MATH REVIEW

Most math problems a water treatment plant operator solves requires plugging numbers into formulas and calculating the answer. When working with formulas, here are some simple rules to follow.

- Work from left to right.
- Do anything in parenthesis first.
- Do multiplication and division in the numerator (above the line) and in the denominator (below the line), then do addition and subtraction in the numerator and denominator.
- Divide the numerator by the denominator last.

Volume

The volume of a tank in cubic feet is equal to the tank area multiplied by the tank height. The capacity in gallons is equal to the volume in cubic feet multiplied by 7.48 gallons per cubic foot.

For a rectangular tank:
To find the capacity of a rectangular or square tank:

Multiply length (L) by width (W) to get area (A).

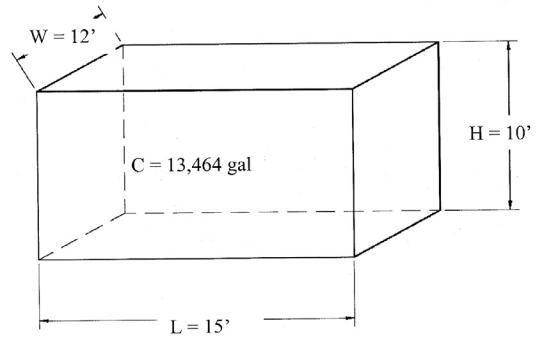
Multiply area by height (H) to get volume (V).

Multiply volume by 7.48 gallons per cubic foot to get capacity (C).

$A = L \times W$
$V = A \times H$
$C = V \times 7.48$

Find the capacity of a rectangular tank 15 feet (ft) long, 12 ft wide, and 10 ft high:

$A = 15\ ft \times 12\ ft = 180$ square feet (ft^2)
$V = 180\ ft^2 \times 10\ ft = 1{,}800$ cubic feet (ft^3)
$C = 1{,}800\ ft^3 \times 7.48\ gal/ft^3 = 13{,}464\ gal$



For a circular tank:
Area (A) =
π (3.14) x diameter squared (D^2) / divided by 4
Volume (V) = A x H
Capacity (C) = V x 7.48 gal/ft^3

$A = [\pi \times (D^2)/4]$
$V = A \times H$
$C = V \times 7.48$

Find the capacity of a circular tank with a diameter of 15 ft and a height of 12 ft:

A = [3.14 x (15 ft^2)/4] = 177 ft^2

V = 177 ft^2 x 12 ft =2,120 ft^3

C = 2,120 ft^3 x 7.48 gal/ft^3 = 15,900 gal

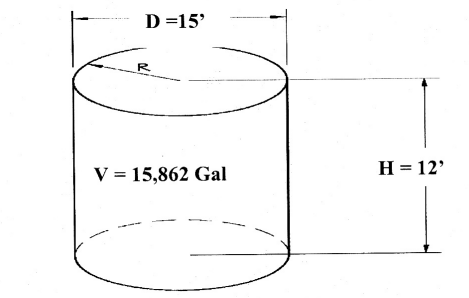
The capacity in gallons of a circular tank can also be written as one formula:

C_{gal} = (π x D^2)/4 x H x 7.48

= (3.14 x 15 ft^2)/4 x 12 ft x 7.48 gal/ft^3

= 15,900 gal

**Your answer may vary slightly due to rounding π



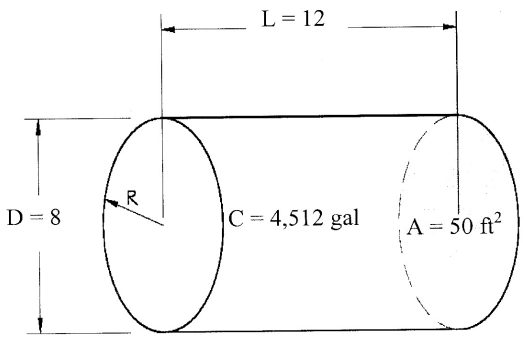
Find the capacity in gallons of a horizontal circular tank that has a diameter of 8 ft and is 12 ft long.

A = (π x D^2)/4 = (3.14 x 8 ft^2)/4 = 50 ft^2

V = A x L = 50 ft^2 x 12 ft = 603 ft^3

C_{gal} = V x 7.48 gal/ft^3 = 603 ft^3 x 7.48 gal/ft^3

= 4,512 gallons



For an oval tank:
To find the gallons in an oval tank:

Multiply the height by width by π (3.14) divided by 4 to get the area of the oval.

Multiply the area of the oval by tank length to get the volume in cubic feet.

Multiply the volume by 7.48 gal/ft^3 to get the capacity in gal.

Find the capacity of an oval tank 3-ft high, 5-ft wide, and 8-ft long.

