FARAD
Food Animal Residue Avoidance & Depletion Species Pages

Calculations and Conversions for Drugs, Forage, Feed and Water Consumptions

Basic Definitions

- Equation 1: 1ppm = 1mg/kg
- Equation 2: 1g/ton = 1,000mg/ 2,000 pounds
- General formula for converting a level of drug in feed (ppm) to the estimated equivalent on a mg/kg basis:
  Equation 3: $\frac{(level\ in\ feed(ppm))\times(kg\ feed\ eaten)}{body\ weight\ in\ kg} = mg\ drug/\ kg\ body\ wt.$
- Equation 4: $ppm\ in\ feed = \frac{(mg\ drug\ /\ kg\ body\ wt)}{(percentage\ of\ body\ wt\ eaten\ as\ food\ /\ day)}$
- Equation 5: $ppm\ in\ feed = \frac{Toxicity\ of\ drug\ in\ mg\ /\ kg}{percent\ body\ wt\ eaten\ as\ feed}$
- Equation 6: $Amount\ of\ medicated\ feed\ to\ add\ to\ mixer =$
  $$Amount\ of\ product\ to\ add\ (lb) = \frac{Drug\ Use\ Level\ \left(\frac{g}{ton}\right)\ x\ Batch\ size\ (ton)}{Concentration\ of\ the\ Drug\ Source\ (\frac{g}{lb})}$$

1. **Converting from ppm to percentage.** There is a direct relationship between ppm and percentage. To convert ppm to percentage, move the decimal point 4 places to the left. To convert percentage to ppm move the decimal point 4 places to the right.

   Example 1: Determining percentage equivalent of 1 ppm.
   a. 1 ppm= 1mg/kg= 1 mg/1,000,000 mg
   b. 1 ÷ 1,000,000 = 0.000001
   c. Convert to % by multiplying by 100
   d. 0.000001 x 100 = 0.0001%
   e. Therefore, 1 ppm is the same as 0.0001%, so to convert ppm to percent divide the ppm by 10,000.

1. Equation 1,2: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.10. Permission granted by author, 3/16/2016.
2. Equation 3,4: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.11. Permission granted by author, 3/16/2016.
3. Equation 5: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.12. Permission granted by author, 3/16/2016.
4. Equation 6: Herrman, Timothy J., Scott Baker, and Gerald L. Stokka. "Medicated feed additives for beef cattle and calves." (1995). p.3. Permission granted by author, 3/22/2016.
5. Example 1: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.9. Permission granted by author, 3/16/2016.

Table 1: Relationship between PPM and Percentage. Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Second Edition. p.9.	
PPM	**Percentage**
0.001 ppm = 1 ppb	0.0000001%
0.01 ppm = 10 ppb	0.000001%
0.1 ppm = 100 ppb	0.00001%
1 ppm= 1000ppb	0.0001%
10 ppm	0.001%
100 ppm	0.01%
1,000 ppm	0.1%
10,000 ppm	1.0%

2. **Calculating Toxicity Level:** Equation 4: $ppm\ in\ feed = \frac{(mg\ drug\ /\ kg\ body\ wt)}{(percentage\ of\ body\ wt\ eaten\ as\ food\ /\ day)}$ Is useful if data is available on the toxicity of a drug (as mg drug/ kg body weight basis) and one wishes to know what the equivalent level in the feed would be in order to produce a similar toxicological effect. Therefore, if the toxicity of the drug or chemical is known and feed intake can be estimated. Then the equivalent exposure on a ppm basis can be calculated. Judgement can then be made of whether or not levels found are enough to cause veterinary toxicological problems.

Example 2: Assume that you know based on published information, that the toxicity of a new feed additive is 2mg/kg body weight for young pigs. At this dose the pigs become anorexic. You are called in on a case where the pigs being fed the new drug have become anorexic and scouring. The person responsible for mixing the feed claims to have added the appropriate amount to achieve the drug level of 10ppm. However, based on a report of chemical analysis you suspect the level is 30 ppm. Would 30 ppm be high enough level to cause problem? Assume that this case involves 10 pound pigs eating an amount equivalent to 8% of their body weight/day.

