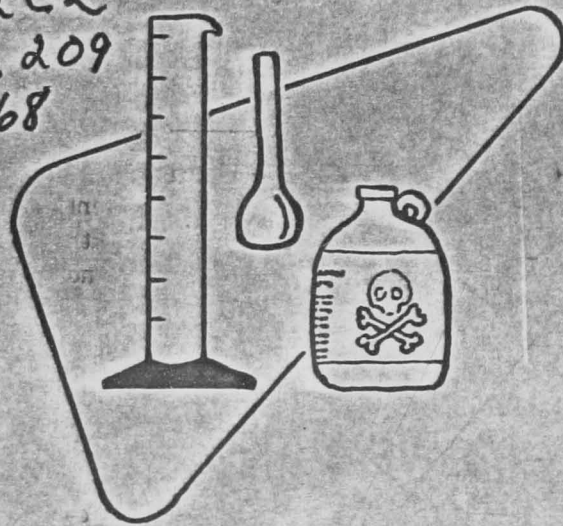


TREATMENT TIPS

How to determine
quantities for
chemical treatments
in fish farming

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UNITED STATES
DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
Fish Farming Experimental Station
Stuttgart, Arkansas



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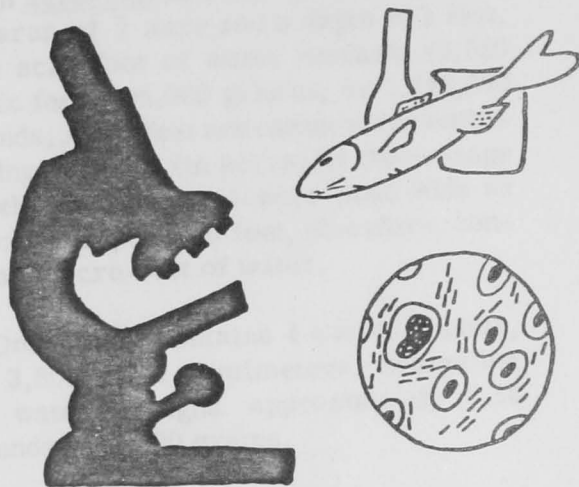
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TREATMENT TIPS

By Fred P. Meyer
Fish Farming Experimental Station
Stuttgart, Arkansas

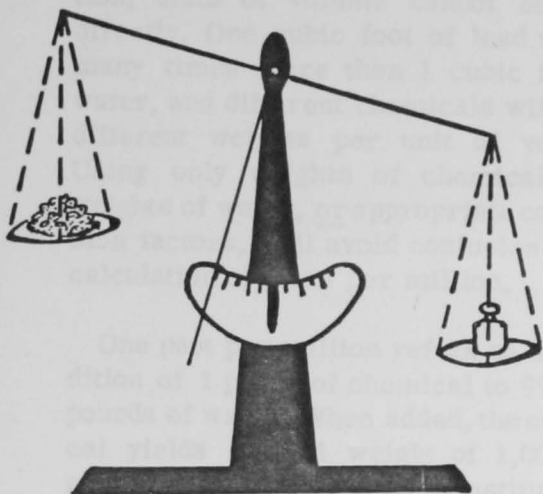
Fish farmers often find it difficult to calculate amounts of chemicals for treatment of fish. Differences in terminology, prescriptions, units of measure, units of treatment, and in formulations may be confusing.

This pamphlet defines terms, gives calculating procedures, and describes typical situations.



UNITS OF MEASURE

Most of us are familiar with such units as pounds, acres, and gallons, and with percent (%). In fish culture, additional standard units and proportions are used; these will be discussed individually.



A pound contains 16 ounces or 453.6 grams (usually rounded off to 454 grams). An ounce contains 28.35 grams.

In the metric system, weights are expressed as grams and kilograms. A kilogram is the equivalent of 1000 grams or 2.2 pounds. Volumes are expressed in cubic centimeters, better known as cc (pronounced see-see's) or milliliters. One thousand cc or milliliters make up a liter. A gallon contains 3.8 liters.

Metric units are frequently used when working with very small amounts of chemical. Thus, we may apply grams per gallon, grams per cubic foot, cc per gallon, or cc per cubic foot. Large units of volume require large units of weight; it is most convenient to use pounds per acre-foot for such treatments.

