where most of the corals processes will work best, around 8.15-8.3. This maximizes the efficiency and productivity of the coral to make use of the whole photoperiod.

THE BASICS -3

Both Frag Farm and Fauna Marin have known for some time (decades) that there are really only two important FACTORS that drive pH:

FACTOR 1

The buffer system, in this case the carbonate buffer system. This is the complex equilibrium of carbonate chemistry that buffers and absorbs acid effect on the water to resist changes in pH. It is also the supply mechanism for the carbonate and bicarbonate needed for coral growth. When we measure alkalinity with a home titration test kit we are measuring only a part of the overall carbonate buffer system. The direction of travel of the equilibrium equation determines the change of pH in the tank as this governs the amount of CO2 present in the water. CO2 in water forms carbonic acid, the method by which the carbonic acid is created determines whether your tank pH goes up or down. This is explained in more detail later in the document.

FACTOR 2

Photosynthesis. Efficient photosynthesis has the most profound effect on raising pH. This is determined by bicarbonate availability, halogens and trace elements as well as the correct amount of light of the appropriate spectrum. Photosynthesis consumes CO2/Bicarbonate and together with water and light creates energy for the corals mainly in the form of sugars. The stronger the rate of photosynthesis the more CO2 is consumed during the photoperiod and the higher the pH rises. pH should not be controlled from a bottle containing a high pH liquid. To create a longterm tank of healthy, colorful and fast-growing corals it is vital to create the best conditions for both the buffer system AND the photosynthesis. The end result of this is good pH and high rates of coral growth.

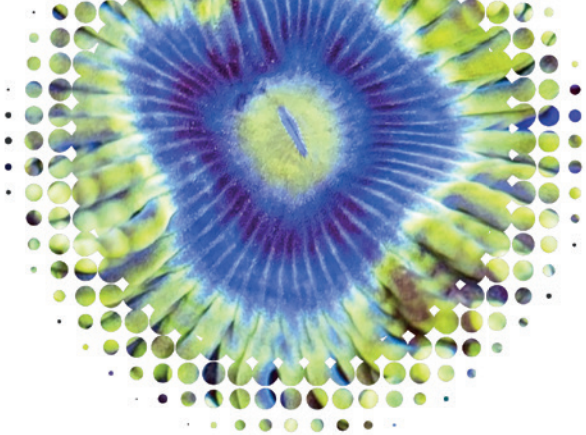
The pH will vary during the photoperiod, we aim for 8.15-8.2 at the beginning of the photoperiod to 8.3-8.4 by the time the lights go off. In certain cases pH can go much higher, we've seen some systems reach a pH of 8.6-8.7 with the Bolus method.

The pH may of course be affected by feeding, carbon dosing, additions of chemical absorbers etc. that all have an acid effect on the water; pH also benefits from good ventilation and amount of fresh air the tank receives. During the night many tanks drop below the 8.15-8.2 threshold, which is normal. This is the purpose of the Bolus, to raise the pH to a level at the time the photo-period starts where the photosynthesis can take over from the bolus dose and continue to raise the pH yet further.

BOLUS METHOD

HOW DO I START WITH THE BOLUS METHOD?

- Ensure your salinity is within range, ideally at 35 ppt.
- Calcium and Magnesium need to be within range. Calcium between 400 - 435 mg/l, Magnesium between 1300-1450 mg/l. Alkalinity should be 7-9 dKH
- It is advisable to perform an ICP test prior to starting the Bolus method, check that all parameters are broadly within range. Most important are Calcium, Magnesium, Boron, Strontium, Sulphur, Fluorine and Iodine. Seek advice from your Fauna Marin ICP consultant or Fauna Marin support.
- Ensure that your dosing pump is working well and that any peristaltic tubes are not worn out. The extra demands of the Bolus dose on your dosing pump will show any weaknesses in your pump also check the calibration to ensure the dose is accurate.
- Calibrate your pH probe (if you have one) and ensure it is reading consistently and accurately.
- Calculate the current amount of alkalinity that you are dosing over a 24hr period.
- The Bolus works best when the tank is in a well ventilated space with access to fresh air, ideally with a fresh air feed to the skimmer.

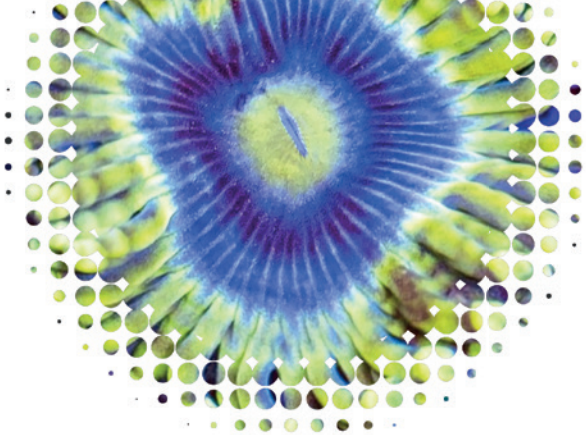


BOLUS METHOD

STEP-BY-STEP

1.LIGHTING

- Set your photoperiod to be 11hrs maximum.
- Have little or no ramp up time when your lights come on, if you insist on a ramp up time then we suggest no more than 10 minutes from darkness to your chosen maximum intensity. Increase the intensity of your white light by 20% at the very start of the photoperiod, keep your blue light at your chosen level. We call this the SOLUS period. Program this 20% higher setting to be on for 20 minutes if you have very intense lighting, then ramp it down to the normal level of each channel that you would run your tank at. You can experiment with the intensity and duration of the Solus, if you corals are happy then extend the solus period every few days until you have 2-3 hours of Solus period. What your tank is able to take will be highly dependent on the chemistry, the type of lighting and the tank inhabitants. The basic principle is that we want a blast of light at the very beginning of the photoperiod, this is possible due to the extra halogens that are dosed with the Bolus dose, these act to protect the coral from the extra light. The use of a PAR meter is recommended to double check the light intensity.
- The rest of your light program may remain the same as you had previously.
- Ensure that your lights are set at the correct distance from the water, most modern lights have a wide angle of dispersion which means the height makes a huge difference to the output of the lights. Check the instructions for your lights to ensure they are mounted at the manufacturers recommended height (this video does a good job of explaining the inverse square law https://www.youtube.com/watch?v=F-xNMdIXJIs



BOLUS METHOD

STEP-BY-STEP

2. DOSING

- Calculate the total existing dose of Fauna Balling Light Alkalinity that you dose over 24 hrs and change your doser to dispense that amount as a single dose (the Bolus) 30 minutes before your lights come on (the Solus). For example, if your photoperiod starts (Solus) at 9am then dose your alkalinity Bolus at 8:30 am.