First one needs to determine what the feed level would be to give an exposure equivalent to 2mg/kg.

Method 1:

$$ppm\ in\ feed = \frac{\frac{mg\ drug}{body\ wt\ in\ kg} * (body\ wt\ of\ animal\ in\ kg)}{(body\ wt\ of\ animal\ in\ kg) * (Percentage\ of\ body\ wt\ eaten\ eaten\ as\ feed)}$$

$$= \frac{\left(\frac{2\text{mg}}{\text{kg}}\right) * \left(10\text{ pounds} \div 2.205\frac{\text{pounds}}{\text{kg}}\right)}{\left(\left(10\text{ pounds} \div \frac{2.205\text{pounds}}{\text{kg}}\right) * (0.08)\right)}$$

1. Equation 4: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.11. Permission granted by author, 3/16/2016.
2. Example 2: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. pp.11-12. Permission granted by author, 3/16/2016.

$$= \frac{\left(\frac{2mg}{kg}\right)*(4.535kg)}{(4.535kg*0.08)}$$
$$= \frac{9.070mg}{0.363kg}$$

= 24.98 mg/kg ≈25 ppm

Method 2: This problem can be solved more directly with the simplified formula:

Equation 5: $ppm\ in\ feed = \dfrac{Toxicity\ of\ drug\ in\ mg\ /\ kg}{percent\ body\ wt\ eaten\ as\ feed}$

$$= \frac{2\frac{mg}{kg}}{0.08} = 25\ ppm$$

Since you have reason to believe the level is actually fed (30 ppm) exceeds the toxicity of 2 mg/kg or 25ppm in feed, you would consider that this level could cause toxicological problems.

3. Calculating the Amount of Medicated Feed to Add to a Mixer:

Equation 6: $Amount\ of\ product\ to\ add\ (lb) = \dfrac{Drug\ Use\ Level\ \left(\frac{g}{ton}\right)\ x\ Batch\ size\ (ton)}{Concentration\ of\ the\ Drug\ Source\ (\frac{g}{lb})}$

The following equations can be used to convert the desired drug use levels to grams/ton. The desired drug use levels can be listed various ways and need to be converted prior to using the equation listed above:

- Equation 7: $Use\ level\ \left(\frac{g}{ton}\right) = \dfrac{(mg/head\ /day\ )}{lb\ fed\ daily}\ x\ \dfrac{1g}{1000mg}\ x\ \dfrac{2000\ lb}{1\ ton}$
- Equation 8:
  $Use\ Level\ \left(\frac{g}{ton}\right) = (\dfrac{mg/100lb\ body\ wt/day}{lb\ fed\ daily}\ \ x\ lb\ body\ weight\ \ x\ \dfrac{1g}{1000mg}\ \ x\ \dfrac{2000\ lb}{1\ ton}$
- Equation 9:
  $Use\ Level\ \left(\frac{g}{ton}\right) = \dfrac{mg\ /\ lb\ body\ weight\ \ /day}{lb\ fed\ daily}\ x\ lb\ body\ weight\ x\ \dfrac{1g}{1000mg}\ x\ \dfrac{2000\ lb}{1\ ton}$

If the drug activity level (concentration of the source) is listed as a percent, it can be converted to grams per pound by multiplying the decimal equivalent of the percent drug activity by 454. Generally manufacturer's will provide directions to determine the amount of feed needed to achieve the desired concentration in a table showing the amount of their product to add to attain the desired drug-use level.

Example 3: Assume the desired drug use level is 500 milligrams per head per day. The drug concentration in the medicated feed additive is 11 percent and the animal will eat 5 pounds of feed per day. Use Equations 7 and 6 to arrive at the correct inclusion rate (12 pounds) of the medicated feed additive to add to the mixer, if 3 tons of feed are manufactured.

