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PINPOINT®
pH Controller

Users Manual

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PINPOINT pH Controller USERS Manual

I. Overview

This device consists of a pH Monitor and electronics, which control external devices, based on the pH reading. Accordingly, there are two adjustments that must be made to the controller before putting into service. The calibration of the electronics which read the pH and the adjustments of the controller setpoints. After the controller is in service, it will be necessary to re-confirm and perhaps re-calibrate the pH monitor.

It is important that you understand these instructions and it is critical that you follow the cautions in this manual. Most users will be controlling the addition of CO2 into their system with this instrument and there can be disastrous results if CO2, another acid or a base is added to the system in an uncontrolled fashion. It is critical that one pay special attention to the placement of the pH probe in the system. You must frequently check the condition and calibration of the pH probe. We strongly require that you build sanity into your system. Needle valves, and similar devices, should be designed to throttle-down the flow of gases into the system at a reasonable rate. If a base is being added, the maximum rate of addition should be slow enough so that there are not disastrous consequences over a short period of time. Control electronics are not human, they are not intelligent and they can not "know" when something has happened to make their input or output invalid. If the probe is not immersed in the system, it will no longer be reading the correct pH; either acid or base might be added in a completely uncontrolled fashion. If solenoid valve sticks open, the controller will not be able to shut it off. So you must be very certain that the pH probe will not become uncovered and your needle valve settings should be chosen so that if the control solenoid valve sticks open, you will have some reasonable period of time to notice that there is a problem. Installing a pH Controller on your system does not mean that you no longer have to pay attention to it. You must still monitor the system so that you can note when a problem exists and correct it in a timely fashion.

II. GENERAL SPECIFICATIONS

pH Measurement Range 1.00 - 14.00
pH Setpoint Range 4.00 - 10.00
3 1/2 Digit LCD Display
Resolution 00.00 pH Unit
2 Independent 5 Amp 110 VAC Relay Outputs

III. Displays and Adjustments

pH Display
pH Monitor Adjustment & Instrument Status
Controller Set Point Block
Display Mode
Controller Status LED's
110 VAC Outlets (#1 &2)
pH Probe

UPPER LEFT (pH Display)

The 3 1/2 digit LCD (Fig. A) at the top left of the controller displays a numeric value corresponding either to the pH as measured through the probe, or the high or low controller setpoints.

LOWER LEFT (pH monitor Adjustment & Instrument Status)

Below the display are two adjustment screws, which are used to calibrate the electronics to properly read the pH, and two LED's which report the status of the instrument.

The adjustment screw marked "CALIB" (Fig. B) is used to zero the pH monitoring electronics, and the "SLOPE" (Fig. C) is used to adjust the slope. Detailed information on how to make these adjustments is given later.

The red POWER LED (Fig. D) is illuminated when the power is turned on to the controller. The pH LED (Fig. E) is illuminated when the display is indicating the

pH as measured through the probe with the slide switch in the "read" position. The pH LED is off when the display is indicating either the high or low controller setpoints.

CENTER (Controller Setpoint Block)

There are two potentiometers that are used to adjust the controller setpoints. They control the RANGE (Fig. F) and CENTER VALUE (Fig. G) of the controller, respectively. Detailed information regarding their adjustment is given later in the ADJUSTING THE CONTROLLER section.

LOWER RIGHT (Display Mode)

The position of the SLIDE SWITCH (Fig. H) determines what the LED display will show. At the center position, the display indicates the pH that the probe is measuring, and the red pH LED (Fig. E) at the lower left of the instrument will be illuminated. Sliding the switch up or down will cause the display to show the high and low controller setpoints, respectively.

UPPER RIGHT (Controller Status LED's)

There are a total of 4 LED's here. The upper row (Fig. I) shows the status of the 110 VAC outlets, which you will find, on the back of the controller beneath the LCD pH display. The lower LED lights (Fig. J) are activated when the slide switch is in either the HIGH or LOW position.

110 VAC OUTLETS

There are two outlets, which will be energized when the pH is above (outlet #1) or below (outlet #2) the controller setpoints. A common application for the controller will be to control the addition of CO2 to the system. Since the addition of carbon dioxide lowers the pH, a NORMALLY CLOSED solenoid valve controlling the flow of CO2 would be plugged into the HIGH control outlet (Outlet #1). If a basic substance is being dispensed into the system (i.e. a lime water reactor for a reef aquarium) the device(s) controlling the flow would be attached to the LOW control outlet # 2.
NORMALLY CLOSED means that the valve will be closed when NOT energized.

