



COAGULATION BEAKER TEST

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COAGULATION

Coagulation is a chemical water treatment designed to remove suspended particles and dissolved compounds from a water source. A chemical coagulant, such as Aluminum Sulphate, is added to the water in a volume determined by a *pre-testing* of the water. This pre-test is known simply as the 'beaker test.'

The beaker test determines the amount of chemical required to treat a dugout\cell, and also gives an indication of the expected results. The coagulant is diluted to a one percent solution and added to a 1L sample of the water to be treated, until a desired pH level of about 6.0 and/or alkalinity concentration of about 40 mg/L is reached. This determines the amount of one percent chemical solution required for each litre of water to be treated. If the volume of the dugout is known, the amount of chemical needed to treat the entire water body can then be estimated (For more detailed information on the coagulation procedure, see the *Water Quality Matters* publications "How To Coagulate Your Dugout Or Cell").

MATERIALS REQUIRED

To perform a beaker test, *ideally*, the following materials are required:

- two litre measuring container
- a 10-60 ml syringe
- rubber spatula for mixing
- pH meter and/or alkalinity strips
- one percent coagulation chemical solution
- distilled water



Caption

PREPARATION OF SOLUTION

A dilute coagulant solution must be used in order for the beaker test to provide useful results. For simplicity sake, a one percent solution consisting of raw coagulant (from the pail\drum) and distilled water is used. The solution is prepared as follows:

1. Measure 495 mL of distilled water with a measuring container.
2. Pour this into a *clean*, plastic bottle.
3. Use the syringe to measure 5 mL of raw coagulant into the bottle.
4. Replace lid on bottle and shake vigorously for 30 seconds.
5. Rinse the syringe 3 times with distilled water so that it can be reused.

You now have a one percent coagulant solution ready for use in a beaker test.

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Table 1: Approximate dose of stock required for various alkalinity Concentrations

Alkalinity (mg/L)	Approximate 1% Ferric Chloride Dose (mL)	Approximate 1% Aluminum Sulphate Dose (mL)
60	6.4 to 9.6	7.6 to 17.6
80	10.6 to 16.0	12.6 to 29.2
100	15.0 to 22.4	17.6 to 41.0
120	19.2 to 28.8	22.6 to 52.6
140	23.6 to 35.2	27.6 to 64.4
160	27.8 to 41.6	32.6 to 76.0
180	32.0 to 48.0 >40 mL not recommended	37.6 to 92.6 >60 mL not recommended
> 180	not recommended	not recommended

ESTIMATING DOSAGE FOR BEAKER TEST

A successful coagulation treatment requires proper chemical **dosage** - the amount of coagulant necessary to effectively and safely treat the water. The proper dosage for a particular water source can be obtained from the beaker test. To quickly arrive at an approximate coagulant dose (in mL) to use with your beaker test, determine the alkalinity of your water (in mg/L) and consult **Table 1** below. Higher alkalinity corresponds to higher coagulant dose. It is recommended that the lower coagulant dose in the *optimum* range be used when starting the beaker test.

BEAKER TEST - STEP-BY-STEP

- Measure 1L of dugout water into the 2L measuring container
- Add the minimum volume of one percent coagulant solution (from Table 1) to the container
- Stir *vigorously* for 10 seconds
- Immediately measure and record the pH and/or alkalinity
- If the pH has not dropped to 6.0 or lower, and/or the alkalinity is 40 or greater, add more 1% solution in reasonable increments (i.e. - 2.5 or 5 mL at a time)
- Stir *gently* for another 10 seconds, and then measure and record the pH and/or alkalinity

- Repeat steps 5 & 6 until the pH is 6.0 or lower, and/or the alkalinity is around 40
- Record the amount of one percent solution (mL) necessary to drop the pH and/or alkalinity to the desired levels (6.0 pH units and 40 mg/L respectively)

DETERMINING DUGOUT SIZE

There are several formulas available to calculate the size of your dugout. Some of these are very accurate, but they tend to rely on overly complex and tedious math calculations. If you have Internet access, this process is greatly simplified by visiting the following website: www.agric.gov.ab.ca/calculator/dugout.html

Here you can enter in your dugout measurements and the formula will instantly produce your dugout volume in several different units. If you don't have access to the Internet, and your dugout has a end slope of 4:1 and sideslope of 1.5:1, you can estimate the water volume of the dugout by Figure 1. Only the length and width of the water surface and an approximation of the depth is required. Estimation of the water volume for a dugout with the following length and width is shown on Figure 1.

- End slopes of 4:1 and side slopes of 1.5:1
- Approximate water depth = 3.6 m (12 ft)
- Overall length = 50 m (164 ft)
- Width = 25 m (82 ft)

CONVERSIONS

To get Litres multiply m³ by 1000: 2500 m³ x 1000 = 2,500,000L

To get Imperial Gallons multiply m³ by 220: 2,500 m³ x 220 = 550,000 Imp. Gal.

To get meters multiply ft by 0.305: 164 ft x 0.305 = 50 meters

CALCULATING HOW MUCH COAGULANT IS NEEDED FOR YOUR DUGOUT

Once the Beaker Test is complete and you've calculated the size of your dugout\cell, it is possible to calculate how much raw coagulant is actually needed to treat your water source. This involves using the volume of coagulant previously determined in the Beaker Test and the calculated water volume in your dugout\cell in this simple formula:

$$\text{Raw Coagulant Volume (mL)} = \frac{\text{Beaker Test Volume (mL)} * \text{Volume of Dugout\Cell (L)}}{100}$$

As an example, when the dugout *water* volume is 2,500,000 L, and the optimum dose of one percent coagulant from the Beaker Test is determined to be 30 mL per litre of raw water, the raw coagulant volume (from drum) to treat the dugout would be:

$$\begin{aligned} \text{Raw Coagulant Volume} &= \frac{20 \text{ mL/L} * 2,500,000 \text{ L}}{100} \\ &= 500,000 \text{ mL or } 500 \text{ L} \end{aligned}$$

This means it will take *approximately* **500 L** of raw coagulant to properly treat this dugout.

IMPORTANT TIPS

- When stirring the coagulant into the container for the Beaker Test, do not stir vigorously for longer than suggested. Over stirring can have an adverse effect on the results.
- The amount of raw coagulant calculated in the final formula should only be used as a guideline so that enough coagulant is on hand to perform the treatment. The best way to know how much coagulant is necessary for treatment is by constant monitoring of the pH and/or Alkalinity throughout the treatment.
- To improve the accuracy of the coagulant volume calculation, it is strongly suggested that actual measurements of the dugout are taken prior to treatment. Guessing at your dugout size may provide a close estimate, but an incorrect guess can substantially skew the results.

Dugout Volume

