Calculating Dilutions
and Site Size
Learning Objectives

After you complete your study of this module, you should be able to:

- Identify factors you may need to consider when calculating how much pesticide you will need to use and how much to dilute the formulation.
- Use formulas to calculate dilutions.
- Use formulas to convert between square feet and acres.
- Use formulas to calculate the area of both regularly and irregularly shaped sites.
- Use formulas to calculate the volume of enclosed spaces.

Terms To Know

**Active ingredients** — The chemicals in a pesticide product that control the target pest.

**Calibration** — The process of measuring and adjusting the amount of pesticide that application equipment will apply to the target area.

**Concentrate** — Pesticide having a high percentage of active ingredient; occasionally applied full-strength, but usually diluted before application.

**Diluent** — Anything used to dilute a pesticide.

**Dilute** — To make less concentrated.

**Formulation** — Pesticide product as sold, usually a mixture of active and inert ingredients.

**Labeling** — The pesticide product label and other accompanying materials that contain directions that pesticide users are legally required to follow.
A pplying the correct amount of pesticide is a "must" for responsible, effective pest control. The pesticide label and other recommendations tell you how much to apply. It is your job to:

- dilute the formulation correctly,
- accurately calculate the size of the application site, if necessary, and
- calibrate your application equipment accurately.

This unit, plus the unit on equipment calibration, should help you have a basic understanding of how to be sure you are applying the right amount.

Diluting Pesticides Correctly

Unless you have the correct amount of pesticide in your tank mix, even a correctly calibrated sprayer can apply the wrong amount of pesticide to the target.

Formulations such as wettable and soluble powders, emulsifiable concentrates, and flowables usually are sold as concentrates and must be diluted in the spray tank. Water is the most common diluent, but kerosene, oil, and other liquids are sometimes used. Consult the labeling or other recommendations to find out what diluent to use and how much the formulation should be diluted.

You usually will need to do some simple calculations based on the capacity of your sprayer, how your equipment is calibrated, how much area you want to treat, and the recommended application rate. This unit gives you the formulas you need to figure dilutions in most ordinary situations, and it includes examples of how the formulas can be used.

But don’t rely totally on the formulas plus your pencil or calculator — use your common sense, too. It is easy to make a mistake in calculation, so it is a good idea to always make a rough estimate of what you would expect the amount to be. Then you will be better able to judge whether the results of your calculations are reasonable. Many of the "hints" that accompany the examples in this unit are designed to help you make these kinds of estimates.
Diluting Dry Formulations

Pounds per 100 gallons

Directions for dry formulations, such as wettable or soluble powders, may be given in pounds of pesticide formulation per 100 gallons of diluent. You must know how many gallons your sprayer tank holds (or the number of gallons you will be adding to the tank if the job requires only a partial tank load). Then use the following formula:

\[
\text{Gallons in tank} \times \frac{\text{pounds per 100 gallons recommended}}{100 \text{ gallons}} = \text{Pounds needed in tank}
\]

Example:

Your spray tank holds 500 gallons. The labeling calls for 2 pounds of formulation per 100 gallons of water. How many pounds of formulation should you add to the tank to make a full tank load?

**HINT:** 100 gallons is 5 times less than your tank holds, so you will need 5 times more than 2 pounds of formulation.

\[
\frac{\text{Gallons in tank} \times \text{pounds per 100 gallons}}{100 \text{ gallons}} = \text{Pounds needed in tank}
\]

\[
500 \times 2 = 10 \text{ pounds needed in tank}
\]

Example:

You need to spray only 1 acre, and your equipment is calibrated to spray 60 gallons per acre. The labeling calls for 2 pounds of formulation per 100 gallons of water. How much formulation should you add to the tank to make 60 gallons of finished spray?

**HINT:** 60 gallons is slightly more than half of 100 gallons, so you will need slightly more than 1 pound (1/2 of the recommended 2 pounds) of formulation.

\[
\frac{\text{Gallons in tank} \times \text{pounds per 100 gallons}}{100 \text{ gallons}} = \text{Amount needed in tank}
\]

\[
60 \times 2 = 1.2 \text{ pounds needed in tank}
\]

\[
1.2 \text{ pounds} \times 16 \text{ ounces per pound} = 19.2 \text{ ounces needed in tank}
\]

Pounds of formulation per acre

The label may list the recommended rate in terms of pounds of pesticide formulation per acre.