A cubic foot is a unit of volume measuring 1 foot square and 1 foot high. One cubic foot of water weighs 62.4 pounds and contains approximately 7.5 gallons. The number of cubic feet in a space is computed by multiplying the length (in feet) by the width (in feet) by the depth (in feet). Thus, a tank 20 feet long and 2 feet wide, with water 1.5 feet deep, contains 60 cubic feet of water ($20 \times 2 \times 1.5$).

An acre-foot is a unit of volume having an area of 1 acre and a depth of 1 foot. One acre-foot of water contains 43,560 cubic feet, 326,000 gallons, or 2,718,000 pounds. Acre-feet are computed by multiplying the area (in acres) by the average depth (in feet). A 1-acre pond with an average depth of 3 feet, therefore, contains 3 acre-feet of water.

One gallon contains 4 quarts, 8 pints, or 3,800 cubic centimeters. One gallon of water weighs approximately 8.34 pounds or 3,800 grams.



In treating fish, it is common practice to add chemicals to the water to produce a known concentration. Desired concentrations are generally expressed as parts per million, usually written ppm. The term "parts per million" should be used only in a weight-to-weight relation; units of volume cannot be used directly. One cubic foot of lead weighs many times more than 1 cubic foot of water, and different chemicals will have different weights per unit of volume. Using only weights of chemicals and weights of water, or appropriate conversion factors, will avoid confusion in the calculation of parts per million.

One part per million refers to the addition of 1 pound of chemical to 999,999 pounds of water. When added, the chemical yields a total weight of 1,000,000 pounds of solution and constitutes 1 pound in a million pounds of mixture--1 part per million. To avoid working out the appropriate conversion factor each time, the amounts of chemical needed to



produce 1 part per million in each of the standard units of volume have been computed. These are given below:

1 ppm requires--

- 2.7 pounds per acre-foot.
- 0.0038 gram per gallon.
- 0.0283 gram per cubic foot.
- 1 pound in a million pounds.
- 1 gram in a million grams.

The weight of chemical in pounds needed for 1 part per million in a gallon or cubic foot of water is not given since the decimal is too small. If this figure is desired, it can be derived by dividing the required number of grams by 454.

Another method of treatment is the incorporation of a chemical in the daily ration of the fish. Such a treatment is based on body weight because medication is prescribed according to the size

of the fish. Standard units of treatment are given in grams of chemical per 100 pounds of fish per day. If you have 100 pounds of fish to be treated with Terramycin at the rate of 2.5 grams per 100 pounds of fish per day, the amount of feed offered each day must contain 2.5 grams of pure Terramycin or its equivalent. Generally speaking, fish are fed at the rate of 3% of their body weight per day. At this level, 3 pounds of feed are fed each day to 100 pounds of fish. For treatment purposes, the feed requires 2.5 grams of Terramycin activity in every 3 pounds of ration. The feed to be ordered should contain $100/3 \times 2.5$, or 83.3, grams of Terramycin activity per 100 pounds. Higher or lower feeding schedules can be adjusted by substituting the actual feeding rate for the 3%.

FORMULATIONS

So far, we have assumed that all the chemicals we use are pure compounds or 100% active ingredient. Unfortunately, few of the compounds used in fish culture are pure chemicals. It is very important, therefore, that the user read the label each time before using a chemical. Most of the compounds are formulations which contain a stated percentage or level of active ingredient UNLESS the recommended use specifically indicates otherwise.

If a formulation contains only 25% active ingredient, then to get the same amount of active ingredient in a prescribed treatment, you will need 4 times as much (or $100/25$).



Feed formulations of antibiotics are usually composed of the culture material remaining after drug levels pure enough for human use have been removed. This remaining material still contains sufficient antibiotic to be useful in the treatment of animals. Most frequently, such formulations will contain about 25 grams of activity per pound of material. If we want to incorporate 2.5 grams of active ingredient into a quantity of feed using such material, we need $2.5/25$ or 0.1 pound of the formulation. Another way to express this quantity is $0.1 \times 16 = 1.6$ ounces or $0.1 \times 454 = 45.4$ grams.