- Start your calcium dosing 1hr after the bolus dose has been dispensed. You can spread out the calcium dose over each hour throughout the photoperiod. It is not recommended to dose calcium throughout the night. We recommend 8-10 doses starting 1 hr after the Bolus dose. For example: If you dose 40ml of calcium per day then you can dose 5ml per hr throughout the photoperiod for the next 8 hours. With the Bolus method it is important to keep your calcium within the range of 400-435mg/l. If your calcium exceeds 440mg/l it rapidly increases the rate of precipitation of calcium carbonate.

- Magnesium may be dosed as normal throughout a 24 hr period and kept within the range of 1300-1450mg/l, this is marginally higher than the ICP reference range as the Bolus is an increased amount of bicarbonate and having the higher magnesium level helps to stabilize the chemistry.

- It is advisable that any dose that would have a detrimental effect on pH is moved to later in the day so that it does not interfere with the bolus chemistry. This includes for example, carbon dosing, Lanthanum chloride or coral or fish feeding.

- Dose your Bolus dose into the last chamber of your sump with your return pump. If you don't have a sump then it is recommended to dose into an area of high flow.

- Bolus may be dosed manually (without a dosing pump), just ensure there is an hour between the Bolus and calcium and magnesium doses

STEP-BY-STEP

3. MEASURING AND ADJUSTING YOUR BOLUS DOSE

The Bolus method creates a chemical phenomenon where the amount of alkalinity measured on a test kit will be misleading in the first hours of the bolus dose. When running the Bolus method it is recommended that you test alkalinity when the pH is highest, this is typically at the end of the photoperiod. As your alkalinity will decrease throughout the day it can be important to choose a time each day to test your alkalinity and only use measurements taken at the same time to make comparisons.

We recommend that you keep a record of your alkalinity and test at the same time each day in the early stages of running this method. Generally we see the demand for alkalinity increasing substantially as the tank transitions to this new system. If you have an automatic alkalinity tester then set it to take a reading late in the photoperiod, the readings taken shortly after the Bolus dose should not be used to make decisions on dosing adjustments.

As you see the alkalinity demand increase you will see your alkalinity reading drop from day-to-day, this will require the Bolus dose to be increased. We recommend that changes are made slowly and never increase or decrease the Bolus dose by a maximum of 5% up or down. Small changes of 2% of the dose seem to work best. Change the dose, test at the end of the day and take your time to determine if the alkalinity is dropping.

The signs of the need to increase the Bolus dose are:

- A general down-trend in alkalinity measured at the end of the day
- pH gains after the Bolus dose are not as high as they have been previously
- Maximum pH at the end of the photoperiod is not as high

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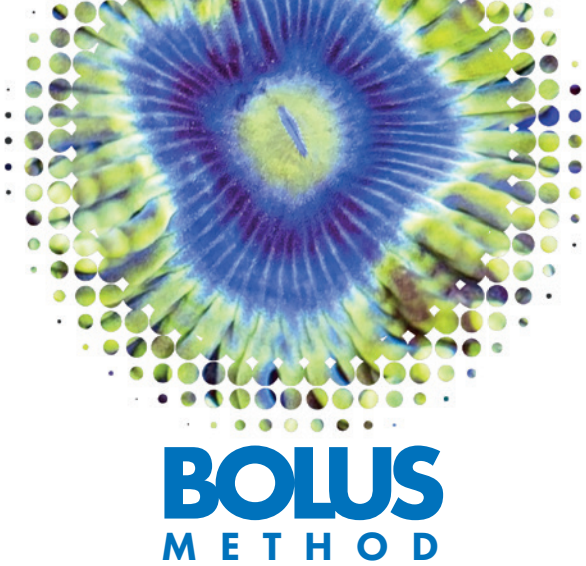


STEP-BY-STEP

3. MEASURING AND ADJUSTING YOUR BOLUS DOSE

→ From page 10

The signs of the need to decrease the Bolus dose are:

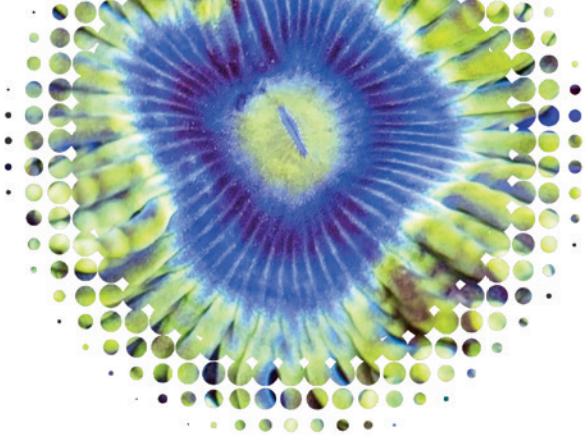
- A large upward change in alkalinity that is accumulating day-to-day.
- pH much higher than normal both after the Bolus dose and at the end of the day

When increasing the Bolus dose there will be an expected boost in pH and it is important to monitor your alkalinity to ensure it is not rising too much after the dose adjustment. Any spikes in alkalinity should stabilize within 24-48 hrs.

It is common for the alkalinity to rise up high and remain high and constant for a large part of the photoperiod. This 'Table-top' effect where the alkalinity will plateau is a feature of the Bolus method and creates a remarkably stable alkalinity throughout the photoperiod. If you have the means of measuring this phenomenon it is evidence that the Bolus method is working as it should in your tank.

It is important that you DO NOT use an automatic alkalinity device to measure and determine the dose for the Bolus. It is ok to measure alkalinity with such a device, but DO NOT allow it to calculate and dose automatically in response to the measurement.

Observe the corals closely in the first days and weeks of using the Bolus method. If you see any negative effects then please contact Fauna Marin support or your local ICP consultant. Some of the negative effects may be due to the increased light at the beginning of the photoperiod; this may be due to elemental deficiencies (send a Fauna Marin Total ICP) or simply due to the corals not coping well with the extra light.



BOLUS METHOD

STEP-BY-STEP

4. WHAT TO EXPECT WHEN YOU START THE BOLUS METHOD

It can be a little daunting to dose a large amount of alkalinity in a single dose, we reefers have been programmed to believe that swings in alkalinity kill corals, this is not true. The Bolus method has been tested extensively and is based on a dosing method that we used to use in the 1980s and 90s prior to the availability of dosing pumps where calcium and alkalinity were administered in single daily doses. When first setting the Bolus method you may see large swings in alkalinity of 1-2dKH within a short period of time, this is perfectly normal and will not affect the health of the tank if kept within a reasonable range of (6 dKH-10 dKH)

When the Bolus is dosed there is an adjustment made to the carbonate chemistry in your tank, this is using a completely natural phenomenon where the bicarbonate dosed is converted to a small amount of carbonate but a large amount of carbonic acid. The effect of this is to increase the pH, but the alkalinity will not go up as far as you might expect.