**If the job requires a full tank,** you must know how many gallons your equipment applies per acre and the spray tank capacity. Use these formulas:

\[
\text{Gallons in tank} \div \text{Gallons applied per acre} = \text{Acres sprayed per tankful}
\]

\[
\text{Acres sprayed per tank} \times \text{Pounds formulation per acre} = \text{Pounds formulation needed in tank}
\]

Example:

Your sprayer applies 15 gallons per acre and your tank holds 400 gallons. The labeling rate is 3 pounds of formulation per acre. How much formulation should you add to the tank to make a full tank load?
HINT: 400 gallons is much more than 15 gallons, so you will be able to spray many acres with a tankful and will need to add many pounds of formulation to the tank.

\[
\text{Gallons in tank (400) = Acres sprayed per tankful} \\
\text{Gallons per acre (15)}
\]

\[
400 \div 15 = 26.7 \text{ acres sprayed per tankful}
\]

\[
\text{Acres sprayed per tankful (26.7) \times Pounds formulation per acre (3) = Pounds needed in tank}
\]

\[
26.7 \times 3 = 80.1 \text{ pounds needed in tank}
\]

Add 80.1 pounds of pesticide formulation to the tank.

If the job requires less than a full tank, you must know how many acres you want to treat and how many gallons your sprayer is delivering per acre. You must figure both the number of gallons needed in the tank and the pounds of formulation to add. Use these formulas:

\[
\text{Gallons per acre} \times \text{Acres to be treated} = \text{Gallons needed in tank}
\]

\[
\text{Acres to be treated} \times \text{Pounds formulation per acre} = \text{Pounds needed in tank}
\]

Example:
You want to spray 3 1/2 acres. Your equipment holds up to 100 gallons and delivers 15 gallons per acre. The labeling rate is 3 pounds per acre. How much water do you need to add to the tank? How much pesticide should you add to the tank?

\[
\text{Gallons per acre (15) \times Acres to be treated (3 1/2) = Gallons needed in tank}
\]

\[
15 \times 3.5 = 52.5 \text{ gallons of water needed in the tank}
\]

\[
\text{Acres to be treated (3 1/2) \times Pounds formulation per acre (3) = Pounds formulation needed in tank}
\]

\[
3.5 \times 3 = 10.5 \text{ pounds formulation needed in tank}
\]

Pounds of formulation per 1,000 square feet
If the application rate is listed as pounds or ounces of formulation per 1,000 square feet, use the following formula:

\[
\frac{\text{Amount in tank} \times \text{Rate per 1,000 square feet}}{\text{Amount equipment applies per 1,000 square feet}} = \text{Amount of formulation needed in tank}
\]

Example:
Your sprayer tank holds 3 gallons and applies 2 quarts of spray per 1,000 square feet. The labeling directions indicate a rate of 4 ounces of formulation per 1,000 square feet. How much formulation do you need to make a tankful of spray?

HINT: Your sprayer holds 3 gallons, which is equal to 12 quarts. Also be aware that 16 ounces equals 1 pound.

\[
\frac{\text{Amount in tank (3 gallons = 12 quarts) \times rate per 1,000 square feet (4 oz.)}}{\text{Amount equipment applies per 1,000 square feet (2 quarts)}} = \text{Amount form. needed in tank}
\]

\[
12 \times 4 + 2 = 24 \text{ ounces}
\]

\[
24 \text{ oz.} \div 16 \text{ oz. per pound} = 1.5 \text{ pounds needed in tank}
\]
Pounds of active ingredient per acre

If the recommended rate is given as pounds of active ingredient (a.i.) per acre, you must first convert that figure to pounds of formulation per acre. Use the following formula:

\[
\frac{\text{Pounds of a.i. per acre} \times 100}{\text{Percent of a.i. in formulation}} = \text{Pounds formulation per acre}
\]

Then follow the formulas listed above under the heading “Pounds of formulation per acre” to find the pounds of formulation to add to your tank.

Example:

You want to apply 2 pounds of active ingredient per acre. Your formulation is 80 percent WP. How much formulation do you need per acre?

**HINT:** Your formulation is less than 100 percent, so you will need a little more than 2 pounds of formulation.

\[
\frac{\text{Pounds of a.i. per acre} \times 100}{\% \text{ a.i. in formulation (80\%)}} = \text{Pounds formulation per acre}
\]

\[
2 \times 100 \div 80 = 2.5 \text{ pounds of formulation per acre}
\]

Percent of active ingredient in tank

If the recommended rate is a percentage of active ingredient in the tank, another formula is necessary. First find the number of gallons of spray in the spray tank (either the tank capacity or gallons needed for job if less than tank capacity). Then:

\[
\frac{\text{Gallons in tank} \times \% \text{ a.i. wanted} \times \text{Weight of carrier (lbs. per gal.)}}{\% \text{ a.i. in formulation}} = \text{Pounds formulation to add to tank}
\]

Example:

Your directions call for a spray containing 1.25 percent active ingredient. You need to mix 4 gallons of spray for the job. The pesticide is a 60 percent SP and you will use water as the diluent. How much formulation do you need to add to the tank?