A pH electrode is supplied with the controller. A plastic fluid-filled cap will protect the end of the electrode. The fluid inside the cap is a mixture of #4.0 calibration fluid + 3M KCL. This is commonly known as storage fluid. There is a suction cup attached to the electrode, which may be used to secure it, or a user-devised scheme of holding the electrode may be employed.

IV CALIBRATING THE pH METER SUBSYSTEM

This is a two-point calibration instrument therefore TWO different calibrations must always be used. A pH 7.00 fluid must be used to set the CALIB and a pH 10.00 or 4.00 fluid is used to set the slope.

COMPLETE INSTRUCTIONS:

Before you begin the calibration, you should disconnect the pumps or valves that you are controlling, because the pH electrode will be put into solutions with a pH that is probably far outside the controller limits you have established.

Before you begin, make sure that you have the pH calibration fluids, and some room temperature tap water to rinse the electrode between calibration solutions. You must have a #7.00 calibration solution, and another solution with either be higher or lower pH (typically 4 or 10). If you are doing this for the first time, read through these instructions once to determine what is required before you begin.

1.Set the display mode switch (far right) to the central position (read). The pH LED (lower left) should be illuminated.

2.Remove the plastic cap protecting the end of the electrode if you are doing this for the first time. If the electrode has already been in service you should note the condition of the electrode and clean it if required.

3.Rinse the electrode with room temperature tap water taking cares to remove any accumulated salt. Rinsing the electrode prevents you from carrying over contaminating substances into the calibration solutions. Gently shake the electrode to remove any clinging drops of water.

4.Immerse the tip (bottom 1 inch) of the electrode into the pH 7 calibration fluid. It is important to use the pH 7 solution first. Be sure that the tip of the probe is fully immersed in the calibration fluid for a stable and reliable result.

5. Keeping the glass bulb immersed, gently swirl the ends if the electrode in the calibration fluid until the pH reading stabilizes. If the electrode is in good condition, the reading should stabilize in a few seconds. If the electrode does not

easily stabilize; this may be a sign that the electrode is in need of cleaning or should soon be replaced.

6.Adjust the CALIB screw to bring the displayed pH to about 7.00

7.Remove the electrode from the pH 7.0 calibration solution and rinse it with room temperature tap water. Gently shake the electrode to remove clinging drops of water.

8.Immerse the end of the electrode into either the low or high calibration fluid. Usually pH 4 or pH 10 is the most common. Swirl the end of the electrode in the fluid until you obtain a stable reading, then adjust the SLOPE screw until the display shows the value of your calibration fluid (typically 4.00 or 10.00).

9. Again, rinse the electrode with room temperature tap water and shake of any clinging drops.

10.Re-immerse the electrode in the pH 7 calibration solution and now repeat steps 6-7-8 until the display shows 7.00 in the pH 7 fluid and 4.00 or 10.00 in the other calibration fluid that you have selected.

11.Rinse the electrode and return it to service in your system. Remember that the sensitive glass bulb of the electrode must not be allowed to dry out. Use the clear plastic cap filled with storage fluid or pH 4 calibration fluid when not in use.

The pH calibration process is now complete.

V. PROPER PLACEMENT OF THE pH ELECTRODE

When the controller is operational, it is critical that the tip (bottom 1-inch) of the electrode be immersed in the system at all times. If the water level falls below the sensing tip of the electrode, the pH probe will not read properly. If the erroneously measured pH is higher than the controller setpoint, devices connected to that outlet will remain permanently ON, irrespective of the actual pH.

Take some time to determine how much the fluid level around the probe will fluctuate. Adjust the position of the probe accordingly.

Consider the final placement of the probe and attach it securely so that it remains in position. Be sure to check the probe position occasionally. Complacency usually sets in when you feel that “Everything is running fine”.

VI. ADJUSTING THE CONTROLLER SETPOINTS

The PINPOINT pH Controller is capable of controlling pH within the range of pH 4 through pH 10. After the selection of the pH setpoint you will find that the controller can create a span around this setpoint, both above and below, from about +/- 0.1 pH unit to +/- 1.0 pH unit.

Two adjustment screws on the front panel determine the controller pH setpoints. The right adjustment screw determines the “center value” or the point halfway between the high and low setpoints. The left adjustment screw controls the range both above and below the selected pH setpoint.