FOR EXAMPLE:

The Balling Light alkalinity concentration is 0.5 dKH for every 10ml of alkalinity per 100 l of tank water. For a 500 l tank, if your dose is 50ml that would raise alkalinity by 0.5 dKH under normal (non Bolus) conditions.

With Bolus, if you tested alkalinity within a couple of hours of the Bolus dose, it is common to see the alkalinity being raised far less than you would expect, in many cases nearly half of the alkalinity will seem to disappear. In this example it would be normal to see that 50ml dose increases the alkalinity by only 0.3 dKH, it is important not to react to this and to resist adjusting your dose, test at the end of the day and determine whether the dose needs to be refined for the next Bolus. The lost 0.2 dKH will come back during the course of the day.

If you see a cloudiness in the water or a white deposit on your glass then stop the Bolus method immediately and seek some advice from your Fauna Marin ICP consultant or from Fauna Marin support.

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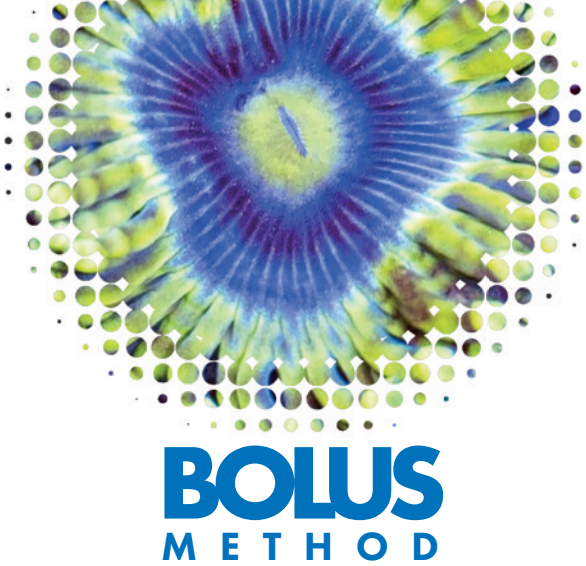

STEP-BY-STEP

4. WHAT TO EXPECT WHEN YOU START THE BOLUS METHOD

→ From page 12

The overall observations and feedback we have received from early testers of this method includes:

- Increased rate of calcification of corals and a significant increase in the tanks demand for Balling Light.
- Better colour definition, stronger basal disc growth, better polyp extension.
- Increased demand for halogens, in particular Fluoride and Bromine.
- Increased demand for metals, in particular the dynamic elements (Zinc, Vanadium, Copper, Nickel and Molybdenum). This will change from tank to tank but it may be important to increase the frequency of ICPs at the early stages of the Bolus method to ensure there are sufficient metals available to the corals.
- We have some early evidence to suggest that corals, in particular SPS, become more resilient to pests and are more capable of defending against bacterial infection such as Vibrio.

It is quite common for the demand for alkalinity to increase quite significantly in the early stages of running this method. We have some testers reporting that their demand has increased 4x in the first 4-6 weeks. Sometimes the demand for magnesium and calcium does not go up quite as rapidly and the ratio of alkalinity to calcium may go from 3 or 4:1 to 5 or 6:1 or more, meaning that the amount of alkalinity dosed has increased compared to the amount of calcium.

It takes some time for the Bolus system to settle down. The effect is cumulative, so each day there is small increase in overall pH, this builds up over time to to create good pH, we would aim for a pH of 8.2 around 1hour after the Bolus dose and it should reach a peak of 8.4 by the end of the photoperiod. Each tank will be different, the ideal conditions are when you achieve an average pH of 8.3 over the 24 hr cycle.

If you have been previously dosing kalkwasser or high pH carbonate solutions, it will take extra time for the Bolus to settle down, this is the process of rectifying the damage that has been done to the buffer system. The Bolus will heal that damage over time, this can take a number of weeks, maybe months.

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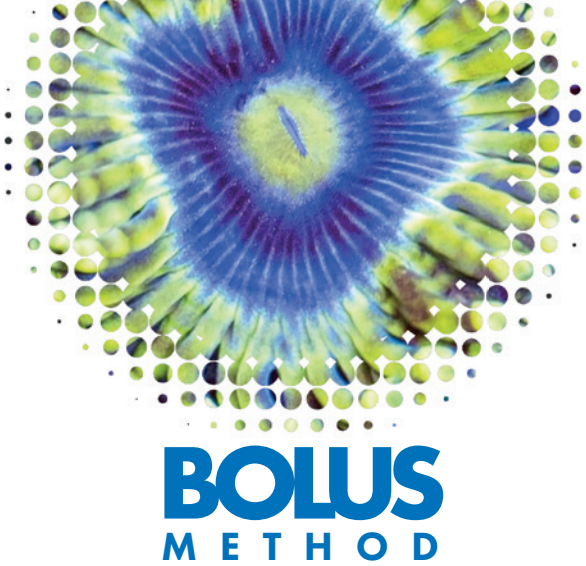

STEP-BY-STEP

4. WHAT TO EXPECT WHEN YOU START THE BOLUS METHOD

→ From page 13

One feature of the Bolus method is a surprising stability in your alkalinity during the photoperiod. When the Bolus is working well, the alkalinity will rise up after the bolus dose and typically will stay high and stable for the majority of the photoperiod. This defies all logic as it is clear the corals are growing and consuming alkalinity. This phenomenon is explained in the 'How does Bolus work' section of this guide. It is completely normal for the alkalinity to drop when the lights go off, the difference between the high and low points over a 24hr cycle can be 1-1.5 dKH, in some cases higher, this is normal.

If your end of day alkalinity is rising then you simply reduce your bolus dose (by no more than 5% at a time). Conversely raise the bolus dose by no more than 5% if your alkalinity is dropping. Any activity that creates an acid effect such as feeding, carbon dosing etc. will affect your alkalinity slightly.

A 'broken' buffer system?

If your tank has been using high pH dosing solutions based on carbonates or hydroxides there is a good chance that your buffer system may be in a poor condition. When your buffer system is not working properly there can be the following indicators:

- The tank is unable to maintain a good pH without constant dosing of the high pH additive. Try not dosing your alkalinity or kalkwasser and observe the pH, if the tank is unable to maintain a reasonable pH then you may have an issue with your carbonate buffer system.