**HINT:** Your product has 60 percent a.i. and your spray mixture is to be much less, only 1.25 percent. You will need to add only a small amount of formulation per gallon.

\[
\text{Gallons in tank (4)} \times \text{Percent a.i. needed (1.25)} \times \text{Weight of water/gal (8.3)} = \text{Pounds form. needed in tank}
\]

\[
\frac{\% \text{ a.i. in formulation (60)}}{4 \times 1.25 \times 8.3 \div 60 = .69 \text{ lbs. of formulation needed in tank}}
\]

.69 pounds \times 16 \text{ ounces per pound} = 11 \text{ ounces of formulation needed in tank}
Diluting Liquid Formulations

Application rates for liquid formulations (EC, F, etc.) are often listed as pints, quarts, or gallons per 100 gallons of diluent or per acre. To make these calculations, use the same formulas you use for calculating dilutions for dry formulations, but substitute the appropriate liquid measure for “pounds” in the formulas.

**Pints/quarts/gallons per 100 gallons**

Use the following formula:

\[
\frac{\text{Gallons in tank} \times \text{Amount per 100 gal. recommended}}{100 \text{ gallons}} = \text{Amount formulation needed in tank}
\]

**Example:**

The labeling rate is 2 pints of pesticide formulation per 100 gallons of water. Your spray tank holds 30 gallons. How much pesticide formulation do you need to add to the tank?

**HINT:** Since your tank holds about 1/3 of the 100 gallons, you will need about 1/3 of the 2 pints per 100 gallon rate.

\[
\frac{\text{Gallons in tank (30) \times Pints per 100 gal. (2)}}{100 \text{ gallons}} = \text{Pints of formulation needed in tank}
\]

\[
30 \times 2 = 60 \text{ pints} \times \frac{1}{100} = 0.6 \text{ pints of formulation needed in tank}
\]

\[
0.6 \text{ pints} \times 16 \text{ ounces per pint} = 9.6 \text{ ounces of formulation needed in tank}
\]

**Pints/quarts/gallons of formulation per acre**

Use these formulas:

\[
\frac{\text{Gallons in tank}}{\text{Gallons applied per acre}} = \text{Acres sprayed per tankful}
\]

\[
\text{Acres sprayed per tank} \times \text{Amount formulation per acre} = \text{Amount formulation needed in tank}
\]

**Example:**

Your sprayer applies 22 gallons per acre and your tank holds 400 gallons. The labeling rate is 1½ quarts per acre. How much pesticide formulation should you add to make up a full tank?

**HINT:** 22 gallons per acre will treat just under 5 acres with 100 gallons, so 400 gallons will treat just under 20 acres. Therefore, your answer should be less than 20 acres \(\times\) 1½ quarts per acre, or less than 30 quarts.

\[
\frac{\text{Gallons in tank (400)}}{\text{Gallons per acre (22)}} = \text{Acres sprayed per tankful}
\]

\[
400 \div 22 = 18.2 \text{ acres sprayed per tankful}
\]

\[
\text{Acres per tankful (18.2) \times Amount of form. per acre (1.5 qts) = Amount form. needed in tank (27.3 qts.)}
\]

\[
18.2 \times 1.5 = 27.3 \text{ quarts (27 quarts plus 9.6 ounces) per acre}
\]

\[
(1 \text{ qt.} = 32 \text{ oz., therefore, } 32 \text{ oz.} \times .3 = 9.6 \text{ oz.)}
\]

Calculating Dilutions and Site Size
Pints/quarts of formulation per 1,000 square feet

If the application rate is listed as pints or quarts of formulation per 1,000 square feet, use the following formula:

\[
\frac{\text{Amount in tank} \times \text{Rate per 1,000 square feet}}{\text{Amount equipment applies per 1,000 square feet}} = \text{Amount formulation needed in tank}
\]

**Example:**

Your sprayer tank holds 10 gallons and applies 1½ quarts of spray per 1,000 square feet. The labeling directions indicate a rate of 5 tablespoons per 1,000 square feet. How much formulation do you need to make a tankful of spray?

