SODIUM CARBONATE FOR REDUCING SEEPAGE FROM PONDS

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INTRODUCTION

This report was prepared to answer the numerous inquiries concerning the use of sodium carbonate (Na_2CO_3) for reducing seepage from ponds. It is based on our research experience with two stock ponds in central Arizona plus some laboratory work. The research data have not been completely evaluated and the information is presented only as a general guide.

The seepage problems particularly prevalent in the Southwestern United States are ultimately the result of the presence of large quantities of calcium in the water and soil. The calcium causes the clay to aggregate and form a porous, water-stable structure with good water permeability characteristics. This property can be modified to reduce seepage by replacing calcium with a suitable quantity of sodium which causes the aggregates to disperse and the clays to swell. The chemical treatment using different sodium salts has been very often supplemented with physical treatment such as compaction. In the systems we studied, sodium carbonate was the best salt for reducing seepage without any compaction.

The treatment outlined below has been field-tested only on calcareous soils containing montmorillonitic clay minerals. It is believed, however, that the method will work on other types of soils which meet the requirements listed in the next section on Pretreatment Survey.

Pretreatment Survey

The following measurements and analyses should be made before any treatment is attempted.

1. Measure the rate of water loss to make sure you have a seepage problem. This can be done by driving a marked stick into the pond bottom and measuring the drop in the water surface over a period of several days. Part of the water loss is due to evaporation which can exceed 0.3-inch per day during the summer.

2. Measure the depth of soil in the pond bottom.

3. Take three random soil samples from the bottom of the pond and three from the side at the 0-6 inch depth. Mix the three bottom samples together and mix the three side samples together. Then have these two composite samples analyzed for the following:

   a. Clay content - percent by weight less than 2 microns.

   b. Cation exchange capacity (CEC) in milliequivalents per 100 grams of soil.

   c. Exchangeable sodium (ES) in milliequivalents per 100 grams of soil.

4. Measure the area and depth of the pond. Don't guess! Calculate the amount of water the pond holds at different water depths.

Treatment Criteria

Experience indicates that treatment with sodium carbonate should be successful if the following requirements are met.

1. The depth of soil overlying sand, gravel or porous rock should be at least 12 inches.

2. Clay content should be 15 percent or greater.

3. Cation exchange capacity (CEC) should exceed 15 milliequivalents per 100 grams of soil.

Calculating Amount of Sodium Carbonate*

In the following calculations, use the information from the soil sample with the highest CEC. The amount of sodium carbonate required for treatment can be estimated with the following equation.

$$Na_2CO_3 = 0.004\ DA\ (0.15\ CEC - ES) \quad (1)$$

Where:

Na_2CO_3 = pounds of sodium carbonate

D = depth of soil to be treated (in inches)

A = area to be treated (in square feet)

CEC = cation exchange capacity (meq/100g)

ES = exchangeable sodium (meq/100g)

A step-wise procedure for the above calculation is as follows:

1. Multiply the CEC by 0.15.

2. Subtract the ES from step 1.

3. Multiply step 2 by 0.004 to get the pounds of sodium carbonate needed per square foot of soil area per inch of soil depth.

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* Granular soda ash, technical grade, 99 to 100 percent sodium carbonate.

4. Multiply step 3 by the treatment depth in inches to obtain the treatment rate in pounds per square foot (we have used a 4-inch treatment depth).

5. Multiply step 4 by the square feet of surface area to be treated to get the total salt required.

Treatment Procedure

The sides and bottom of the pond must be cleared of grass, shrubs, trash, and rocks prior to treatment. To insure uniform distribution of the salt, stake out a grid system on the treatment area using string or twine stretched between stakes. Each grid section should cover an area that can be conveniently treated with 20, 50, or 100 pound quantities of salt, assuming that the salt is obtained in 100 pound bags. If the salt is obtained in bulk, the amount applied to each grid section should be weighed. Broadcast the salt on the surface and then work it into the soil by disking or harrowing to the predetermined treatment depth. Face masks are recommended during salt broadcasting. Soil compaction is not necessary. The pond is ready to receive water immediately after treatment.

Maintenance

Two or three years after treatment the seepage rate may start to increase as sodium is lost. The initial treatment should drastically reduce seepage, but does not completely stop it. Seepage after treatment of our ponds was reduced to about 0.1 inch per day from a pretreatment rate of 5 inches a day. Calcium and magnesium in the pond water will eventually replace the sodium applied in the treatment.

This problem can be solved by adding sodium carbonate and sodium chloride to the water in the pond. The maximum amount of sodium carbonate added should not exceed 0.88 pounds per 1,000 gallons of water. More than this may increase pH above 9.5 and cattle may not drink the water. Additional sodium must be added in the form of sodium chloride. A suggested guide is as follows:

1. $Na_2CO_3 = 0.88\ V$

   where: Na_2CO_3 = pounds of sodium carbonate

   V = volume of pond in 1,000 gallon units.

2. NaCl = 0.25 Na_2CO_3 used in original treatment minus the Na_2CO_3 added to water.

   Where: NaCl = pounds of sodium chloride

Total salt = 1 + 2.

The sodium chloride and sodium carbonate can be mixed together and broadcast evenly over the water surface. Broadcasting from a small boat is usually desirable.

Calculation Examples

1. Original treatment.

   Assume: pond area = 20,000 ft^2

   soil depth = 24 inches

   clay fraction = 45 percent

   CEC = 40.0 meq/100 g

   ES = 1.0 meq/100 g

   treatment depth = 5 inches

Then: a. 40 meq/100 g x 0.15 = 6

b. 6 - 1.0 meq/100 g = 5

c. 5 x 0.004 = 0.02 pounds Na_2CO_3/ft^2/inch

d. 0.02 x 5 inches = 0.10 pounds/ft^2

e. 0.10 x 20,000 ft^2 = 2,000 pounds Na_2CO_3 for total treatment area.

2. Maintenance application.

Assume: same pond above

volume = 250,000 gallons

Then: a. 0.88 x 250 = 220 pounds Na_2CO_3

b. 0.25 x 2,000 [from (e.) in example 1] = 500

c. 500 - 220 = 280 pounds NaCl

Total salt = 220 pounds Na_2CO_3 + 280 pounds NaCl.