- If you are dosing a high pH additive but the pH is no longer being raised. This is a common issue with long-term use of Kalkwasser

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BOLUS METHOD

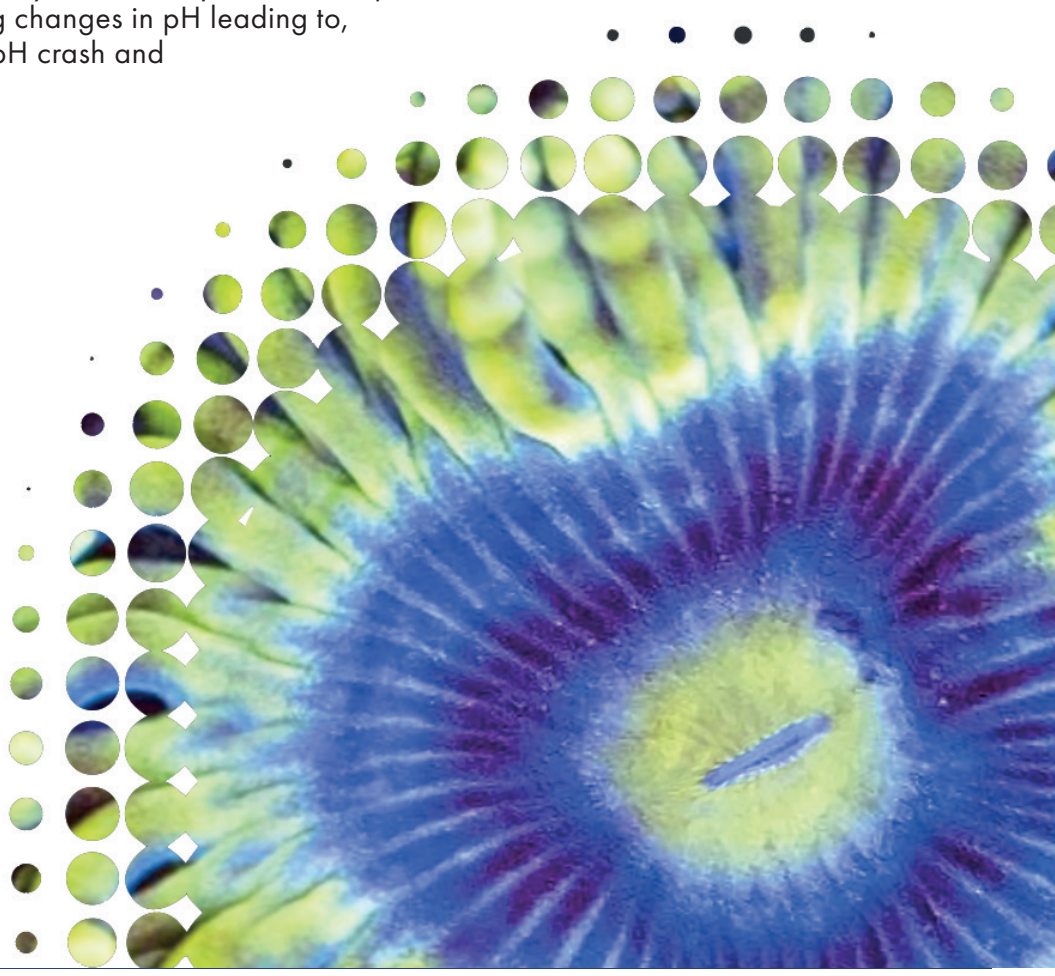
STEP-BY-STEP

4. WHAT TO EXPECT WHEN YOU START THE BOLUS METHOD

→ From page 14

The Bolus method is a viable means of 'repairing' your carbonate buffer system. This happens over time and slowly re-builds the carbonic acid pool allowing the tank to regulate the pH chemistry without the need for high pH additives.

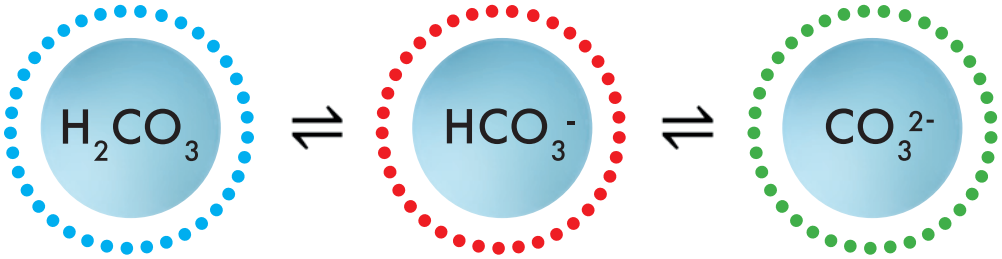
Hydroxides tend to have the worst effect as carbon dioxide/carbonic acid is taken up directly by the hydroxide and forms a carbonate ion. Constant depletion of the carbonic acid pool by regular dosing of high pH solutions will cumulatively reduce the amount of carbonic acid available to the buffer system and cause instability in the equilibrium, causing constant re-balancing. Ultimately the buffer system fails to perform the task of absorbing changes in pH leading to, in extreme cases, a pH crash and often tank failure.



BOLUS METHOD

HOW DOES BOLUS WORK?

THE FUNDAMENTALS OF THE CARBONATE BUFFER SYSTEM



CARBONIC ACID | BICARBONATE | CARBONATE

The carbonate buffer system consists of 3 primary components that work in a complex equilibrium.

An equilibrium, in this context, means that each component of the buffer system is able to transform itself into the component next to it by the removal or the addition of H+ ions. This means that carbonic acid, if it were to release a hydrogen ion (H+) can turn itself into a bicarbonate ion. The action of releasing the H+ ion affects the pH (which is a measurement of the concentration of H+ in the water) , H+ is the basis of an acid so this action would have a negative effect on pH, so your pH would go down.

At first glance this chemistry seems to be illogical, how can carbonic acid be present to prevent changes to pH, surely an acid will have a negative effect on pH? The reefing community has been misled a little in this area.

Carbonic acid is nothing more than carbon dioxide that has been taken into solution in water, it is the backbone of the buffer system in seawater and without it the pH of the oceans and our tanks would crash. Carbonic acid is a regulator and is both a supply source for bicarbonate as well as an escape valve for excess carbon dioxide.

