

Who's Testing the Test Kits?

A good testing regimen is crucial to understanding your saltwater aquarium. There is a concert of invisible chemical reactions happening in a delicate balance, and knowing how to manipulate your water quality can be the difference between a thriving environment and an expensive tank crash. Without testing for baseline values, making changes with any accuracy is impossible. Investing in quality tools is just as important as using a quality salt, but are all test kit brands available the same? There's an abundance of anecdotal evidence on which brands give the most accurate results, but it's difficult to know who and what to trust. We've taken a look at four popular hobbyist test kits and compared their performance against an industry standard ICP analysis to let the data do the talking.

How Does Fritz Ensure Consistency?

Fritz RPM Salt is designed to give your water the proper ratio of elements necessary for a healthy aquarium when mixed according to the stated directions. The guaranteed analysis for any salt will be within an acceptable range; and Fritz RPM Salt is subject to a strict quality control testing process before it is shipped to distributors. While rare, if a batch does not measure up during quality control checks, it does not leave the manufacturing facility. The target values for Fritz RPM are: pH 8.3, Ca 420 ppm, Mg 1325 ppm, Alkalinity 9 dKH (blue box)/ 10 dKH (red box). Our salt is manufactured in small quantities and is tested for many physical and chemical properties, and is considered "passing" if each sample falls in the following ranges:

Fritz RPM Blue Specs

pH 8.2-8.4

Calcium 400-450 ppm

Magnesium 1300-1450 ppm

Alkalinity 8.0-9.5 dKH



Fritz RPM Red Specs

pH 8.2-8.4

Calcium 400-450 ppm

Magnesium 1300-1450 ppm

Alkalinity 9-11 dKH



The low and high end of each range is still comfortably within a normal concentration and, for most situations, will not need further adjustment. These ranges also allow for slight material stratification and sensitivities of different grades and methods of testing. Material stratification can occur during shipping and handling due to the difference in particle size of each of the ingredients of the salt, but is easily reblended with a quick stir.

Our QC results are always available if you contact us with your Lot Number, located on each box or bag of Fritz RPM Salt.

Best Practices

Many hobbyists have their own personal preferences when mixing saltwater and achieve good results. While some shortcuts can save time and effort, not all are equal in long term outcomes. Set yourself up for success with the following tips:

- Always add salt mix to your water, and slowly, in small portions. Adding water onto the full amount of salt you need can cause precipitation and may take longer to fully dissolve.
- Limit the amount of aeration or longterm intense circulation in the saltwater mixing vat. Introduction of CO₂ to the water will cause a drop in alkalinity. If you notice this, cease circulation for a few hours and retest.
- Saltwater can be stored long term in a closed container. We do not recommend continuous circulation during storage as this may cause a drop in alkalinity and precipitation of calcium.
- Wait at least two hours after mixing for alkalinity to stabilize before performing a water change or testing for anything other than salinity.
- Keep your salt container closed tightly. The dry salt will absorb the moisture in the air rapidly and may solidify. This will not change the composition of the salt, but will make measuring more difficult.

How Test Kits Work

All of the brands in our comparison use color change titration as their analysis method. Titration is the most precise of the economical at-home methods of water testing when used correctly. Titration “measures” the concentration of the element you are testing for by identifying the endpoint with an indicator solution that changes color at a specific pH.

Calcium

This test measures the concentration of the calcium in your sample by combining EDTA and a calcium specific indicator dye. Because calcium and magnesium molecules are structurally very similar, the magnesium must be “removed” from the sample by precipitation or bonding it with another compound that renders it “unrecognizable” to the test.

Brand	Color at Start	Color at Endpoint	Resolution (Accuracy)	Measurement per drop
Test Kit A	Pink/Red	Blue	0.01 mL	0.01 mL = 5 ppm
Test Kit B	Red/Purple	Blue	0.01 mL	0.01 mL = 5 ppm
Test Kit C	Pink	Blue	0.01 mL	0.01 mL = 5 ppm
Test Kit D	Pink	Blue	0.01 mL	0.01 mL = 5 ppm

Table 1: Characteristics of Calcium test kits used in the study

Magnesium

This test measures the concentration of the magnesium in your sample by combining EDTA and a magnesium specific indicator dye. Because calcium and magnesium molecules are structurally very similar, the calcium must be “removed” from the sample by precipitation or bonding it with another compound that renders it “unrecognizable” to the test.