A = H x W x π/4

= 3 ft x 5 ft x 3.14/4

= 11.8 ft^2

V = A x L

= 11.8 ft^2 x 8 ft

= 94 ft^3

C = V x 7.48 gal/ft^3

= 94 ft^3 x 7.48 gal/ft^3

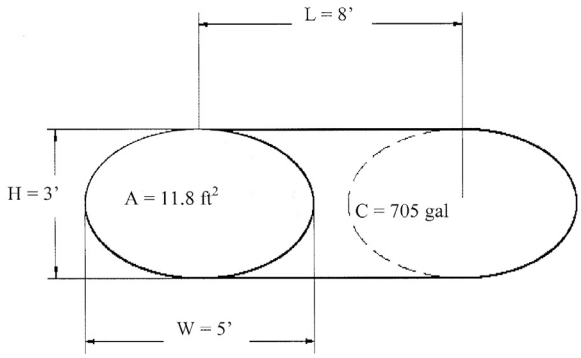
= 705 gal

The capacity of an oval tank can also be written as one formula:

C = (H x W x 3.14/4) x L x 7.48 gal/ft^3

= (3 ft x 5 ft x 3.14/4) x 8 ft x 7.48 gal/ft^3

= 705 gal



Capacity, Metric

The capacity of a tank in cubic meters (m^3) is equal to the tank area multiplied by the tank height. The volume in kiloliters (kL) is equal to the volume in m^3 multiplied by 1 kL/ m^3. 1 kL is equal to 262.4 gal.

To find the volume of a rectangular or square tank:

Multiply length by width to get area.

Multiply area by height to get volume.

1 m^3 is equal to 1-kL volume.

Find the volume of a rectangular tank 3-m long, 2-m wide, and 2-1/2–high.

A = area, Square meters (m^2)

V = volume, cubic meters (m^3)

L = length, meters (m)

W = width, meters (m)

H = height, meters (m)

V = volume, cubic meters (m^3)

C_{kL} = capacity, kiloliters (kL)

A = L x W = 3 m x 2 m = 6 m^2

V = A x H = 6 m^2 x 2.5 m = 15 m^3

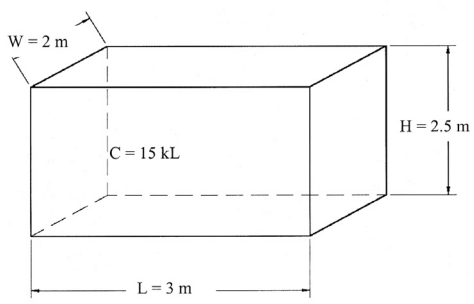
C_{kL} = 15 kL

These steps can be combined in one formula:

C_{kL} = L x W x H x 1 kL/ m^3

= 3 m x 2 m x 2.5 m x 1 kL/ m^3

= 15 kL



Concentration

Concentration is usually expressed as milligrams per liter (mg/L), or parts per million (ppm). Because the weight of 1 cubic centimeter of water is 1 gram, and there are 1 million milligrams in one liter of water, water treatment operators can use these terms interchangeably.

Feed Rate

Feed rate is the amount of chemical metered into the water. Chemical feed rate needs to be calculated when selecting a metering pump, when a change in concentration is needed, and to ensure that an adequate amount of chemicals are on hand for uninterrupted operation.

To calculate feed rate the basic formula (pounds formula) is:

Feed rate (pounds per day, lb/day) = flow (million gallons per day, mgd) times dose (milligrams per liter, mg/L) times 8.34 pounds per gallon.

The pounds formula is also used to determine how much liquid solution, such as sodium hypochlorite, is needed.

Sodium hypochlorite (chlorine bleach) is available in strengths from 5 to 15 percent. To determine how much you need to disinfect a tank, you must know the strength.

The pounds formula for liquids is:

Gallons needed = (amount of water to be treated divided by 1 million) x required dose (mg/L) x 100/solution strength (in percent).

To find the amount of hypochlorite to use, multiply tank volume in gallons/1,000,000 times the desired chlorine dose in mg/L divided by solution strength, percent.

To find the amount of 5 percent hypochlorite to use in a 13,500-gallon tank to achieve a chlorine dose of 50 mg/L:

13,500 gallons/1,000,000 x 50 mg/L x 100 /5 = 13.5 gallons hypochlorite

To find the amount of 5 percent hypochlorite to use in a 13,500-gallon tank to achieve a dose of 1 mg/L:
13,500 gallons/1,000,000 x 1 mg/L x 100/5
= 0.27 gallons, or about one quart sodium hypochlorite.

To find how much 5.25 percent hypochlorite is needed to disinfect 1,000 gallons at a dose of 2 mg/L:
Gallons of hypochlorite needed
= (1,000 gal/1,000,000) x 2 mg/L x (100/5.25)
=0.038 gallons, about 5 ounces

To find how much 5.25 percent hypochlorite is needed to disinfect a well with a 12-inch casing and static water level of 50 feet with a 50-mg/L dose, you must first find the volume (V) of water to be treated.

$V = (\pi \times D^2)/4 \times H \times 7.48$

$V = (3.14 \times 1\ ft^2)/4 \times 50\ ft \times 7.48$

$= 294$ gal

Amount of hypochlorite needed

= (294 gal/1,000,000) x 50 ppm x (100/5.25)

=0.28 gal, about 1 quart.

Equivalents

There are 4 quarts in a gallon,
so 1 quart = 0.25 gallon.

There are 16 cups in a gallon,
so 1 cup = 0.0625 gallons.

There are 128 fluid ounces in a gallon,
so 1 ounce = 0.0078 gallons.

1 teaspoon = 5 mL

1 fluid ounce = 30 mL

1 quart = 0.95 liters

1 gallon = 3.8 liters