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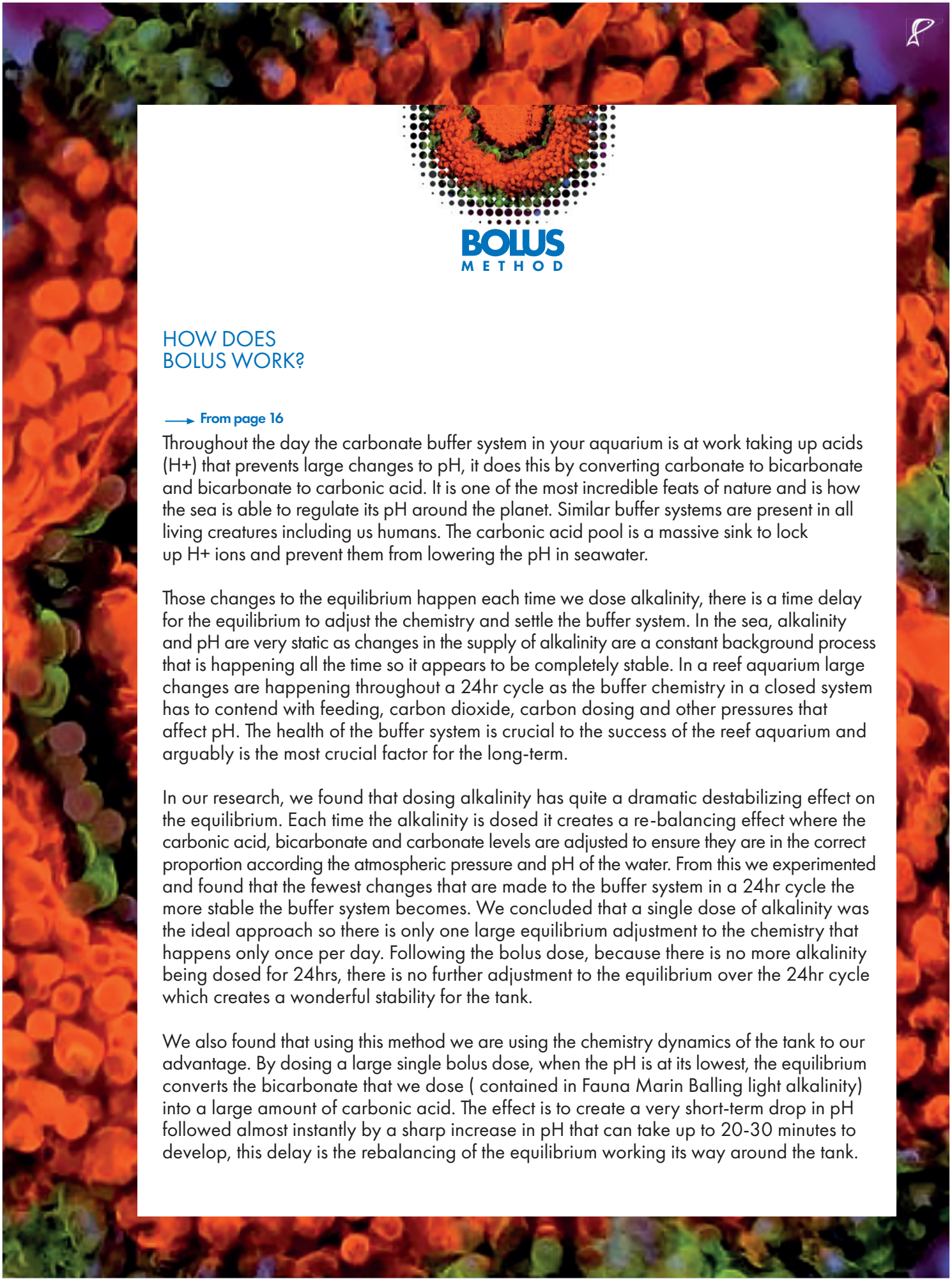

BOLUS METHOD

HOW DOES BOLUS WORK?

From page 16

Throughout the day the carbonate buffer system in your aquarium is at work taking up acids (H+) that prevents large changes to pH, it does this by converting carbonate to bicarbonate and bicarbonate to carbonic acid. It is one of the most incredible feats of nature and is how the sea is able to regulate its pH around the planet. Similar buffer systems are present in all living creatures including us humans. The carbonic acid pool is a massive sink to lock up H+ ions and prevent them from lowering the pH in seawater.

Those changes to the equilibrium happen each time we dose alkalinity, there is a time delay for the equilibrium to adjust the chemistry and settle the buffer system. In the sea, alkalinity and pH are very static as changes in the supply of alkalinity are a constant background process that is happening all the time so it appears to be completely stable. In a reef aquarium large changes are happening throughout a 24hr cycle as the buffer chemistry in a closed system has to contend with feeding, carbon dioxide, carbon dosing and other pressures that affect pH. The health of the buffer system is crucial to the success of the reef aquarium and arguably is the most crucial factor for the long-term.

In our research, we found that dosing alkalinity has quite a dramatic destabilizing effect on the equilibrium. Each time the alkalinity is dosed it creates a re-balancing effect where the carbonic acid, bicarbonate and carbonate levels are adjusted to ensure they are in the correct proportion according the atmospheric pressure and pH of the water. From this we experimented and found that the fewest changes that are made to the buffer system in a 24hr cycle the more stable the buffer system becomes. We concluded that a single dose of alkalinity was the ideal approach so there is only one large equilibrium adjustment to the chemistry that happens only once per day. Following the bolus dose, because there is no more alkalinity being dosed for 24hrs, there is no further adjustment to the equilibrium over the 24hr cycle which creates a wonderful stability for the tank.

We also found that using this method we are using the chemistry dynamics of the tank to our advantage. By dosing a large single bolus dose, when the pH is at its lowest, the equilibrium converts the bicarbonate that we dose (contained in Fauna Marin Balling light alkalinity) into a large amount of carbonic acid. The effect is to create a very short-term drop in pH followed almost instantly by a sharp increase in pH that can take up to 20-30 minutes to develop, this delay is the rebalancing of the equilibrium working its way around the tank.

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BOLUS METHOD

HOW DOES BOLUS WORK?