As an illustration of how the two adjustments are related, consider the following:

When the measured pH moves from the center of the acceptable pH range to above the high setpoint, the device attached to the HI outlet is activated and will remain ON until the pH is brought to the center value.

Adjusting the Controller Setpoints

Determine the “Center Value” that you wish to establish and the range around this center value you feel is acceptable (between +/- 0.1 and 1.0 pH units). Remember, if you are only adding CO2, you will have pH control in only one direction.

For example, if the acceptable range is a total of .4 pH units from a LOW of 6.8 to a HIGH of 7.2 this means that the center value is 7.0 since it is equidistant from 7.2 and 6.8 When the pH rises to 7.2 the CO2 will be activated (Outlet #1) until the pH reaches 7.0(Center Value) at which time it will be turned off.

If you would like to use a different center value, 8.0 for example, then adjust the center value screw until the HIGH setpoint is 8.2 This will make the LOW setpoint 7.8 If you would like the range to be a total of .2 pH units then adjust the range screw accordingly. If you would like to have a larger range of .8 pH units then adjust the range screw accordingly.

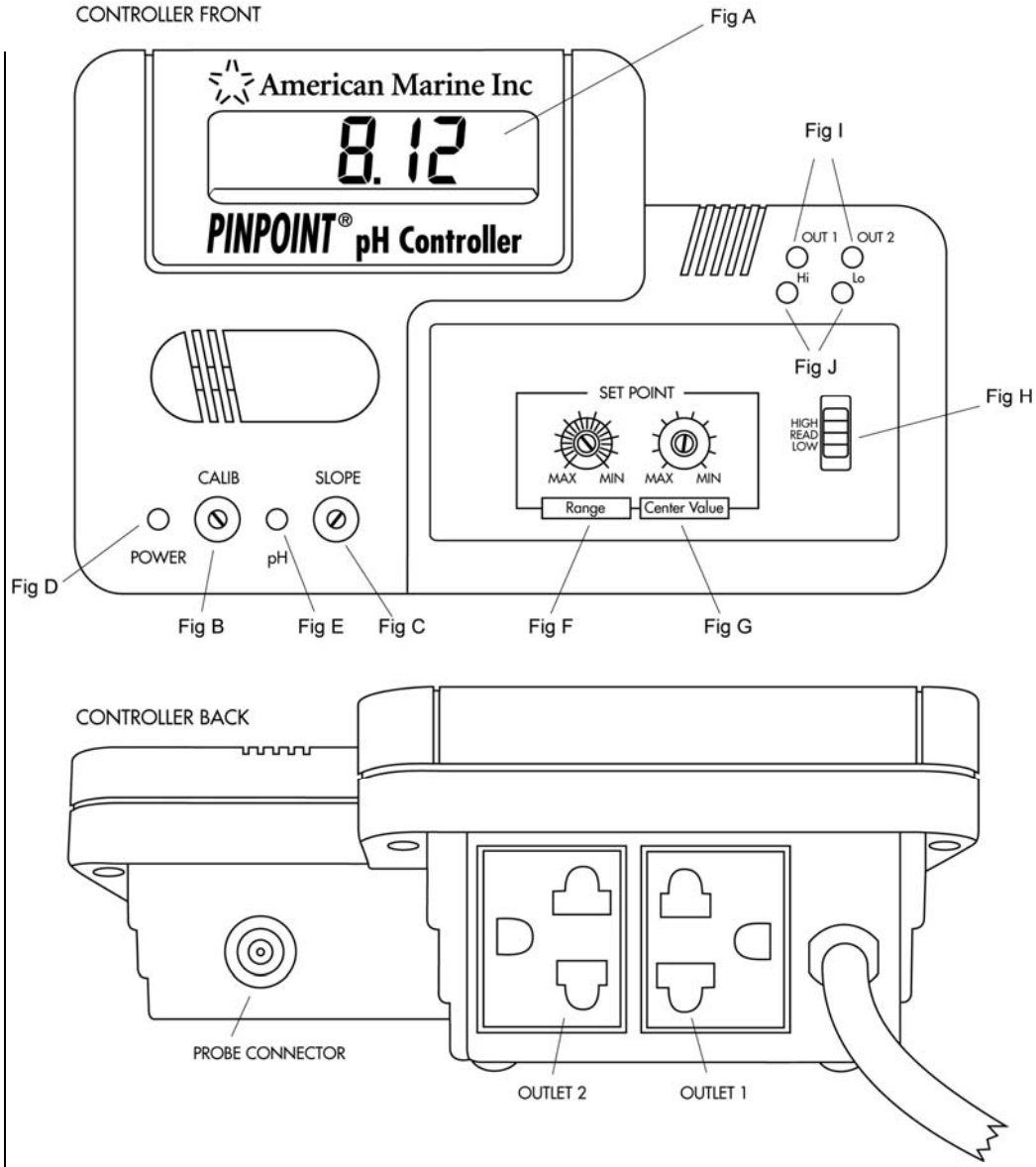
Remember to slide the switch between the HIGH and LOW positions to determine the center value as well as the range that you have selected. Keep in mind that the Center Value is not displayed and must be calculated as the average of the HIGH and the LOW setting.

