

# 1 Overview

## 1.1 What it does

The idea is to have a simplified automated test to help maintain a stable Alkalinity.

This specific design does NOT give the actual dKH number. It is simpler. It would instead give notice if Alkalinity is above or below the calibrated sample. Essentially, you create a perfect water sample, then it warns you if your tank drifts up or down from that, and vaguely by how much.

## 1.2 How it works

The key chemistry concept is that as you add Acid to a solution, the PH will change a different amount depending on Alkalinity.

What makes it simple is that adding the acid is a simple pump, and PH probes are common, pretty cheap, and easily attached to a micro-controller. Far less complex than some sort of automated color changing titration.

For example:

You take a Liter of tank water, and measure the PH,  
Then add 25 mL of 0.1N acid, mix, and then measure the new PH.  
From that difference, you can calculate Alkalinity.  
That is technically backwards from the normal method, but should work at target ranges.

But it can be simplified more:

Scientifically, results must be precise, but zero accuracy is needed.  
You don't really need to calculate true Alk level or true PH.  
So no probe calibration, and no fancy ph/acid/alk curves.  
You just need to compare the final probe voltage against pre-measured thresholds, essentially calibrating, which is simple and repeatable.

## 1.3 Downsides

- 1) This method uses quite a bit of tank water.
  - Using a tiny bit of water might work, but errors could be huge.
  - So the water needs to be automatically replaced as well.
  - If part of an automated water exchange system, this is a non-issue.
- 2) CO<sub>2</sub> affects the measurement.
  - This is a factor as well. Both before Acid, and during addition.
  - So care must be taken to keep CO<sub>2</sub> levels constant.
  - Needs more thought and testing!

## 2 The system

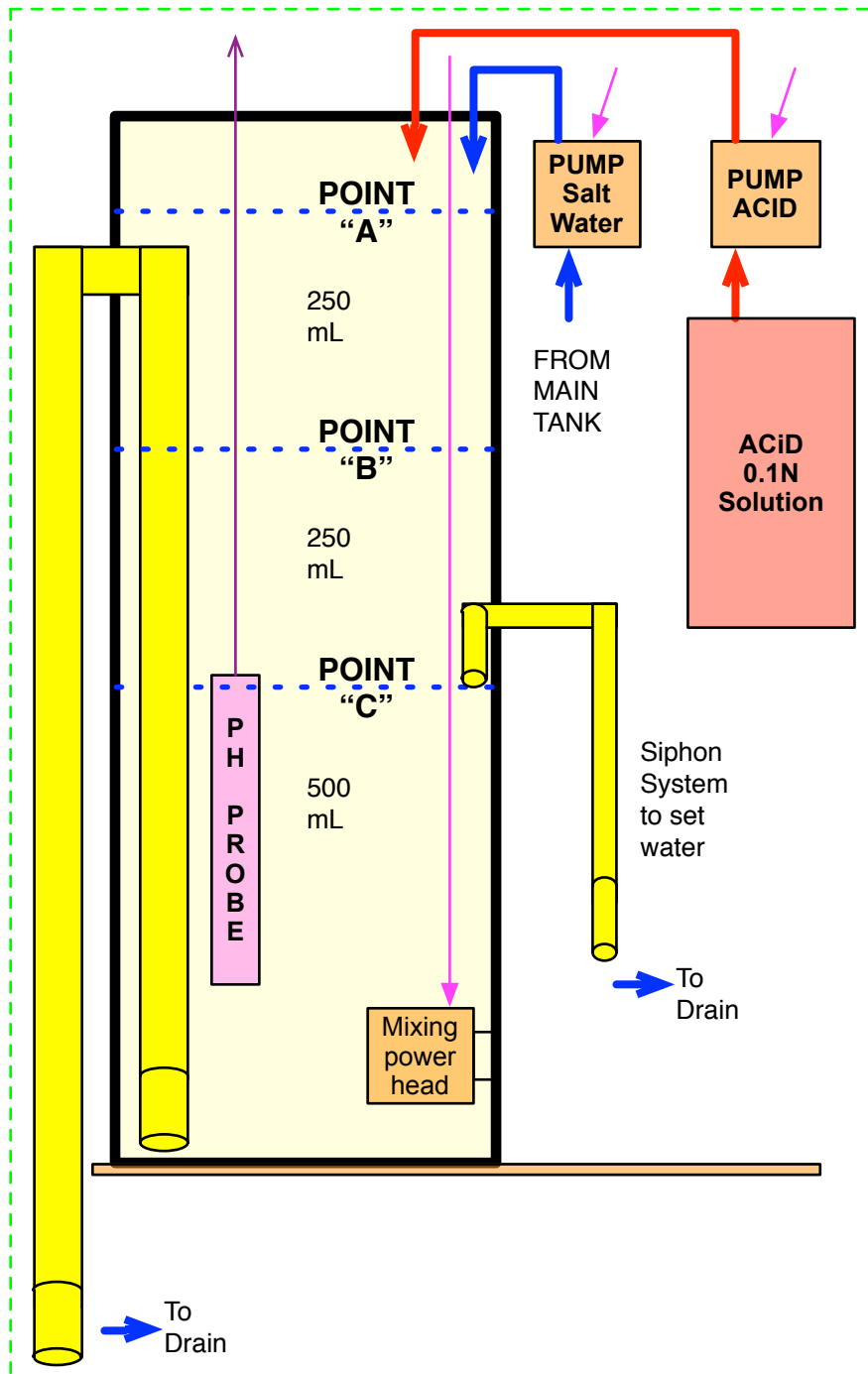
Simple diagram of system. Explanations will follow.