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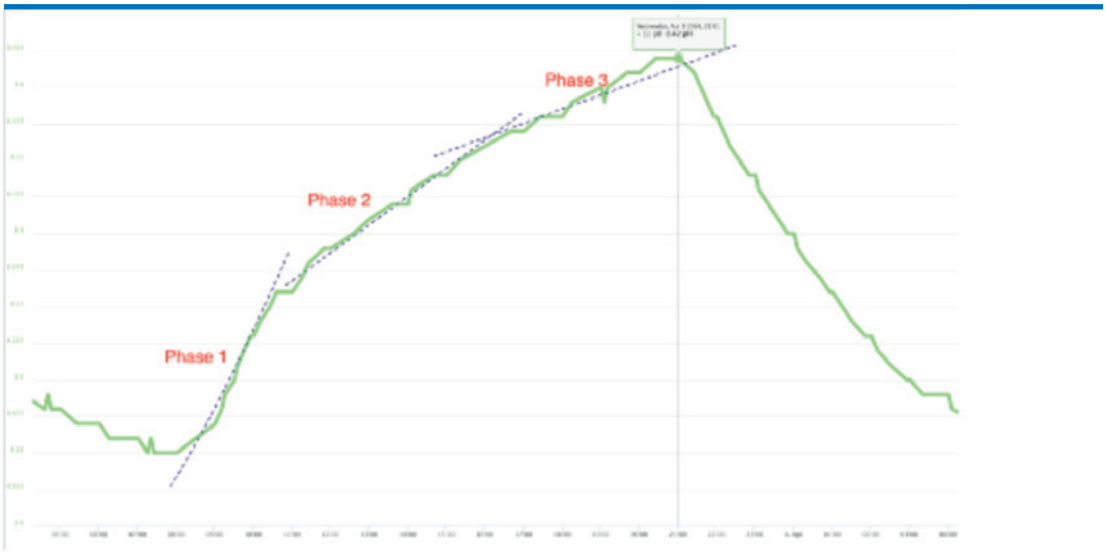

In this graphic we see the pH profile throughout the day that we would expect in most tanks running the Bolus method.

The Bolus is dosed just prior to PHASE 1...

...the lights are on at the chosen maximum level and the pH rises rapidly in this phase. The carbonate equilibrium adjusts to form the correct amount of carbonic acid which raises pH.

The effect of the Bolus dose and the sudden blast of light kick-starts the photosynthesis as well as dramatically improving the rate that corals are depositing skeleton.

Most well balanced reef tanks should be able to achieve a pH of 8.15-8.2, at minimum, by the end of Phase 1. This is the perfect environment to initiate both photosynthesis and growth.

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BOLUS METHOD

HOW DOES BOLUS WORK?

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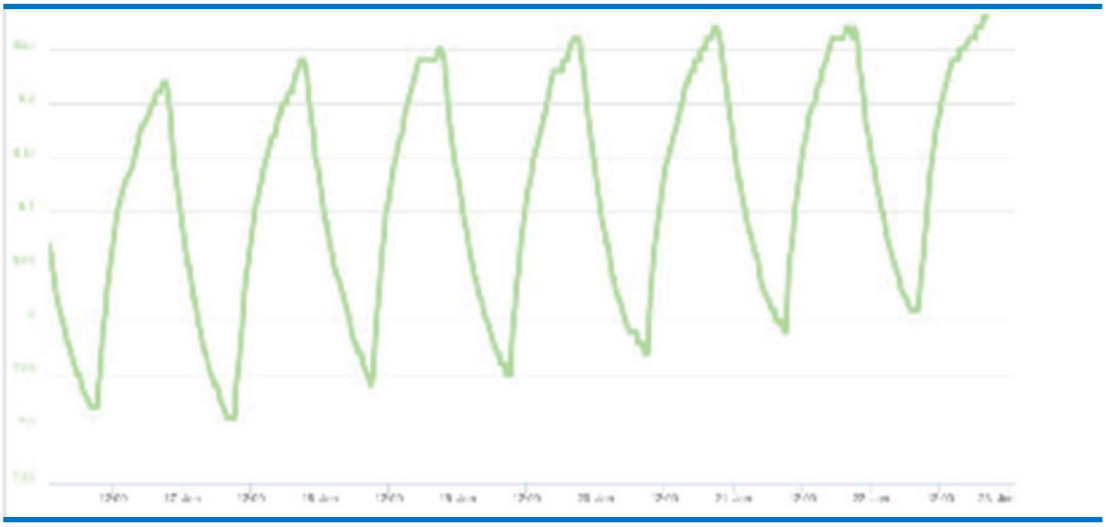
PHASE 2

is focused primarily on photosynthesis, providing coral with the energy needed for the growth phase. During the previous phase, plenty of carbonic acid and CO2 were created and is now available to fuel a fast rate of photosynthesis.

The rate of pH improvement slows as coral growth starts, this has a slightly negative effect on pH, also the carbonate equilibrium starts to adjust and produce more carbonate in readiness for the next phase.

PHASE 3

is focused on deposition of calcium carbonate (growth). pH gains are much slower but we see the highest rate of alkalinity depletion. Many well balanced reef tanks will achieve a peak pH of 8.4 or higher.



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BOLUS METHOD

HOW DOES BOLUS WORK?

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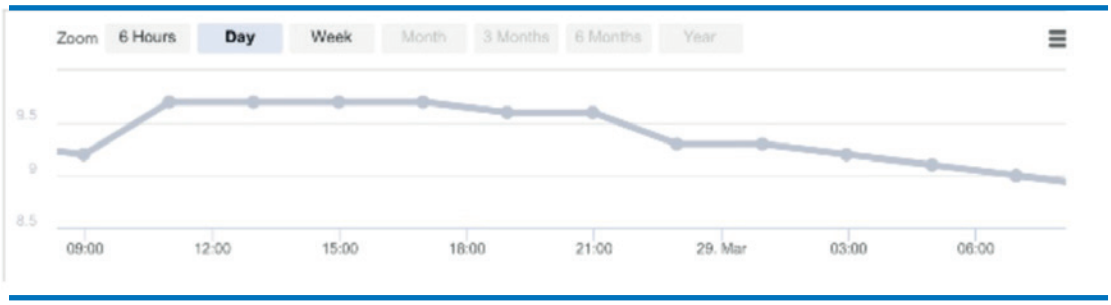
It is important to note that when first moving onto the Bolus method there is a cumulative effect, the pH levels shown may not happen immediately. The small gains that are made each day build upon each other until it reaches the perfect balance as shown in the graphic.

Protein skimming is vital throughout the night and the beginning part of the Bolus process; generally we recommend keeping an appropriately sized skimmer on 24hrs per day. We would not recommend running this method without a skimmer in operation.

Ensuring the room that contains the tank is well ventilated will also assist in maximizing the Bolus effect. If you have the option of feeding your skimmer with air from outside it will enhance the effect further. Maintaining the gains in pH are partially controlled by operation of skimming.



BOLUS AND THE TABLE-TOP - EFFECT

Perhaps the most unexpected effect of the Bolus method is the TABLE-TOP effect. This is a flattening of the alkalinity throughout the photoperiod as shown in the graph below.

Given that a large single dose is administered you would expect to see a large increase in alkalinity should you test it. In all of our tests we saw that when dosing, for example, 1.6dKH of Balling Light Carbonate much less would be visible when testing alkalinity shortly afterwards; often 50% or less would register on an alkalinity test, so the test result would imply that only 0.7dKH was added. This is why we strongly recommend to make dosing decisions based on alkalinity tests in the evening and/or when the pH is at its highest point. This is a feature of the Bolus method, don't worry that missing alkalinity comes back later and can be explained with the TABLE-TOP.