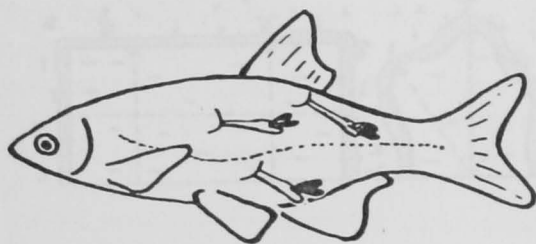
Some chemicals come in liquid form, containing a stated number of pounds of chemical per gallon of liquid. Typical products of this type contain 4 pounds per gallon, in which 1 quart contains 1 pound of active ingredient and 1 pint contains one-half pound.

In this case, it may be easier to work with the metric unit, the cubic centimeter. A gallon contains 3800 cc, thus

a 4-pound-per-gallon formulation contains 1816 grams (4×454) of active ingredient or $1816/3800 = 0.48$ gram per cc. Remember, use the weight of the chemical when computing parts per million to be used.

Other chemicals are liquids in their pure form. A typical one is formaldehyde solution, also known as formalin. Chemically speaking, this solution contains only 38% formaldehyde gas, but it is considered a pure compound for fish cultural purposes. To use a chemical like this, it is necessary to know how it compares in weight with water. If it is heavier per unit of volume, fewer cc will be needed to deliver the desired weight of chemical.

Formaldehyde solution weighs about 9 pounds per gallon so it is $9/8.34$ or 1.08 times as heavy as water. This figure, 1.08, is called the specific gravity of formaldehyde solution. To determine the exact amount of a liquid chemical to use to produce a given concentration, divide the number of grams required by the specific gravity to convert it to the number of cc which will be required. If the weight is computed in pounds, divide by $8.34 \times$ the specific gravity to convert it to gallons.



COMPUTING TREATMENTS

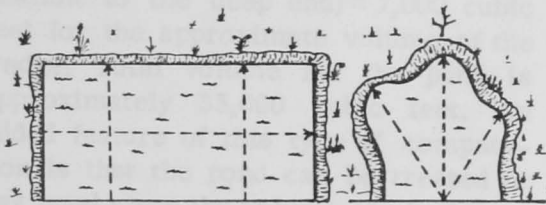
Let us consider some of the typical situations in which treatments are made. A common situation is a tank treatment. Unless the exact volume is known in gallons, it is best to measure its length, width, and water depth in feet. Inches can be converted to feet by dividing by 12. Multiplying these together will give the volume of the tank in cubic feet.

A formula for determining the amount of a chemical to use is: volume x amount of chemical needed to produce 1 ppm in each unit of volume x ppm desired = amount of chemical to apply (if it is a pure compound).

Assume we wish to treat a tank measuring 12 by 2.5 by 2 feet with 0.25 ppm of malachite green. Our calculation for the volume is $12 \times 2.5 \times 2 = 60$ cubic feet. Since it takes 0.0284 gram to yield 1 ppm in a cubic foot, we multiply $60 \times 0.0284 \times 0.25 = 0.42$ gram of chemical.

If the area of a pond is known in acres, the average depth can be determined by sounding with a weighted line at regular intervals along several transects of the pond. The average depth can be computed by adding all the measurements together and then dividing by the number of readings. If the pond is covered by measuring the depth along several representative transects (as in the figure below), these should give a sufficiently accurate estimate for treatment purposes. Be sure to measure both the deep and the shallow areas of the pond.

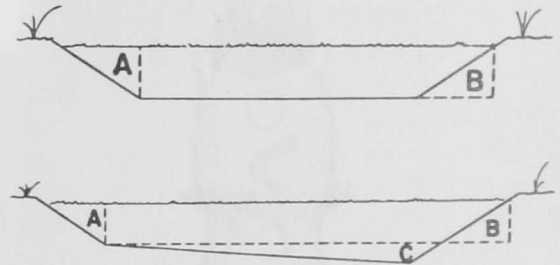
If the pond is uniform in shape, a transect through the center along the long axis and another along the short axis are adequate. Do not rely on an estimate or a guess. Many fish have been killed by overdoses resulting from such procedures. For large reservoirs, the Soil Conservation Service representative in your area will be able to help you determine the area. In such reservoirs, soundings are the only way to determine the average depth. Determine the volume of your ponds BEFORE a treatment is needed. Valuable time can be lost if the determination must be made after a problem has arisen.