1. Equation 5: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.12. Permission granted by author, 3/16/2016.
2. Equation 6,7,8, 9: Herrman, Timothy J., Scott Baker, and Gerald L. Stokka. "Medicated feed additives for beef cattle and calves." (1995). p.3. Permission granted by author, 3/22/2016.
3. Example 3: Herrman, Timothy J., Scott Baker, and Gerald L. Stokka. "Medicated feed additives for beef cattle and calves." (1995). p.3. Permission granted by author, 3/22/2016.

Drug use level (g/ton) = $\frac{\left(\frac{500\frac{mg}{head}}{day}\right)*1g*2000lb)}{5\ lb\ feed\ daily*1000mg*1ton}$ = 200 g/ton

Amount of product to add (lb) = $\frac{\left(200\frac{g}{ton}\right)*3ton}{(454g/1lb)*0.11}$ = 12.0

Example 4: Assume the desired drug use level is 5 milligrams per pound of body weight per day. The medicated feed additive has a drug concentration (activity level) of 100 grams per pound and cattle weighing an average of 1,000 pounds will be fed 10 pounds per day. To manufacture 2.5 tons of feed, use Equations 9 and Equation 6 to arrive at the correct inclusion amount (25 pounds) of medicated feed additive to add to the mixer.

Drug use level (g/ton = $\frac{(5mg/lb\ body\ weight/day\ *1000\ lb\ body\ weight*1g*2000lb)}{(10\ lb\ fed\ daily*1000mg*1ton)}$ = 1000g/ton

Amount of product to add (lb) = $\frac{(1000g/ton\ *2.5ton)}{100g/lb}$ = 25.0 lb

Example 5: Assume that the desired drug use level is 22.7 milligrams per 100 pounds of body weight per day. The drug concentration in the medicated feed additive is 27.2 grams per pound and the animal will be fed 10 pounds of feed per day. If the cattle weigh an average of 800 pounds, and 2 tons of feed will be manufactured, use Equations 8 and 6 to arrive at the correct inclusion rate (2.7 pounds) of the medicated feed additive to add to the mixer.

Drug use level (g/ton)= $\frac{(22.7mg/100lb\ body\ weight/day\ *800lb*1g*2000lb)}{(10lb\ fed\ daily*1000mg*1ton)}$ = 36.32 g/ton

Amount of product to add (lb)= $\frac{(36.32g/ton\ *2ton)}{27.2g/lb}$= 2.7lb

To Determine the Amount of Intermediate Premix to Add:

Equation 10: $Amount\ of\ product\ to\ add\ (lb) = \frac{Drug\ Use\ Level\ \left(\frac{g}{ton}\right)x\ Batch\ size\ (ton)}{Concentration\ of\ the\ intermediate\ premix\ \left(\frac{g}{lb}\right)}$

4. **Converting from Grams of Drug per Ton of Feed to a ppm Basis.** 100g/ton gives a concentration equivalent to 110ppm.

Example 6: Showing that 1gm/ton is equal to 1.1ppm

a. 1g/ton = 1,000 mg/ 2,000 pounds
b. (1,000 mg) ÷ (2,000 pounds ÷ 2.205 pounds/kg)
c. = 1,000 mg/ 907 kg
d. =1.102mg/kg
e. = 1.102 ppm
f. Therefore, 100g of drug/ ton = 110 ppm

1. Equation 10: Herrman, Timothy J., Scott Baker, and Gerald L. Stokka. "Medicated feed additives for beef cattle and calves." (1995). p.3. Permission granted by author, 3/22/2016.
2. Example 4: Herrman, Timothy J., Scott Baker, and Gerald L. Stokka. "Medicated feed additives for beef cattle and calves." (1995). pp.3-4. Permission granted by author, 3/22/2016.
3. Example 5: Herrman, Timothy J., Scott Baker, and Gerald L. Stokka. "Medicated feed additives for beef cattle and calves." (1995). p.4. Permission granted by author, 3/22/2016.
4. Example 6: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.10. Permission granted by author, 3/16/2016.