When correctly dosed the Bolus method creates a relatively flat alkalinity for the majority of the photoperiod that often only changes by 0.1-0.2 dKH if at all. This occurs due to the pH rising and the equilibrium converting carbonic acid back to bicarbonate, if this rate of conversion matches the rate of consumption of bicarbonate and carbonate then the alkalinity remains completely flat even though no alkalinity is being dosed.

Typically, when the lights start to dim the alkalinity will drop quite rapidly, this is nothing to worry about as long as it does not fall below 6.0dKH. We tend to run our systems at a slightly higher alkalinity to ensure there is sufficient headroom for the nighttime alkalinity drop.

BOLUS METHOD

THE CARBONIC ACID „BATTERY"

The Carbonic acid pool is a major feature of the carbonate buffer system in your tank and therefore plays an important part in the alkalinity and pH of your system.

Carbonic acid is simply carbon dioxide that has reacted with water to form the carbonic acid molecule, it is very closely related to carbon dioxide (that is also able to reside in water without forming a carbonic acid molecule), in fact they sit together in an equilibrium reaction where carbon dioxide is able to convert to carbonic acid and back again. When there is excess carbonic acid the equilibrium converts the excess to carbon dioxide which can be vented off through the air/water interface (notably the protein skimmer). Conversely, if the carbonate equilibrium is short of bicarbonate it is able to bring carbon dioxide in through the air/water interface and form new carbonic acid and resulting bicarbonate from thin air. This has a very negative effect on the tank pH and is can be an indicator that alkalinity is being under-dosed.

At this stage it is important to note that when we measure alkalinity using a home test kit it is measuring just the bicarbonate and carbonate elements of the buffer system, not the carbonic acid pool.

The carbonic acid pool acts much like a battery for the carbonate buffer system. It is able to store carbonic acid that may be converted to bicarbonate as needed. As with any battery it has two primary measurements, the charge level and the overall capacity. When the Bolus is dosed a large amount of bicarbonate is added to the system and the equilibrium has to rebalance, this means that there is a small increase in the amount of carbonate, but also a large increase in the amount of carbonic acid; the Bolus is 'recharging' the carbonic acid BATTERY. The timing of the Bolus is also critical because we are dosing when the pH of the tank is at its lowest.

The pH determines the battery capacity, the lower the pH the more carbonic acid can be stored. As the pH rises the capacity of the battery shrinks and it is converted to bicarbonate. This is the reason the alkalinity 'disappears' when the bolus is dosed and reappears later during the day. It is also the reason that the alkalinity remains fairly flat throughout the photoperiod as the battery capacity shrinks there is a slow conversion of carbonic acid into bicarbonate; if the rate at which that conversion matches the rate the tank is consuming bicarbonate then the alkalinity will remain constant.

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BOLUS METHOD

THE CARBONIC ACID „BATTERY“

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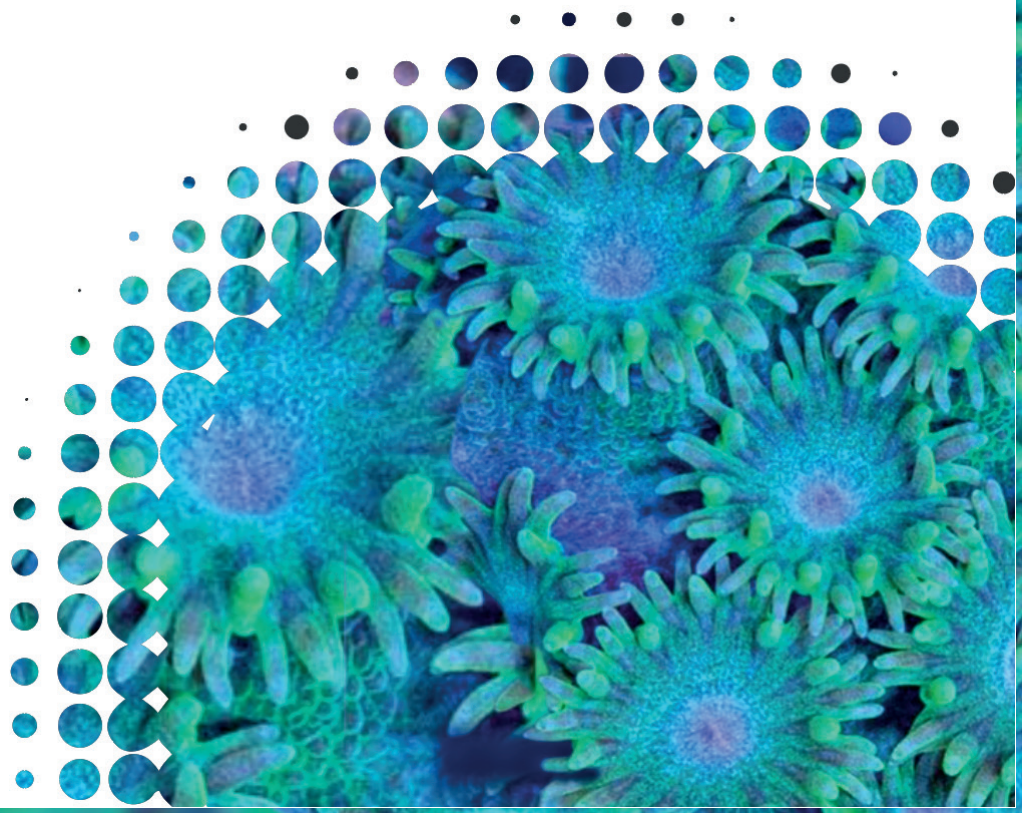
Another small factor is that the carbonic acid battery, when full, will vent off carbon dioxide through the skimmer. The Bolus is actually sacrificing a small amount of bicarbonate in order to maximize the pH gain.

This is another feature of the method, where there will be a slight increase in the CO2 levels around the tank in the first few hours of the photoperiod, ventilation is the best cure.

This carbonic acid 'battery' is perhaps the most fundamentally important part of the buffer system and we are exploiting its unique properties to our advantage in the Bolus method. We have researched this to some considerable depth to understand why the effect of this method can have such a profound impact on the tank. The understanding of the chemistry of the carbonic acid pool played an important role in the creation of this system.



BOLUS METHOD

WHY SHOULD THE BOLUS METHOD ONLY BE USED WITH FAUNA MARIN BALLING LIGHT?