Note water level points A, B, and C.

Note siphon systems to pull water out.

When water reaches top of siphon, at exit point, siphon starts.

Siphon will then pull water out until it reaches bottom of tube.



### 3 Detailed steps

This describes the exact test procedure

At the start, canister will be full of old cruddy acidic water slightly above point C.

#### Step 1: Over-Fill Test Canister to point A

Pump quite a bit of water from main tank. Lots extra.

Should over-flow canister, and go down drain.

KEY: This also starts the large siphon.

Siphon will then empty test canister once pump stops.

At the end of step 1, canister will be basically empty.

It actually starts small siphon as well, but that is irrelevant.

#### Step 2: Fill Test Canister #2 to point B

Pump water from main tank to get it roughly to point B. Can vary a lot.

Enough to start the small siphon, but not enough to start the large siphon.

Small siphon should empty water down to EXACTLY point C.

That may take some time.

At the end of step 2, canister will be partly full at point C with 1/2 liter of nice fresh tank water.

#### Step 3: Measure PH probe voltage

Get the base value of normal tank water.

Accurate PH is not needed, but must be repeatable.

Note that this value is useful to track and store in general.

#### Step 4: Add 12 mL of Solution 0.1N Acid

Pump in an amount of acid using a decent peristaltic pump.

Needs to be a very repeatable amount, but not accurate.

This pump is really the only thing that needs to be precision!

During this step, also turn on small power-head to mix solution.

Both can be run off same relay.

It may be important NOT to aerate though, since that may affect PH.

#### Step 5: Measure new PH probe voltage

Get post-acid value

Accurate PH is not needed, but must be repeatable.

Now leave the slightly acid solution as-is until next time.

That keeps things from growing and reduces possible calcification.

Plus it is key to keep PH probe submerged.

## 4 Calculations

### 4.1 Baseline checks

Does the new baseline match the old stored calibrated baseline value?

Yes = Great

Mostly = OK, but add/subtract a small offset

Way off = BAD

Something went wrong. Send message.

Log change in PH.

### 4.2 Acidified PH check

Does the new value match the old stored calibrated acidified value?

Yes or close = Great

Off a bit = The Alk needs adjusting. Send message.

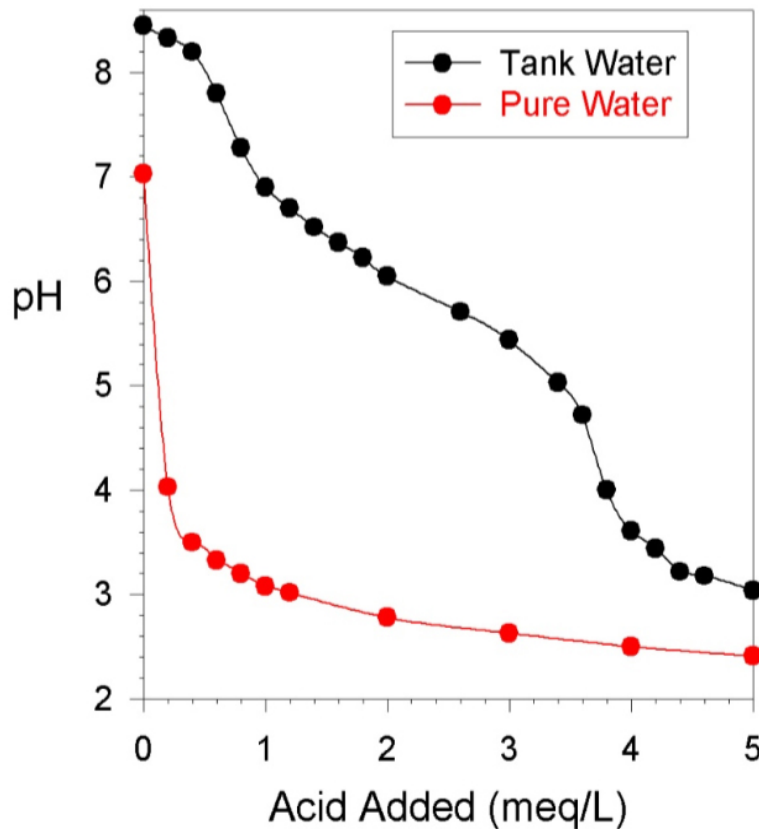
Way off = BAD

Something went wrong. Send message.