VII. pH Monitor Theory

To make the above adjustment of the pH meter portion of the controller more comprehensible, this is a brief discussion of how pH electrodes work.

There is a special glass bulb that is in contact with the solution. There are also special solutions inside the body of the electrode, and a liquid junction that allows minute amounts of ions to exchange between the electrode body and the solution. This junction completes the electrical circuit. The pH Electrode acts like an extremely weak battery, whose voltage is dependent upon the amount of H+ ions present in solution. Because the electrical properties of this special glass are dependent on the H+ ion concentration of the solution in contact with the glass bulb. Because this current is very small, the signal must be handled very carefully, and the electronics in this monitor have been specially designed to handle very weak voltage, measure it accurately, translate it from a voltage to pH units, display that quantity and pass it to the controller subsystem.

The voltage output from this very weak battery happens to be 0 mV at pH 7. This is why a pH 7 solution is always used to "zero" the meter. The zero happens to be marked CALIB on the instrument case. A second standard solution, with either a pH higher or lower than 7 (usually 4 or 10) is used to adjust the slope for the response of the electronics. Since the pH scale is linear in nature you may be interested to know that this instrument will adjust 59mV per pH unit step.



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***This example is for a CO2 dosing system. When CO2 is added to water; it will lower the pH of the water.

-You must first select an acceptable range of pH like 6.6 to 6.4
At any pH value over 6.6 Outlet #1 will be energized and the CO2 will bubble into the water until the pH reaches the level of 6.4 At the 6.4 level the CO2 will shut off and stay off until the pH rises above the 6.6 level.

-To achieve these setpoints, the selector switch should read 6.60 when placed in the HI position and 6.20 when put in the LO position. The Center Value is the number that is exactly between the HI and the LO. The Center Value in this example is 6.40 This Center Value must be calculated; it is not displayed.

-To arrange these settings (HI = 6.60, LO = 6.20, Center Value = 6.40) into the controller you must do the following 2 part adjustments.

1-Put the selector switch to the HI position and note the number. Then put the switch to the LO

position and note the number. By adjusting the RANGE screw in the center of the controller you must create a difference of 0.40 between the HI and the LO. It is NOT important at all which numbers are used, it is important that there the difference of 0.40 between HI to LO. The numbers may be HI-6.40 and LO-6.00 or perhaps HI-8.98 and LO-8.58. The only thing is that the difference from HI to LO is 0.40 pH units.

2-With the selector switch in the HI position, adjust the Center Value screw until it reads 6.60
That is all!

What you have done is to put the HI setting to 6.60 and the LO setting is 6.20 therefore the Center value is 6.40

PINPOINT pH Controller Has control ability in *both* directions

In our example the setpoints are as follows:

HI	6.60
Center Value	6.40
LO	6.20

The controller is set up to control CO2. There is a solenoid attached to Outlet #1 in the back of the controller.

When the pH of the water is above 6.60 the Outlet #1 will energize the solenoid and CO2 will bubble into the water until the pH of the water reaches the Center Value of 6.40. When the pH value reaches the Center Value of 6.40 the CO2 will shut off.

After the CO2 is shut down if the water still has a falling pH then the LO setting is important. If the pH of the water is below the LO setting of 6.20 then

outlet #2 will energize. Outlet #2 should have a regular air pump connected to it and the air should disperse in the water by an airstone. The air will drive off the extra CO2 and return the water to the Center value pH of 6.40 at that time the air pump will shut off.

***The American Marine line of pH and ORP Controllers are unique because they can give control at both directions around the center value. The user can determine the range of acceptable pH around the center value.

Calcium Reactor Theory and Setup

•Calcium Reactors are excellent systems designed to add a steady amount of natural elemental calcium and minerals to a marine aquarium system.