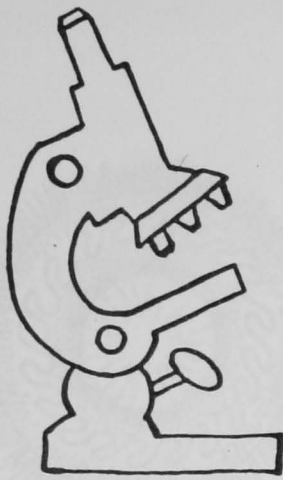


Since many ponds are rectangular, steps can be taken to reduce the calculation needed to determine the volume. The first figure below is a cross-section of a pond on its short axis; it is apparent that the volume in the space designated "A" is equal to that designated "B". The crosswise dimension of the pond can thus be converted from a figure with sloping sides to one with square sides.

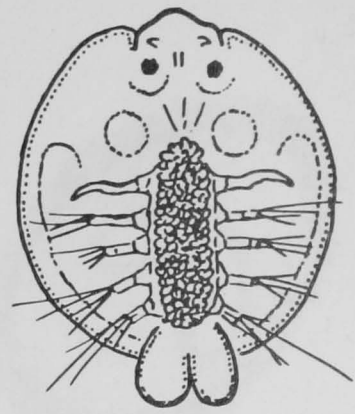
The lower figure is a cross-section along the long axis. Again, note that section "A" can be moved to "B" to convert part of the pond to a rectangular dimension. Section "C" is a triangular block. Thus the pond has been reduced to a rectangular block formed by subtracting the length of the foot of the levee at the shallow end from both the width and the length of the pond and to a wedge-shaped block formed by the slope of the pond bottom.

As an example, consider a pond measuring 206 feet long by 76 feet wide; levees have a 3 to 1 slope; the depth at the foot of the levee at the shallow end is 2 feet, and at the deep end is 3 feet.



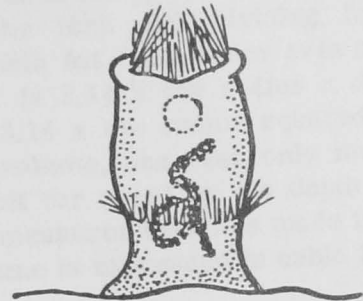


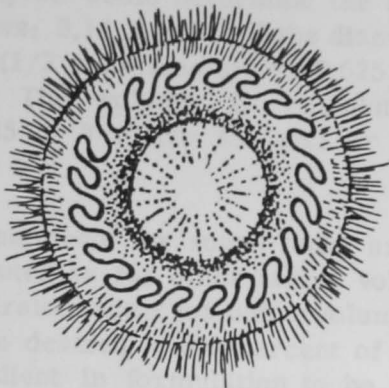
With a slope of 3:1 on the levees, it is 6 feet from the shore to the foot of the levee at the shallow end; we can subtract 6 feet from the length and from the width to get the dimensions of the rectangular block. (If the slope of the levee is not known, the distance can be determined by sounding to locate the foot of the levee and then measuring the distance from shore). The figures for the block are 200 feet by 70 feet by 2 feet deep, and the volume is 28,000 cubic feet. The triangular block is half of a rectangular piece, so we can use the formula $1/2 \times \text{the length} \times \text{the width} \times \text{the depth}$ or $1/2 \times 200 \times 70 \times 1 \text{ ft}$ (the amount the bottom slopes from the shallow to the deep end) = 7,000 cubic feet for the approximate volume of the wedge. Total volume for the pond is approximately 35,000 cubic feet. An added feature of this type of computation is that the pond can be treated at any level since the volume can be determined with a minimum of arithmetic.



Our procedure for determining the amount of chemical needed to treat the pond with 2 ppm of a 25% active formulation is as follows: volume in cubic feet (35,000) \times 0.0283 \times 2 \times 100/25 = 7924 grams. To convert grams to pounds divide by 454. Thus, 17.35 pounds of the 25% formulation is required.