**HINT: Your sprayer holds 10 gallons, which is 40 quarts, and 64 tablespoons = 1 quart.**

\[
\frac{\text{Amount in tank} (10 \text{ gallons} = 40 \text{ quarts}) \times \text{Rate per 1,000 square feet} (5 \text{ Tbsp})}{\text{Amount equipment applies per 1,000 square feet} (1.5 \text{ quarts})} = \text{Amt. form. needed in tank}
\]

\[
40 \times 5 = 133 \text{ Tbsp}
\]

\[
133 \text{ Tbsp} \div 64 \text{ Tbsp per quart} = 2 \text{ quarts plus 5 Tbsp (2.08 quarts) formulation needed in tank}
\]

Pounds of active ingredient per acre

The recommendation for the liquid formulation may be listed as pounds of active ingredient per acre. You must first calculate how many gallons of formulation would be needed per acre to achieve that rate. The label of a liquid formulation always tells how many pounds of active ingredient are in a gallon of the concentrated formulation (4 EC has approximately 4 pounds of active ingredient per gallon; 6 EC contains approximately 6 pounds per gallon, etc.). Use the following formula:

\[
\frac{\text{Pounds a.i. to apply per acre}}{\text{Pounds a.i. per gallon formulation}} = \text{Gallons of formulation per acre}
\]

Then use the formulas above under “pints/quarts/gallons per acre” to figure the dilution.

**Example:**

The recommendation is for 1 pound of active ingredient per acre. You purchased an 8 EC that contains 8 pounds of active ingredient per gallon. Your tank holds 500 gallons and is calibrated to apply 25 gallons per acre. How many acres per tankful can you treat? How much formulation would you need for a full tank?

\[
\frac{\text{Pounds a.i. to apply per acre} (1)}{\text{Pounds a.i. per gallon} (8)} = \text{Amount per acre}
\]

\[
1 \div 8 = .125 (1/8) \text{ Gallons per acre}
\]

\[
\frac{\text{Gallons in tank} (500)}{\text{Gallons per acre} (25)} = \text{Acres per tankful}
\]

\[
500 \div 25 = 20 \text{ acres per tankful}
\]

\[
\text{Acres per tankful} (20) \times \text{Gallons per acre} (1/8 \text{ or } .125) = \text{Gallons to add to tank}
\]

\[
20 \times .125 = 2.5 \text{ gallons to add to tank}
\]
Percentage of active ingredient in tank

If the recommended rate is a percentage of active ingredient in the tank, use this formula:

\[
\frac{\text{Gallons in tank} \times \% \text{ a.i. wanted} \times \text{Weight of water (8.3 pounds per gallon)}}{\text{Pounds a.i. per gallon of formulation} \times 100} = \text{Gallons of formulation to add}
\]

**Example:**

You want to make 100 gallons of a 1 percent spray, using water as the diluent. You have a 2 EC formulation (pesticide label tells you that this is 2 pounds active ingredient per gallon). How many gallons of the 2 EC should you add to the 100 gallons of water in the tank?

\[
\frac{100 \times 1 \times 8.3 + 2 \times 100}{2 \times 100} = 4.15 \text{ gallons of formulation to add to tank}
\]

Mixing Concentrates for Airblast Sprayers or Mist Blowers

Spray mixtures used in an airblast sprayer or mist blower usually are 2, 3, 4, 5, or 10 times more concentrated than those used in boom or hydraulic sprayers. If no recommended rate is listed for airblast or mist applications, simply figure the dilution as you would for a boom or hydraulic sprayer and then multiply the last answer by the concentration factor (2×, 3×, 4×, 5×, or 10×).

The unit on Calibration has additional information on choosing an appropriate concentration and adjusting the equipment to apply it correctly.

\[\text{Pounds/gallons of form. per tank} \times \text{Concentration factor} = \text{Pounds/gallons form. per tank in concentrate form}\]

**Example:**

The label lists the rate as 4 pounds formulation per 100 gallons of water for dilute application. Your airblast sprayer tank holds 600 gallons. You want to apply a 5× concentration.

\[
\frac{\text{Gal. per tank (600)} \times \text{Lbs. per 100 gallons recommended (4)}}{100 \text{ gallons}} = \text{Lbs. needed in tank for hydraulic sprayer}
\]

\[600 \times 4 \times 100 = 24 \text{ Lbs. needed in tank for hydraulic sprayer}\]

\[\text{Pounds form. per tank for hydraulic sprayer (24) } \times \text{Conc. wanted (5×) } = \text{Pounds of form. to add to airblast tank}\]

\[24 \text{ pounds } \times 5 = 120 \text{ pounds of formulation to add to airblast tank}\]

Converting Between Square Feet and Acres

If the application rate is given in pounds, pints, quarts, or gallons per 1,000 square feet, and you have calibrated your equipment in terms of acres, you must convert the 1,000-square-foot rate to the rate per acre:

\[
\frac{43,560 \text{ (sq. ft. in acre)}}{1,000 \text{ sq. ft.}} = 43.5
\]

\[\text{Amount of formulation per 1,000 sq. ft. } \times 43.5 = \text{Amount formulation to apply per acre}\]

Or you may have calibrated your equipment in terms of 1,000 or 100 square feet when the application rate is given in pounds, pints, quarts, or gallons per acre. To convert from the rate per acre to the rate per 1,000 square feet (or 100 square feet):

\[
\frac{\text{Amount form. recommended per acre}}{43.5 \text{ (435 for 100 sq. ft.)}} = \text{Amount form. per 1,000 sq. ft. (or 100 sq. ft.)}
\]
Calculating Size of Target Sites

To determine how much pesticide is needed for a job, you must measure or calculate the size of the site to be treated. The following examples will help you to calculate the area of both regularly and irregularly shaped surfaces and the volume of some enclosed spaces.