This is achieved by the careful addition of CO2 gas to the system seawater, thus lowering its pH to the acidic range and passing this seawater through aragonite coral chips housed inside the reactor <see diagram>.

Because the CO2 treated seawater has a pH in the range of 6.6-6.8 (or lower); it will readily dissolve aragonite coral chips housed inside the calcium reactor. This enriched calcium seawater, also called ***effluent***, should be sufficiently aerated to drive off the CO2 and return the pH to the normal range while still carrying the additional calcium in solution before it is re-introduced back into the aquarium.

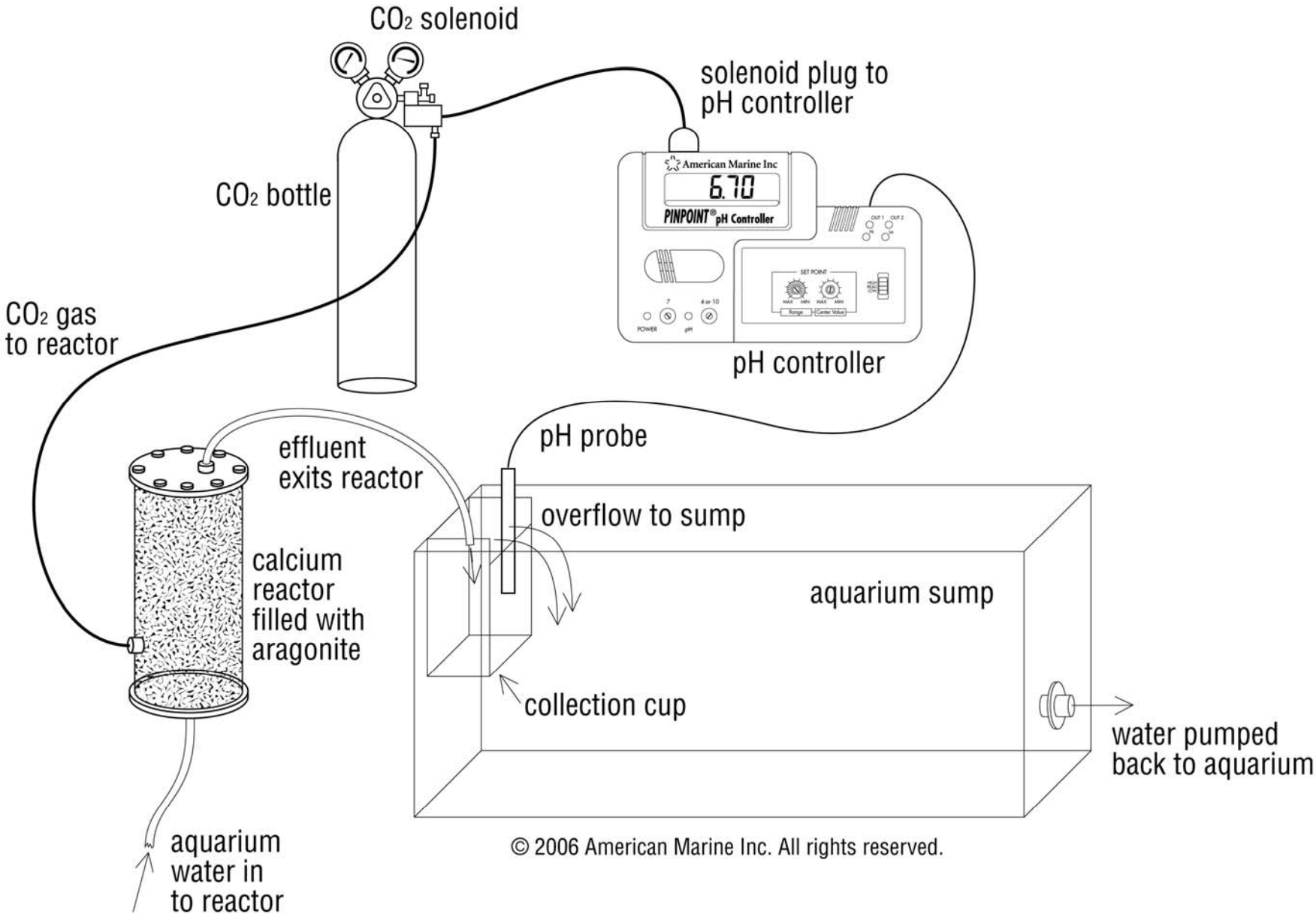
You will be controlling the pH of the fluid inside the reactor. Generally speaking a pH of 6.6-6.8 (or lower) will readily dissolve aragonite media. If the pH of the seawater surrounding the aragonite is too low, the aragonite will turn to "mush" and no longer have fluid flow through the chips. If the pH is too high there will not be a sufficient acid environment to dissolve the aragonite. Trial and error with your brand of aragonite should be performed.