Don't bother running further.

Send email to fix or possibly re-calibrate.

### 4.3 Possible Curve



## 5 System Components

A fairly programmable micro-controller

DIY or Reef-Angel are the only real candidates here.

Apex and most others are not programmable enough.

Needs to be Ethernet connected, to send status.

PH probe, connected to micro-controller

Most anything will work.

<https://www.tindie.com/products/SparkysWidgets/miniph-i2c-ph-interface/>

Simple Pump:

To pump water from main tank to test canister

Generally will be part of water exchange system

Tiny power-head:

To mix water in test canister

Can be a stirrer or a pump as well.

Peristaltic Pump:

To add Acid solution.

Slow peristaltic pump on exact timer should be precise enough.

Normal tubing should withstand mild acid.

Container system:

The container, tubing, siphons, etc.

See drawing earlier in document.

## **6 Calibration**

### **6.1 Normal usage calibration**

Make a “perfect” water samples. Large enough to hold probe, otherwise any size. Start with normal tank water, and tweak it.

Add Carbonate to raise it.

Add RODI + table salt to lower it.

Use a normal test kit to measure the value.

Once that is done, measure PH probe voltage:

First get PH on the sample.

Then add acid to the sample.

Then get PH on the sample again.

For the first time, it is wise to do this a couple of times, and see if measurements are consistent.

This calibration only needs to be done occasionally. Probably yearly. Drift in the measurement of the initial PH value before acid should give you warning of when you need to re-calibrate.

### **6.2 Early design calibration**

For design work, two more samples are needed.

Sample 1 = Modify to exact target dKH. As above.

Sample 2 = Modify to low warning point dKH.

Sample 3 = Modify to high warning point dKH.

Get probe voltage for all those samples both before and after acid.

### **6.3 Early design aeration calibration and test**

This might kill the idea, so a good idea to do first.

Just use most any normal tank water.

Test PH with a real accurate meter.

Blow bubbles in it, stir it well, wait an hour.

Test PH with a real accurate meter again.

Now add acid quickly, stir slightly, and very quickly test new PH.

Wait 5 minutes, test again.

Blow bubbles in it, stir it well, wait an hour, test again.

This is to get a good idea on how PH varies on aeration.

## 7 Target Alkalinty Levels and voltages

Everyone may differ. Just thrown in for fun.

### 7.1 Alkalinity thoughts:

Seawater = 2-3 meq/L = 5.6 - 8.4 dKH

Aquarium tends to be a bit more acidic, so a bit higher Alk than normal may help.

The idea being that additional buffering is safer.

Rumors off the net:

Soft corals like around 3.0 meq / 8.2 dKH

LPS corals like higher around 4.3 meq / 12.1 dKH

SPS corals grow faster if higher, but color better if lower.

Many places recommend 8-12 dKH

Instant Ocean (std) usually is around 11 dKH

### 7.2 My opinion:

Things seem to do a bit better with higher Alk, plus I do not want to be way off my salt mix parameter. So 9-11 is my target range.

I do not push Calcium all that high.

Center ideal target = 3.4 meq/L = 10 dKH

Send adjust-up message at 9 dKH

Send adjust-down message at 11 dKH

Low scary point = 7

High scary point = 12

### 7.3 Voltages:

<TODO>

Put measured voltages here.

## 8 Special Credit

Many thanks to Randy Holmes-Farley.  
His DIY Alkalinity test was a big inspiration to this idea.  
And I used his PH/Acid curve drawing.

[http://www.reef2reef.com/blog/a-diy-alkalinity-test-by-randy-holmes-farley/?utm\\_source=Reef2Reef+News+Letter&utm\\_campaign=a1867f74cb-A+DIY+Alkalinity+Test%3A+By+Randy+Holmes-Farley&utm\\_medium=email&utm\\_term=0\\_52ba5d29d2-a1867f74cb-62588129](http://www.reef2reef.com/blog/a-diy-alkalinity-test-by-randy-holmes-farley/?utm_source=Reef2Reef+News+Letter&utm_campaign=a1867f74cb-A+DIY+Alkalinity+Test%3A+By+Randy+Holmes-Farley&utm_medium=email&utm_term=0_52ba5d29d2-a1867f74cb-62588129)