Regularly Shaped Sites

Rectangles
The area of a rectangle is found by multiplying the length (L) by the width (W).

\[ \text{Area} = \text{Length} \times \text{Width} \]

Example:

\[ L = 125 \text{ feet}, \ W = 40 \text{ feet}, \]
\[ \text{Area} = 125 \text{ ft.} \times 40 \text{ ft.}, \quad \text{Area} = 5,000 \text{ sq. ft.} \]

Circles
The area of a circle is the radius (one-half the diameter) times the radius times 3.14.

\[ \text{Area} = \text{Radius} \times \text{Radius} \times 3.14 \]

Example:

\[ R = 35 \text{ feet}, \]
\[ \text{Area} = 35 \text{ ft.} \times 35 \text{ ft.} \times 3.14, \quad \text{Area} = 3,846.5 \text{ sq. ft.} \]

Triangles
To find the area of a triangle, multiply the width at the base (W) by the height (H), and divide by two.

\[ \text{Area} = \frac{W \times H}{2} \]

Example:

\[ W = 55 \text{ ft.}, \ H = 53 \text{ ft.}, \]
\[ \text{Area} = \frac{55 \text{ ft.} \times 53 \text{ ft.}}{2}, \quad \text{Area} = 1,457.5 \text{ square feet} \]

Irregularly Shaped Sites
Irregularly shaped sites often can be reduced to a combination of rectangles, circles, and triangles. Calculate the area of each and add them together to obtain the total area.

Example:

\[ W = 25 \text{ feet}, \ H = 25 \text{ feet}, \]
\[ L_1 = 42 \text{ feet}, \ W_1 = 30 \text{ feet}, \]
\[ L_2 = 31 \text{ feet}, \ W_2 = 33 \text{ feet} \]
\[ \text{Area} = (W \times H + 2) + (L_1 \times W_1) + (L_2 \times W_2) \]
\[ \text{Area} = (25 \text{ feet} \times 25 \text{ feet} + 2) + (42 \text{ feet} \times 30 \text{ feet}) + (31 \text{ feet} \times 33 \text{ feet}) \]
\[ \text{Area} = 312.5 \text{ sq. feet} + 1,260 \text{ sq. feet} + 1,023 \text{ sq. feet} \]
\[ \text{Total area} = 2,595 \text{ square feet} \]
Another way is to establish a line down the middle of the site for the length, and then measure from side to side at several points along this line. Sites with very irregular shapes require more side-to-side measurements. The average of the side measurements can be used as the width. The area is then calculated as a rectangle.

**Example:**

\[
\text{Area} = L \times \frac{(a + b + c + d + e)}{\text{number of side to side measurements}}
\]

\[
\text{Area} = 45 \text{ feet} \times \frac{22 \text{ feet} + 21 \text{ feet} + 15 \text{ feet} + 17 \text{ feet} + 22 \text{ feet}}{5}
\]

\[
\text{Area} = 873 \text{ square feet}
\]

A third method is to convert the site into a circle. From a center point, measure distance to the edge of the area in 10 or more increments. Average these measurements to find the average radius. Then calculate the area, using the formula for a circle.

**Example:**

\[
\text{Average Radius} = \frac{a + b + c + d + e + f + g + h + i + j}{\text{number of increments measured}}
\]

\[
\text{Average Radius} = \frac{10 \text{ ft} + 12 \text{ ft} + 16 \text{ ft} + 15 \text{ ft} + 11 \text{ ft} + 12 \text{ ft} + 10 \text{ ft} + 9 \text{ ft} + 13 \text{ ft} + 16 \text{ ft}}{10 \text{ increments measured}}
\]

Average Radius = 12.4 feet

Area = \(3.14 \times \text{radius} \times \text{radius}\)

Area = \(3.14 \times 12.4 \text{ feet} \times 12.4 \text{ feet}\)

Area = 482.8 square feet

**Volume of Enclosed Spaces**

To treat an enclosed space, you must determine its volume. To treat bodies of water (other than surface areas), you must determine the volume of the water.

**Spaces shaped like cubes or boxes**

The volume of a cube or box is found by multiplying the length (L) by the width (W) by the height (H).