***Note: Properly designed Calcium Reactor Systems will add natural elemental calcium and minerals to your system and will have *virtually no* effect on the pH of the aquarium.**

There are several equipment considerations:

- Calcium Reactor
- Aragonite Media
- CO2 Tank
- Electric CO2 Solenoid
- PINPOINT pH Controller

Consider the following setup into a marine aquarium sump:



- **Calcium Reactor**-houses the aragonite chips and has a mechanism to infuse CO2 gas inside the reactor. Some models have a built-in port to accommodate a pH probe. Many reactors do not have a port. Models without a port should have the output water (effluent) exit the reactor and collect in a small cup located in the sump area The probe of the pH Controller should be installed in the collection cup so as to measure the pH of the seawater from the Calcium Reactor. As this collection cup fills, it will overflow into sump where it should be properly aerated to drive off the CO2 and return the pH back to normal seawater levels before it enters the aquarium. An airstone or aerating powerhead in the sump area can be beneficial.
- **CO2 Tank or Bottle**-This will be your source of CO2 gas. Obviously CO2 gas when mixed with seawater will lower the pH of seawater. CO2 bottles are easily, and inexpensively, refilled at any welding supply store or any outlet that will recharge fire extinguishers.
- **Electric CO2 Solenoid**-An electrically activated valve that when energized by the outlet on the back of the PINPOINT pH Controller, will allow CO2 gas to exit the CO2 bottle to be released in the aragonite of the Calcium Reactor. This CO2 gas will quickly lower the pH of the seawater inside the reactor. A bubble counter, if available, will visually indicate the volume of CO2 exiting the bottle. This gas volume can be adjusted via the needle valve on the solenoid.
- **Aragonite**-Basically coral fragment. You should experiment to find the pH levels that will dissolve the aragonite most efficiently. If the pH is too low the aragonite will turn to “mush” and no longer have flow through it. If the pH is too high then the aragonite will not be dissolved sufficiently.
- ***PINPOINT* pH Controller**-The electronic pH measurement and control device that will activate the CO2 solenoid to start or stop the CO2 gas flow to the reactor.
  Not all pH Controllers can control devices that will influence pH in both an increasing and a decreasing pH direction as needed. The PINPOINT pH Controller is perfectly suited for any calcium reactor application by controlling pH downward during CO2 addition. It will also control pH upward by using a regular air pump to drive off the CO2 from seawater.

Typical setpoints would be to begin the CO2 flow at a pH of 6.8 and stop the CO2 flow when the pH of 6.6 is reached.

The ***PINPOINT*** **pH Controller**:
-will automate the proper pH settings inside the calcium reactor
-save CO2 by using it only when necessary
-save aragonite by keeping the pH levels in the proper range
-allow easier adjustment of flow through the reactor by keeping pH in the proper range through a range of different fluid flow and CO2 volumes

- **Aragonite**-Basically coral fragment. You should find the pH levels that will dissolve the aragonite most efficiently. If the pH is too low the aragonite will turn to "mush" and no longer have flow through it. If the pH is too high then the aragonite will not be dissolved sufficiently.

To optimize reactor efficiency experiment with:
-lower pH settings to dissolve more aragonite
-Increased CO2 flow to the reactor
-decrease (or increase) the water flow through the reactor
-install an aerating powerhead in the sump to drive out the CO2 gas and return the effluent to normal seawater pH levels before returning to the aquarium.

Discussion:
Some hobbyist want to place the pH electrode directly into the aquarium water. Their objective is to use the pH controller as a safety device to shut off the CO2 gas in the event the aquarium pH becomes too low because the effluent containing the CO2 is being introduced back to the aquarium water at too fast a rate and/or without proper aeration.

Pros:
-You can use the PINPOINT pH Controller to monitor the pH of your aquarium

Cons:
-CO2 gas will be infused constantly whether it is actually needed or not
-You will not be able to monitor the pH of the seawater inside the reactor.
-Flow rate and CO2 input to the reactor will be more difficult to adjust and therefore the reactor pH will more easily be "out of optimal range" frequently too high or too low.