NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

Conserve O Gram

July 1993 Number 6/4

Making Percent Solutions Of Chemicals

From time to time it may become necessary for museum personnel, under the direction of a conservator, to make solutions of chemicals. For example, some iron objects recovered from the sea can be treated by soaking out the chlorides while submerged in a strongly alkaline solution. (See *Conserve O Gram* 6/3.) It would then be necessary to make up a tank of, for example, 5% sodium carbonate mixed into water.

1. For precision, or if non-metric units are used, the solutions must be measured in a *weight to weight* ratio. A solution of a given percent is measured as the ratio of the *weight* of the dissolved material to the *weight* of the total (solution plus dissolved material.) The dissolved material is called the *solute*; the solute is dissolved in a *solvent*. A percent solution, then, would be:

$$\frac{\textit{solute weight}}{\textit{solvent weight} + \textit{solute weight}} \times 100 = \%$$

For a 5% solution, since 5% = 1/20, the above formula would be:

$$\frac{1}{19 + 1}$$

To make a 5% solution, take one part by weight of powder and add it to 19 parts by weight of solvent. For example, dissolve 50 grams of sodium carbonate in 950 grams of water.

$$\frac{50}{950 + 50} = \frac{50}{1000} = 5\% \textit{ by weight}$$

2. In most circumstances, however, the water will not need to be weighed. Since 1 gram of water is very close to 1 ml, then 950 grams of water will equal 950 ml. A 5% solution could be made with 50 grams of sodium carbonate dissolved in 950 ml of water.

3. To make larger quantities of a 5% solution, mix solvent and solute in a 19 to 1 ratio. For example:

   19,000 grams of water
   1,000 grams of sodium carbonate

   Since 19,000 grams of water occupy approximately 19,000 ml, and 19,000 ml is exactly 19 liters, simply add the powder to 19 liters of water.

4. To use non-metric quantities, first calculate in metric, as above, then convert. In the above example,

   19,000 ml = 19 liters = 5 gallons
   1,000 grams = 1 kilogram = 2.2 pounds

5. To calculate 5% for a 100 gallon tank, remember that water weighs about 8.33 pounds per gallon. The total weight of water in the tank would then be 833 pounds. Since 5% is

$$\frac{1}{19 + 1}$$

the weight of sodium carbonate needed would be 833 divided by 19, which equals 43.8 pounds. That is:

$$\frac{43.8}{833 + 43.8} = \frac{43.8}{876.8} = 5\%$$

6. For tanks for which the dimensions are known, but there is no practical way to measure the water flow, measure the cubic volume and use the fact that water weighs 62.4 pounds per cubic foot. For example, water filling a tank two feet wide, two feet deep, and six feet long will occupy 2 x 2 x 6 = 24 cubic feet. And 24 x 62.4 = 1497.6 pounds of water in the tank. To proceed as in #5 above, the calculation for a 5% solution would be:

$$\frac{1}{19 + 1} = \frac{78.8}{1497.6 + 78.8} = 5\%$$

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Formerly issued as part of Conserve O Gram 6/2.
Revised 1993.