Volume = Length \(\times\) Width \(\times\) Height

**Example:**

L = 125 feet
W = 40 feet
H = 12 feet

Volume = 125 feet \(\times\) 40 feet \(\times\) 12 feet

Volume = 60,000 cubic feet (feet\(^3\))
Spaces shaped like cylinders
The volume of a cylindrical structure is found by multiplying the height by the area of the circle at the base. The area of the circle is the radius (1/2 the diameter) times the radius times 3.14.

\[ \text{Volume} = \text{Height} \times \text{Radius} \times \text{Radius} \times 3.14 \]

**Example:**
- Height = 125 feet
- Radius = 35 feet
- Volume = 125 feet $\times$ 35 feet $\times$ 35 feet $\times$ 3.14
- Volume = 480,812 cubic feet ($\text{feet}^3$)

Tent-shaped spaces
The volume of a tent-shaped structure is found by multiplying the length (L) by the width (W) by the height (H) and dividing by 2.

\[ \text{Volume} = \frac{L \times W \times H}{2} \]

**Example:**
- L = 125 feet
- W = 40 feet
- H = 12 feet
- Volume = \[\frac{125 \text{ feet} \times 40 \text{ feet} \times 12 \text{ feet}}{2}\]
- Volume = 30,000 cubic feet ($\text{feet}^3$)

Flat-topped tent-shaped spaces
The volume of a flat-topped tent-shaped structure is found by multiplying the length (L) by the height (H) by the average of the width at the top ($W_1$) and the width at the base ($W_2$).

\[ \text{Volume} = L \times H \times \left( \frac{W_1 + W_2}{2} \right) \]

**Example:**
- L = 125 feet
- H = 12 feet
- $W_1 = 30$ feet
- $W_2 = 40$ feet
- Volume = \[125 \text{ feet} \times 12 \text{ feet} \times \frac{(30 \text{ feet} + 40 \text{ feet})}{2}\]
- Volume = 52,500 cubic feet ($\text{feet}^3$)
Quonset-style structures

The volume of quonset-style structures is found by figuring the area of the end and multiplying that by the length.

Half-circle ends

To figure the area of the half-circle-shaped end, treat it as a whole circle, using the height from the ground to the highest point as the radius \((H_1)\). After you have figured the area of the whole circle \((H_1 \times H_1 \times 3.14)\), divide by 2 to get the area of the half circle. Then multiply by the length to determine the volume.

\[
\frac{H_1 \times H_1 \times 3.14}{2} \times L = \text{Volume of half-circle quonset structure}
\]

Example:

\(H = 12 \text{ feet}\)
\(L = 40 \text{ feet}\)

\[
\frac{12 \text{ ft.} \times 12 \text{ ft.} \times 3.14}{2} \times 40 \text{ ft.} = 9,043.2 \text{ cubic feet}
\]

Half-circle-over-rectangle ends

Figure the area of the half circle as above, and figure the area of the rectangle \((W \times H_2)\). Add these two areas together and multiply by the length of the structure to get the volume.

\[
\left(\frac{H_1 \times H_1 \times 3.14}{2}\right) + (H_2 \times W) \times L = \text{Volume}
\]

Example:

\(H_1 = 8 \text{ feet}\)
\(H_2 = 8 \text{ feet}\)
\(W = 16 \text{ feet}\)
\(L = 40 \text{ feet}\)

\[
\left(\frac{8 \text{ ft.} \times 8 \text{ ft.} \times 3.14}{2}\right) + (8 \text{ feet} \times 16 \text{ feet}) \times 40 \text{ ft.} = 9,139.2 \text{ cubic feet}
\]

Triangle-over-rectangle ends

Figure the area of the triangle \(\frac{(W \times H_1)}{2}\), and figure the area of the rectangle \((W \times H_2)\).

Add these two areas together and multiply by the length of the structure to find the volume.

\[
\left(\frac{W \times H_1}{2}\right) + (W \times H_2) \times L = \text{Volume}
\]

Example:

\(H_1 = 8 \text{ feet}\)
\(H_2 = 8 \text{ feet}\)
\(W = 20 \text{ feet}\)
\(L = 40 \text{ feet}\)

\[
\left(\frac{20 \text{ ft.} \times 8 \text{ ft.}}{2}\right) + (20 \text{ ft.} \times 8 \text{ ft.}) \times 40 \text{ ft.} = 9,600 \text{ cubic feet}
\]
Test Your Knowledge

Q. Your spray tank holds 300 gallons. The labeling calls for 3 pounds of formulation per 100 gallons of water. How many pounds of formulation should you add to the tank to make a full tank load?