Brand	Color at Start	Color at Endpoint	Resolution (Accuracy)	Measurement per drop
Test Kit A	Pink/Red	Grey/Blue	0.01 mL	0.01 mL = 15 ppm
Test Kit B	Red/Purple	Blue	0.01 mL	0.01 mL = 15 ppm
Test Kit C	Pink	Purple/Blue	0.01 mL	0.01 mL = 12.5 ppm
Test Kit D	Pink	Blue	0.01 mL	0.01 mL = 20 ppm

Table 2: Characteristics of Magnesium test kits used in the study

Alkalinity

This test measures the concentration of the carbonates in your sample by adding a strong acid in the presence of a pH indicator dye. When the endpoint pH is reached, the dye changes color.

Brand	Color at Start	Color at Endpoint	Resolution (Accuracy)	Measurement per drop
Test Kit A	Blue/Green	Pink/Red	0.01 mL	0.01 mL = 0.08 dKH
Test Kit B	Blue	Yellow	0.01 mL	0.01 mL = 0.2 dKH
Test Kit C	Blue	Yellow	0.01 mL	0.01 mL = 0.28 dKH
Test Kit D	Blue	Green	0.01 mL	0.01 mL = 0.14 dKH

1 dKH = 0.357 meq/L

Table 3: Characteristics of Alkalinity test kits used in the study



Popular Test Kit Comparison

Three batch lots of Fritz RPM salt were tested with four different brands of popular test kits available to hobbyists. The results for calcium and magnesium were compared against an independent ICP analysis of each lot, as shown in the percent error column, alkalinity against our theoretical values of each parameter. All test kits were purchased for this research, and were unopened previous to testing. All three lots of salt were passed by quality control and have been distributed to the public.

A 5% margin of error is generally considered acceptable for qualitative tests.

	Lot #	Ca (ppm)	Ca (ppm)	Ca (ppm)	% Error	Mg (ppm)	Mg (ppm)	Mg (ppm)	% Error	Alk (dKH)	Alk (dKH)	% Error
		Test 1	Test 2	ICP		Test 1	Test 2	ICP		Test 1	Test 2	
		Theoretical Value 420 ppm				Theoretical Value 1325 ppm				Theoretical Value 9.0 dKH		
Test Kit A	33332	415	425	415	2%	1350	1365	1333	2%	8.9	9.1	1%
	33334	410	415	424	3%	1350	1365	1349	1%	8.9	9.1	1%
	33336	410	415	412	1%	1350	1365	1319	3%	8.5	8.9	5%
Test Kit B	33332	420	420	415	1%	1425	1400	1333	7%	8.3	8.6	8%
	33334	420	420	424	1%	1425	1425	1349	6%	8.4	8.4	7%
	33336	400	410	412	3%	1410	1400	1319	7%	8.6	8.6	4%
Test Kit C	33332	380	370	415	11%	1500	1520	1333	14%	8.0	8.0	11%
	33334	380	380	424	8%	1530	1500	1349	13%	8.0	8.0	11%
	33336	370	370	412	11%	1520	1520	1319	15%	8.0	8.0	11%
Test Kit D	33332	430	420	415	4%	1720	1740	1333	31%	8.0	8.4	11%
	33334	420	420	424	1%	1760	1740	1349	30%	8.2	8.4	9%
	33336	415	420	412	2%	1780	1760	1319	35%	8.8	8.8	2%

Table 4: Fritz RPM salt tested with different test kit brands and methods. Red values indicate a failing measurement to Fritz quality control standards.

Result Interpretation

Most of the kits evaluated in this study performed reasonably—a 5% margin of error is generally considered acceptable. Caution should be taken when interpreting results from brands with higher than 5% error. While some test results will still fall within an acceptable range, external factors and errors can compound the disparity of measured and actual concentrations. Overall, Test Kit A and Test Kit B can be trusted to give accurate results across the board. Test Kit C is not a good choice in any category. Test Kit D magnesium tests consistently produced problematic results and should be avoided.