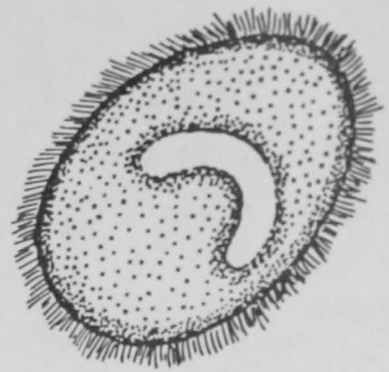
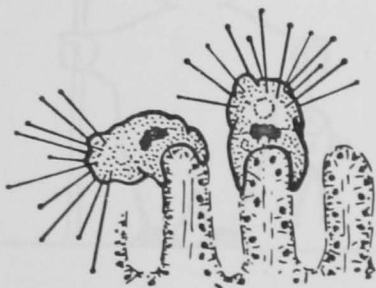
Another way to approach this same problem is to convert the number of cubic feet to acre-feet by dividing by 43,560 (the number of cubic feet in one acre-foot). We now see that the pond has a volume of 0.8 acre-feet. The calculation now becomes acre-feet \times 2.7 (pounds needed to give 1 ppm in 1 acre-foot) \times 2 ppm \times 100/25 = 17.45 pounds of





the 25% formulation. There is a slight difference in the amount of chemical required as determined by the two methods. This difference is due to rounding off in computing the conversion factors; it does not greatly affect the accuracy of the treatment.

If we wish to treat a tank which holds 500 gallons of water, the calculation is 500 gallons x 0.0038 (conversion factor to give 1 ppm in a gallon of water) x ppm desired x 100 divided by the percentage of active ingredient in the formulation. A treatment with malachite green at the rate of 0.25 ppm in the above tank is computed as $500 \times 0.0038 \times 0.25 \times 100/100$ or 0.475 grams. Since malachite



green is a pure compound, the last entry in the formula becomes 100/100 or 1. Treating the tank with 25 ppm formaldehyde is calculated in the same way but involves an extra factor due to the specific gravity since formalin is heavier than water. The calculation is $500 \times 0.0038 \times 25 \times 100/100 \times 1/1.08 = 43.98$ cc of formalin.

If a tank is round and its content in gallons is not known, we must follow a slightly different procedure. Since volume may always be computed as area times depth, we must first find the area of the circular bottom. To do so, we need to know the radius of the bottom. This may be found by measuring the diameter of the tank and dividing by 2. The formula for the bottom area of a round tank is $3.14 \times \text{the radius} \times \text{the radius}$ (or $3.14 \times \text{the radius squared}$). To get the volume, one need only multiply the result (or area) by the depth in feet. If all measurements are made in feet, the volume is expressed in cubic feet.

Assuming we have a round tank measuring 5 feet in diameter and 3 feet in

depth, we would determine the area as follows: 3.14×2.5 (1/2 the diameter) $\times 2.5$. (1/2 the diameter) = 19.625 square feet. The volume is calculated as 19.625×3 (depth in feet) or 58.875 cubic feet.

Treatments for round tanks are then computed as for other tanks: volume \times conversion factor for unit of volume used \times ppm desired $\times 100$ /percent of active ingredient in formulation to be used = amount of chemical needed to treat at the desired level.

To compute the amount of a chemical to be used, you can begin with any unit of volume. In the calculation, you must be sure to use the correct conversion factor which will yield 1 ppm in the unit of volume with which you are working.

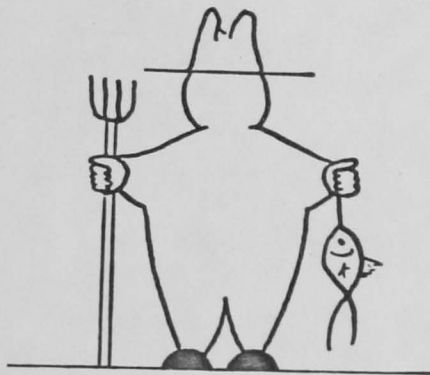


TABLE OF CONVERSION UNITS

1 acre-foot = 1 acre of surface area covered by 1 foot of water.
 = 43,560 cubic feet.
 = 2,718,144 pounds of water.
 = 326,000 gallons of water.

1 cubic foot = 7.5 gallons.
 = 62.4 pounds of water.
 = 28,354.6 grams of water.

1 gallon = 8.34 pounds of water.
 = 3,800 cc.
 = 3,800 grams of water.

1 quart = 950 cc.
 = 950 grams of water.

1 pound = 453.6 grams (454).
 = 16 ounces.

1 ounce = 28.35 grams.

1 ppm requires--

2.7 pounds per acre-foot.
 0.0038 grams per gallon.
 0.0283 grams per cubic foot.
 0.0000623 pounds per cubic foot.