A. \[
\frac{\text{Gallons in tank (300)} \times \text{lbs. per 100 gallons (3)}}{100 \text{ gallons}} = \text{Pounds needed in tank}
\]

\[
300 \times 3 \div 100 = 9 \text{ pounds needed in tank}
\]

Q. You need to spray only 1 acre, and your equipment is calibrated to spray 50 gallons per acre. The labeling calls for 3 pounds of formulation per 100 gallons of water. How much formulation should you add to the tank to make 50 gallons of finished spray?

A. \[
\frac{\text{Gallons in tank (50)} \times \text{pounds per 100 gallons (3)}}{100 \text{ gallons}} = \text{Amount needed in tank}
\]

\[
50 \times 3 \div 100 = 1.5 \text{ pounds needed in tank}
\]

1.5 pounds \times 16 ounces per pound = 24.0 ounces needed in tank

Q. Your sprayer applies 12 gallons per acre and your tank holds 500 gallons. The labeling rate is 2.5 pounds of formulation per acre. How much formulation should you add to the tank to make a full tank load?

A. \[
\frac{\text{Gallons in tank (500)}}{\text{Gallons per acre (12)}} = \text{Acres sprayed per tankful}
\]

\[
500 \div 12 = 41.7 \text{ acres sprayed per tankful}
\]

Acres sprayed per tankful \(41.7\) \times \text{Pounds formulation per acre (2.5)} = \text{Pounds needed in tank}

\[
41.7 \times 2.5 = 104.3 \text{ pounds of formulation needed in tank}
\]

---

**Weights and Measures**

<table>
<thead>
<tr>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ounce = 1 pound</td>
</tr>
<tr>
<td>1 gallon water = 8.34 pounds</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liquid Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 fluid ounce = 2 tablespoons</td>
</tr>
<tr>
<td>16 fluid ounces = 1 pint</td>
</tr>
<tr>
<td>2 pints = 1 quart</td>
</tr>
<tr>
<td>8 pints = 4 quarts = 1 gallon = 128 fluid ounces</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 feet = 1 yard</td>
</tr>
<tr>
<td>16.572 feet = 1 rod</td>
</tr>
<tr>
<td>280 feet = 320 rods = 1 mile</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 square feet = 1 square yard</td>
</tr>
<tr>
<td>43,560 square feet = 160 square rods = 1 acre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,466 feet per second = 88 feet per minute = 1 mph</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 cubic feet = 1 cubic yard</td>
</tr>
</tbody>
</table>
Q. You want to spray 5 acres. Your equipment holds up to 300 gallons and delivers 18 gallons per acre. The labeling rate is 2 pounds per acre. How much water do you need to add to the tank? How much pesticide should you add to the tank?

A. Gallons per acre \(18 \times 5 = 90\) gallons of water needed in the tank
   
   Acres to be treated \(5 \times 2 = 10\) pounds formulation needed in tank

Q. Your sprayer tank holds 5 gallons and applies 1.5 quarts of spray per 1,000 square feet. The labeling directions indicate a rate of 3 ounces of formulation per 1,000 square feet. How much formulation do you need to make a tankful of spray?

A. Amount in tank \(5\) gallons = 20 quarts \(\times\) rate per 1,000 square feet \(3\) oz.
   
   Amount equipment applies per 1,000 square feet \(1.5\) quarts
   
   \[20 \times 3 + 1.5 = 40\text{ oz.}\]
   
   \[40\text{ oz.} \div 16\text{ oz. per pound} = 2.5\text{ pounds needed in tank}\]

Q. You want to apply 3 pounds of active ingredient per acre. Your formulation is 60 percent WP. How much formulation do you need per acre?

A. Pounds of a.i. per acre \(3\text{ pounds} \times \frac{100}{60}\%\text{ a.i. in formulation}\)
   
   \[3 \times 100 \div 60 = 5\text{ pounds of formulation per acre}\]

Q. Your directions call for a spray containing 1.5 percent active ingredient. You need to mix 5 gallons of spray for the job. The pesticide is an 80 percent SP and you will use water as the diluent. How much formulation do you need to add to the tank?

A. Gallons in tank \(5\) \(\times\) Percent a.i. needed \(1.5\) \(\times\) Wt. of water/gal. \(8.3\) \(\%\text{ a.i. in formulation}\)
   
   \[5 \times 1.5 \times 8.3 \div 80 = 0.78\text{ lbs. of formulation needed in tank}\]
   
   0.78 pounds \(\times\) 16 ounces per pound = 12.5 ounces of formulation needed in tank

Q. The labeling rate is 1.5 pints of pesticide formulation per 100 gallons of water. Your spray tank holds 25 gallons. How much pesticide formulation do you need to add to the tank?