5. **Expressing Concentrations of Substances in Body Fluids.** Common units used for expressing concentrations of substances in blood or other fluids are ppm, mg%, mg/0.100mg, milliequivalent, mg/liter, µg/100 ml.

Example 7: Assume given report of analysis of a whole blood sample from a dog as 0.8 ppm. Express residue in other units

1. As mg/100ml
    a. 0.8 ppm = 0.8 mg/kg
    b. 0.8 ppm = 0.08 mg/100ml (assuming specific gravity of blood to be 1)
    c. = 80µg/ 100ml
2. As µg/ ml
    a. 0.8 ppm = 0.08 mg/100ml
    b. 1 mg = 1,000 micrograms
    c. 0.08 mg/ 100ml = 80 µg/ 100ml
    d. = 0.8 µg/ml
3. As mg%
    a. 1 mg% = 1 mg/100ml
    b. 0.8 ppm = 0.08 mg/100ml
    c. = 0.08 mg%

6. **Estimating Dosage Based on Consumption when Exposed to Green Forage that has been Sprayed:** One needs to estimate the amount of forage eaten and estimate the uniformity of the sprayed material on the forage. In general, short grasses will be more uniformly sprayed, whereas, tall weeds or grasses have sprayed materials concentrated at the top with little reaching the lower portions of the plant. To estimate the dosage consumed one needs to know the amount of forage eaten by animals, application rate of the chemical per acre or hectare, and the yield of forage per unit of land sprayed. The application rate is determined by the amount of active ingredient in the chemical and should be used for the calculation.

Osweiler and Van Geldner, 1 pound of chemical per acre results in an exposure in a grazing animal of approximately 7 mg of chemical per kg body weight.

Derivation: The contribution of 1lb of chemical per acre to the diet of a forage-consuming animal can be calculated as follows:
1acre of land= 43,560 sq ft

1lb = 454 g = 454,000mg

1. Example 7: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.10. Permission granted by author, 3/16/2016.
2. Derivation: "Toxicology Math Tutor: Estimating Dosages When Exposure is Based on Consumption of Green Forage that has been Sprayed". The Ohio State University, College of Veterinary Science. http://www.vet.ohio-state.edu/assets/courses/vm640/toxmathtutor/TOCconc.html

454,000mg/ 43,560 sq ft= 10.4 $\frac{mg}{sq\ ft}$

Forage yield should be estimated at 2 tons/acre. Use actual values if known.

2 tons * 907 $\frac{kg}{ton}$ =1814kg / 43,560 sq ft = 0.042$\frac{kg\ forage}{sq\ ft}$ = 42$\frac{g\ forage}{sq\ ft}$

10.4 $\frac{mg}{sq\ ft}$/ 0.042$\frac{kg\ forage}{sq\ ft}$ = 248$\frac{mg\ chemical}{kg\ forage}$

$\frac{mg}{kg\ body\ weight}$ = forage level (ppm) * % body weight eaten as forage (*assumed as 3%)*

= 248 $\frac{mg}{kg}$* 0.03 = 7.4 $\frac{mg}{kg\ body\ weight}$.

Therefore, under these above conditions and assuming all sprayed chemicals remain on the forage (not lost to metabolism or decomposition), animals allowed to graze the sprayed forage would receive approximately 7mg/kg body weight for each pound of chemical applied.

Example 8: If an herbicide is applied at 2 pounds per acre and cows were allowed to graze the exposed forage, the herbicide exposure would be 14 mg/kg. If the no-effect exposure level is 300mg/kg for the herbicide, then it can be concluded that the herbicide would not be responsible for any adverse effects seen in the cattle.

1. Example 8: Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.12. Permission granted by author, 3/16/2016.

7. **Estimated Feed Consumption Rates for Animals Under Ideal Conditions**:

Table 2:

1. Estimated Feed Consumption Rates for Animals Under Ideal Conditions. Number based on NRC Nutrient Requirement Data. Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. pp.13-14.

