

BMP C252: High pH Neutralization using CO₂

Description

When pH levels in stormwater rise above 8.5 it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5, this process is called pH neutralization. pH neutralization involves the use of solid or compressed carbon dioxide gas in water requiring neutralization. Neutralized stormwater may be discharged to surface waters under the General Construction NPDES permit but neutralized process water must be managed to prevent discharge to surface waters. Process wastewater includes wastewaters such as concrete truck wash-out, hydro-demolition, or saw-cutting slurry.

Reason for pH neutralization

A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this neutral pH is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Calcium hardness can contribute to high pH values and cause toxicity that is associated with high pH conditions. A high level of calcium hardness in waters of the state is not allowed.

The water quality standard for pH in Washington State is in the range of 6.5 to 8.5. Groundwater standard for calcium and other dissolved solids in Washington State is less than 500 mg/l.

Causes of high pH

High pH at construction sites is most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime-containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures). The principal caustic agent in cement is calcium hydroxide (free lime).

Advantages of CO₂ Sparging

- Rapidly neutralizes high pH water.
- Cost effective and safer to handle than acid compounds.
- CO₂ is self-buffering. It is difficult to overdose and create harmfully low pH levels.
- Material is readily available.

The Chemical Process

When carbon dioxide (CO₂) is added to water (H₂O), carbonic acid (H₂CO₃) is formed which can further dissociate into a proton (H⁺) and a bicarbonate anion (HCO₃⁻) as shown below:



The free proton is a weak acid that can lower the pH.

Water temperature has an effect on the reaction as well. The colder the water temperature is the slower the reaction occurs and the warmer the water temperature is the quicker the reaction occurs. Most construction applications in Washington State have water temperatures in the 50°F or higher range so the reaction is almost simultaneous.

Treatment Procedures

High pH water may be treated using continuous treatment, continuous discharge systems. These manufactured systems continuously monitor influent and effluent pH to ensure that pH values are within an acceptable range before being discharged. All systems must have fail safe automatic shut off switches in the event that pH is not within the acceptable discharge range. Only trained operators may operate manufactured systems. System manufacturers often provide trained operators or training on their devices.

The following procedure may be used when not using a continuous discharge system:

- Prior to treatment, the appropriate jurisdiction should be notified in accordance with the regulations set by the jurisdiction.
- Every effort should be made to isolate the potential high pH water in order to treat it separately from other stormwater on-site.
- Water should be stored in an acceptable storage facility, detention pond, or containment cell prior to treatment.
- Transfer water to be treated to the treatment structure. Ensure that treatment structure size is sufficient to hold the amount of water that is to be treated. Do not fill tank completely, allow at least 2 feet of freeboard.
- The operator samples the water for pH and notes the clarity of the water. As a rule of thumb, less CO₂ is necessary for clearer water. This information should be recorded.
- In the pH adjustment structure, add CO₂ until the pH falls in the range of 6.9-7.1. Remember that pH water quality standards apply so adjusting pH to within 0.2 pH units of receiving water (background pH) is recommended. It is unlikely that pH can be adjusted to within 0.2 pH units using dry ice. Compressed carbon dioxide gas should be introduced to the water using a carbon dioxide diffuser located near the bottom of the tank, this will allow carbon dioxide to bubble up through the water and diffuse more evenly.
- Slowly release the water to discharge making sure water does not get stirred up in the process. Release about 80% of the water from the structure leaving any sludge behind.
- Discharge treated water through a pond or drainage system.

- Excess sludge needs to be disposed of properly as concrete waste. If several batches of water are undergoing pH treatment, sludge can be left in treatment structure for the next batch treatment. Dispose of sludge when it fills 50% of tank volume.

Sites that must implement flow control for the developed site must also control stormwater release rates during construction. All treated stormwater must go through a flow control facility before being released to surface waters which require flow control.

Safety and Materials Handling

- All equipment should be handled in accordance with OSHA rules and regulations.
- Follow manufacturer guidelines for materials handling.

Operator Records

Each operator should provide:

- a diagram of the monitoring and treatment equipment and
- a description of the pumping rates and capacity the treatment equipment is capable of treating.

Each operator should keep a written record of the following:

- client name and phone number,
- date of treatment,
- weather conditions,
- project name and location,
- volume of water treated,
- pH of untreated water,
- amount of CO₂ needed to adjust water to a pH range of 6.9-7.1,
- pH of treated water and,
- discharge point location and description.

A copy of this record should be given to the client/contractor who should retain the record for three years.