A. Gallons in tank \(25\) \(\times\) Pints per 100 gal. \(1.5\) \(\div\) 100 gallons
   
   \[25 \times 1.5 \div 100 = 0.38\text{ pints of formulation needed in tank}\]
   
   0.38 pints \(\times\) 16 ounces per pint = 6.1 ounces of formulation needed in tank
Q. Your sprayer tank holds 3 gallons and applies 1.5 quarts of spray per 1,000 square feet. The labeling directions indicate a rate of 6 tablespoons per 1,000 square feet. How much formulation do you need to make a tankful of spray?

A. \[
\frac{\text{Amount in tank (3 gallons = 12 quarts)} \times \text{Rate per 1,000 square feet (6 Tbsp.)}}{\text{Amount equipment applies per 1,000 square feet (1.5 quarts)}} = \text{Amount needed in tank}
\]

= \[
\frac{12 \times 6}{1.5} = 48 \text{ Tbsp.}
\]

48 Tbsp. ÷ 64 Tbsp. per quart = 0.75 quarts (1.5 pints) needed in the tank

Q. The recommendation is for 2 pounds of active ingredient per acre. You purchased a 6 EC that contains 6 pounds of active ingredient per gallon. Your tank holds 300 gallons and is calibrated to apply 30 gallons per acre. How many acres per tankful can you treat? How much formulation would you need for a full tank?

A. \[
\frac{\text{Pounds a.i. to apply per acre (2)}}{\text{Pounds a.i. per gallon (6)}} = \text{Amount per acre}
\]

\[
2 \div 6 = .33 \text{ (1/3) Gallon per acre}
\]

\[
\text{Gallons per acre (300)} = \text{Acres per tankful}
\]

\[
\text{Gallons per acre (30)} = \text{Acres per tankful}
\]

\[
200 \div 30 = 10 \text{ acres per tankful}
\]

Acres per tankful (10) \times Gallons per acre (1/3 or 0.33) = Gallons to add to tank

10 \times 0.33 = 3.3 gallons to add to tank

Q. You want to make 200 gallons of a 2 percent spray, using water as the diluent. You have a 4 EC formulation (pesticide label tells you that this is 4 pounds active ingredient per gallon). How many gallons of the 4 EC should you add to the tank?

A. \[
\frac{\text{Gallons in tank (200)} \times \% \text{ a.i. wanted (2\%)} \times \text{Weight of water (8.3)}}{\text{Pounds a.i. per gallon of formulation (4)} \times 100} = \text{Gallons of formulation to add}
\]

\[
200 \times 2 \times 8.3 \div 4 \times 100 = 8.3 \text{ gals. of formulation to add to tank}
\]

Q. The label lists the rate as 3 pounds formulation per 100 gallons of water for dilute application. Your airblast sprayer tank holds 500 gallons. You want to apply a 3X concentration. How many pounds of formulation should you add for a full tank load?

A. \[
\frac{\text{Gal. per tank (500)} \times \text{Lbs. per 100 gals. recommended (3)}}{100 \text{ gallons}} = \text{Lbs. needed in tank for hydraulic sprayer (15)}
\]

\[
500 \times 3 \div 100 = 15
\]

Lbs. form. per tank for hydraulic sprayer (15) \times Con. wanted (3x) = Lbs. of form. to add to airblast tank (45)

15 pounds \times 3 = 45 pounds of formulation to add to tank

Q. How do you calculate the area of a rectangle?

A. Multiply the length (L) by the width (W).

Area = L \times W
Q. How do you calculate the area of a circle?
A. The area of a circle is the radius (one-half the diameter) times the radius times 3.14.
   Area = \( \text{radius} \times \text{radius} \times 3.14 \)

Q. How do you calculate the area of a triangle?
A. Multiply the width at the base (W) by the height (H), and divide by two.
   Area = \( \frac{W \times H}{2} \)

Q. How do you calculate the area of an irregularly shaped site?
A. There are three ways:
   1. Reduce the site to a combination of rectangles, circles, and triangles. Calculate the area of each and add them together to obtain the total area.
   2. Establish a line down the middle of the site for the length, and then measure from side to side at several points along this line. Use the average of the side measurements as the width. Then calculate the area as a rectangle.
   3. Convert the site into a circle. From a center point, measure distance to the edge of the area in 10 or more increments. Average these measurements to find the average radius. Then calculate the area, using the formula for a circle.

Q. How do you calculate the volume of a space shaped like a cube or box?
A. Multiply the length (L) by the width (W) by the height (H).
   Volume = \( L \times W \times H \)

Q. How do you calculate the volume of a space shaped like a cylinder?
A. Multiply the height by the area of the circle at the base.
   Volume = Height \( \times \text{radius} \times \text{radius} \times 3.14 \)

Q. How do you calculate the volume of a space shaped like a tent?
A. Multiply the length (L) by the width (W) by the height (H) and divide by 2.
   Volume = \( \frac{L \times W \times H}{2} \)