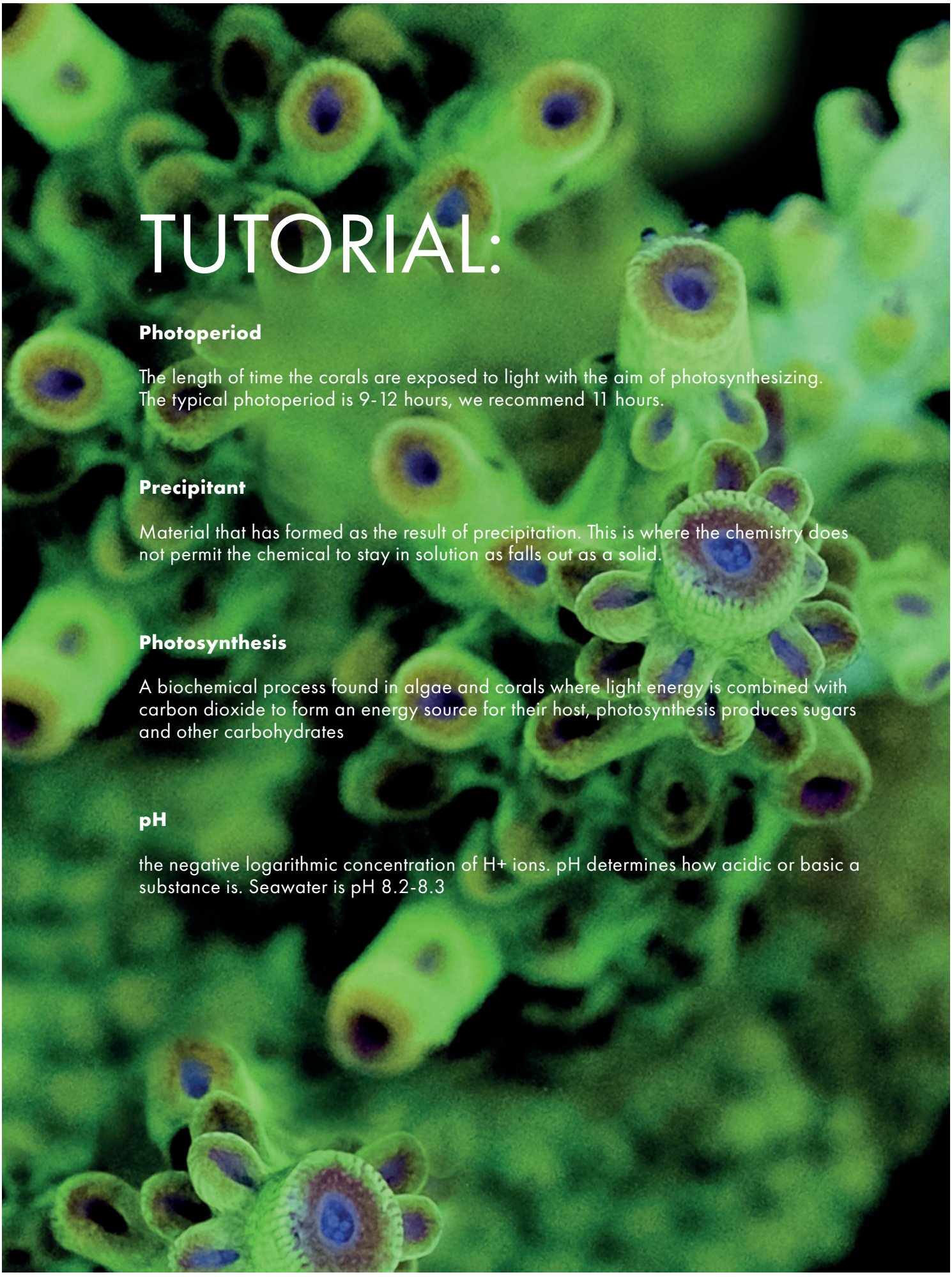
Fauna Marin Balling Light Alkalinity supplement is based predominantly on bicarbonate (not carbonate/soda ash found in most alkalinity supplements). Bicarbonate is the foundation of the carbonate buffer system and has a unique property that other forms of alkalinity supplement do not have. When dosing Bicarbonate on a regular hourly dose basis it has a neutral effect on pH, BUT, when 'overdosing' bicarbonate it initially drops the pH slightly and is followed within a few minutes by a sizeable gain in pH. This is what we call the BOLUS effect. The greater the daily demand for alkalinity the greater the bolus effect and the effect is long-lasting and cumulative. The formulation of Balling trace elements lend themselves well to this bolus method that is less likely to be safe with other bicarbonate formulations. That is why we are asking all users to only apply this method using Balling Light. Additionally, the way the trace elements in Balling Trace 3 have been formulated lend themselves particularly well to this method and provide positive properties for coral health and well-being. **Under no circumstances should this method be used with a carbonate-based product.**

This is in complete contrast to soda ash/carbonate or hydroxides such as kalkwasser that gives the impression of raising the pH, which is only a temporary effect, within an hour or so the pH returns to its original position.

BALLING LIGHT SET

The Balling Light method is an extremely uncomplicated and modern method of supplying the aquarium with calcium, magnesium, carbonate hardness and all the necessary trace elements The Fauna Marin Balling Light System is a complete, selfcontained system that can be used in conjunction with all standard filter systems. It makes no difference whether you use a zeolite system, the standard Berliner system or a natural filter system, e.g. via sludge filtration.

https://www.faunamarincorals.de/Balling-Light-Set/19200V



TUTORIAL:

Photoperiod

The length of time the corals are exposed to light with the aim of photosynthesizing. The typical photoperiod is 9-12 hours, we recommend 11 hours.

Precipitant

Material that has formed as the result of precipitation. This is where the chemistry does not permit the chemical to stay in solution as falls out as a solid.

Photosynthesis

A biochemical process found in algae and corals where light energy is combined with carbon dioxide to form an energy source for their host, photosynthesis produces sugars and other carbohydrates

pH

the negative logarithmic concentration of H+ ions. pH determines how acidic or basic a substance is. Seawater is pH 8.2-8.3

ADVICE:

Here you will find help and support for the product, as well as tips and tricks for marine aquariums:

Certified ICP consultants:
https://lab.faunamarin.de/de/advisor-list

Values + dosage calculator:
https://lab.faunamarin.de/de/calc

Knowledge database on all chemical elements:
https://www.faunamarin.de/wissensdatenbank/

Instructions/HTUs:
https://www.faunamarin.de/support-downloads/

Facebook group:
https://www.facebook.com/groups/1490705804549503/

YouTube channel:
https://www.youtube.com/@FaunaMarin_Official/videos

Email:
Support@faunamarin.de

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