This data is only representative of average percentages of error, which may be due to kit manufacture limitations, subjective measurement error, and other human errors. ICP analysis is also subject to a degree of margin of error as well, but is regarded as an industry standard among professionals and hobbyists.

Do you need an ICP Analysis?

Investing in an ICP analysis is a great way to learn the makeup of your mixed saltwater and concentration of a broad spectrum of elements, including the lower concentration trace and unwanted elements in your aquarium, like Aluminum or Boron. ICP-OES, or Inductively Coupled Plasma - Optical Emission Spectrometry, splits the sample into its component atoms with an electrical spark and quantifies them by identifying the characteristic emission spectral output. Commercially available services require a sample to be mailed in and analyzed, so it can take a few weeks to have the report returned. While not exactly real-time to solve any immediate issues, test kits may not be available or economical for all of these smaller elements. This kind of analysis is comprehensive, but can also be costly and may not be necessary for most situations. However, an ICP test is the easiest way to see the entire picture at once, and may even help identify any problems not easily explained by other methods.

Interpreting Your Own Results

Results from any test kit should be taken with a grain of salt - every qualitative analysis has a margin of error. Familiarize yourself with the resolution of the test kit you are using. Keep in mind how much the result changes with each drop added to the sample. If you aren't sure of the accuracy of your kit, run a test with a known concentration sample; some brands will even include one. If you feel your results don't reasonably match the expected value, try the following troubleshooting tips:

CHECK YOUR SALINITY

The Fritz RPM Salt formula is meant to be mixed to 35 ppm salinity, or 1.026 specific gravity. If the salt concentration is too low or too high, the balance of the other elements will be incorrect and will give test results too low or too high. It's always best to check the calibration of a refractometer before each use. A mistake here can also magnify any mistakes later, it's an easy check before trying to fix a problem you don't have with other supplements.

RE-READ THE DIRECTIONS

Even though the methods are similar, each brand of kit has its own procedure. Manufacturers will use different reagents to offer varying price points, ease of use, and resolution, and it's important to follow the directions carefully. If you think you made a mistake, start over from the beginning with a new sample.

MEASURING INCORRECTLY

These types of kits use small sample and reagent volumes to keep the cost per test low. Measure the required volumes of each step as close as possible (this includes wait times.) When measuring the titrant in the provided syringe, the most important factor is pulling the plunger to the correct volume even if there is air present between it and the liquid. Do NOT measure the volume by the point of the liquid. If you are still not confident, note the actual volume of titrant used instead of converting the amount of titrant left in the syringe to a chart of values.

MISTAKING THE COLOR CHANGE

The endpoint of a titration test is marked with a color shift of the sample. This is a subjective measurement, as there may be a "transition" color in between the start and endpoints. This usually only lasts a few drops, and can happen quickly. Make a note of the titrant volume when you first notice a shift, and when the color fully changes to the expected end color. *The best advice for this step is to be consistent and measure at the same point during every test you run.*

EQUIPMENT CONTAMINATION

If your equipment isn't properly rinsed, residues from previous tests can give you a false measurement. Before testing, always rinse your vials a few times with the sample water to be tested, and in RO/DI water after testing, if it is available, and allow to dry. Titrant syringes should only be used for one titrant, don't use one syringe for many different types of tests. Mark them with the type of test to prevent them from being used with the wrong titrant. All of your equipment can be soaked in vinegar occasionally to remove any built up residue or cloudiness.

EXPIRED KIT

An expired kit isn't guaranteed to give a correct reading. Even before the printed date, the reagents of test kits have shelf lives and, over the life of the kit, can change slightly in result even with the same concentration. Always keep your dry reagents dry and every container sealed unless you are dispensing it for your test. Make sure they are stored in a dark cool area, as light may break down some of the chemicals. If you notice any crystallization or color change to any reagent, discard them and replace your kit.