The Metric System

The proper function of recirculating aquaculture systems requires knowledge of the volume of the system components and the rate at which water flows through the system. Designing a system which requires flooring, decks, stands, and other structures also requires a knowledge of the weight of the tanks and system components when filled with water and designing structures capable to support that load. These parameters can be calculated using the metric measurement system or the English system, currently used in many segments of U.S. industry.

Metric measurements are almost universally used by scientists (although some pumps and aquarium equipment still use English measurements (gallons per hour, for example). However, the simplicity and flexibility of the Metric System makes it advantageous over English units of measure.

The Metric System is a decimal system of physical units based on the meter (Greek *metron*, “measure”). Introduced and adopted by law in France in the 1790s, the meter (39.37 inches) was one-millionth of the distance of a line from the equator to the North Pole going through Paris (of course, at the time they erroneously believed the Earth was a perfect sphere). Later, it was defined as the distance between two fine lines marked on a bar of platinum-iridium alloy, in 1960 as 1,650,763.73 wavelengths of the reddish-orange light given off by a form of the element krypton, and finally in 1983, the meter was defined as the length of the path traveled by light in a vacuum during a time interval of 1/299,792,458 of a second. Since the 1960s the International System of Units ("*Système International d'Unités*" in French, hence "SI") has been the internationally recognized standard metric system.

The Metric System is a decimal system — units of measure increase or decrease by orders of 10. These units use Greek prefixes; for example, *deca* equals ten, *hecto* equals one hundred, *kilo* equals one thousand, *mega* equals one million, *giga* equals one billion, and *tera* equals one trillion. Multiples and submultiples are related to the fundamental unit by factors of powers of ten, so that one can convert by simply moving the decimal place: 1.234 meters is 1234 millimeters, 0.001234 kilometers, etc.

Another advantage of the metric system, particularly for aquaculture, is that volume and mass (weight) are related to water. For example, 1 liter (volume) = 1,000 milliters (volume) = 1,000 cubic centimeters (volume/length) and weighs 1 kilogram (or 1,000 grams). To illustrate the advantages of the metric system over the English system, consider the following calculation.

You have a tank that you are going to use to transport fish in the back of your pickup truck, and you need to know how much it will weigh when filled with water. Let’s say that the tank is 3’ x 3’ x 3’. So how much would it weigh when filled?

3’ x 3’ x 3’ = 27 ft.^{3} …so… 1 ft.^{3} = 7.48 gallons x 27 = 201.96 gallons….and…..
1 gallon weighs 8.3453 pounds….so the final weight is 201.96 x 8.3453 = 1685.41 lbs.

Now, let’s calculate the same for a tank that is similar in size, say 1 meter on a side:

1 m x 1 m x 1 m = 100 cm x 100 cm x 100 cm = 1,000,000 cm^3 = 1,000,000 milliliters = 1,000 liters (1,000 milliliters in a liter) = 1,000 kilograms = 2,200 lbs (2.2 pounds = 1 kilogram)

Calculating Dosage Rate — The use of therapeutics, disinfectants, or simple additives such as salt, must be carefully introduced into aquaculture tanks and systems at a desired concentration. The difference between treating a sick fish and killing it could rely on an accurate calculation of dosage. Appendix 3 provides some examples for determining dosage rates in a variety of tank

designs. Note that determination of the volume of the tank (Objective 3) is the first step in the calculation of dosage. Also, use of the metric system is far more practical than English units of measure (ounces per gallon, for example), because most concentrations are defined as parts per million (ppm) or parts per thousand (ppt — usually designated by the symbol ‰). For example, the salt concentration of seawater is 35 ‰ — so, to make seawater, you would add 35 grams of salt to 1 liter of water (1,000 grams, or milliliters = 1 kilogram, or liter).
Similarly, to add a medication at a rate of 25 ppm to a 50 liter aquarium — 25 milligrams (mg) in 1 liter of water = 1 ppm (1,000 grams in a liter, 1,000 milligrams in a gram = 1,000,000 mg in a liter). Therefore, 25 mg/liter of treatment x 50 liters = 1,250 mg or 1.25 grams.

Calculating Stocking Density — It is important for a culturist to know how many organisms he has to accurately stock culture systems. Correctly stocked systems can maximize productivity and profit. Too often, a culturist will overstock ponds or tanks in an effort to maximize productivity. Overstocked systems can lead to reduced growth, high incidence of disease, and high predation; understocked systems increase production costs and sometimes lead to overfeeding.

Since the culturist cannot reasonably count the number of animals to stock into a tank or pond, he must rely on estimating the population using a sub-sample. Appendix 3 provides some good examples of this method. Notice that a sub-sample can be measured volumetrically, usually by measuring water displacement, or by weight.
For example, you are going to stock seed clams into growout bags at a density of 5,000 clams/bag. Since you can't reasonably count that many seed, 1) count out 50 clam seed (each about the size of a dime), 2) place 100 ml of water into a 250 ml graduated cylinder , 3) add the clams to the water and read the new water level (amount of displacement)…let's say it is now 145 ml…therefore, 50 clam seed had a volume of 45 ml, 4) calculate the volume to achieve 5,000 clams.

Using a proportion: 45/50 = X/5,000 or 50X = 45 x 5,000 or 50 X = 225,000 or X = 4,500 ml or 4.5 liters.

This calculation could also be accomplished using weight of clams measured with an electronic balance.