	Body Weight		Weight of Food Eaten per Day Expressed as Percentage of Body Wt.
Animal	**Pounds**	**Kilograms**	
Food Animal			
Beef			
	300	136	2.3
	450	204	2.5
	650	295	2.4
	1,000	454	2.1
Dairy Cow			
Lactating and nonpregnant	770	350	1.4
	1,760	800	1.2
Last two months gestation	770	350	1.8
	1,760	800	1.6
Swine			
	10-25	4.5-11.3	8
	50	23	6.4
	100	45	5.3
	150	68	4.5
	200	91	4
Lamb			
	59	27	4.5
	99	45	3.9
Ewe			
Nonlactating	141	64	2.4
Lactating	141	64	3.9
Chicken			
	0.5	0.23	14
	1.0	0.45	11.4
	1.5	0.68	9.7
	3.5	1.59	6.7
	5.5	2.50	5.0
[1]Goat			
Maintenance	22	10	2.80
	45	20.4	2.40
	67	30.4	2.20
	90	40.8	2.03
	112	50.8	1.90
	134	60.8	1.82
	157	71.2	1.80
	179	81.2	1.70
	202	91.6	1.64
	224	101.6	1.60

[1] Gimenez, Diego M., Jr. "Nutrient Requirements of Sheep and Goats." *Alabama Cooperative Extension System*. Alabama A&M and Auburn Universities, Aug. 1994. Web. <www.aces.edu/pubs/docs/A/ANR-0812/ANR-0812.pd>. p7.

Table 2 continued:

Estimated Feed Consumption Rates for Animals Under Ideal Conditions. Number based on NRC Nutrient Requirement Data. Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. pp.13-14.

	Body Weight		
Animal	**Pounds**	**Kilogram**	**Weight of Food Eaten per Day Expressed as Percentage of Body Wt.**
Non-Food Animal			
Horse			
Mature	408	185	2.0
Weight	806	365	1.7
Work, moderate	1,203	545	1.6
	1,401	635	1.5
Colt			
Growing	199	90	3.1
Mature Weight -270kg	596	270	1.3
Growing	199	90	3.4
Mature Weight-365 kg	408	185	2.3
	596	270	1.7
	806	365	1.2
Growing	199	90	3.8
Mature Weight-545 kg	806	365	1.7
	1,203	545	1.0
Dog			
Adult	5	2.3	3.9
(Dry food)	15	6.8	2.8
	30	13.6	2.5
	70	31.8	2.5
	110	49.8	2.4
Dog			
Growing	5	2.3	7.8
(Dry Food)	15	6.8	5.6
	30	13.6	5.0
	50	22.7	5.0

If more information is needed for different production classes or conditions of each species, the veterinarian is advised to refer to *The National Academies Press* for the nutrient requirements of each species (http://www.nap.edu/topic/296/agriculture/animal-health-and-nutrition).

8. **Estimated Water Consumption of Domestic Animals Under Normal Conditions:** The animal's size and growth stage has strong influence on daily water intake. Consumption rates can be affected by environmental and management factors. Air temperature, relative humidity and the level of animal exertion or production level are examples of these factors. Additionally the quality of the water, which includes temperature, odor, salinity and impurities affecting taste, will effect water consumption of livestock. The water content of the animal's diet will influence its drinking habits, feed with relatively high moisture content decreases the quantity of drinking water required. If more information is needed for different production classes or conditions of each species, the veterinarian is advised to refer to the *The National Academies Press* for the nutrient and water requirements of each species (http://www.nap.edu/topic/296/agriculture/animal-health-and-nutrition).

Table 3: Estimated Water Consumption of Domestic Animals Under Normal Conditions. Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.14. Permission granted by author, 3/16/2016.

Animal and Condition	Consumption/ Head/ Day	
	Gallons	**Liters**
Horse	0.6 gal/ 100 pounds body weight	5.4 L/100 kg body weight
Horse Lactating		4 L H_2O/ L milk
Range Cattle	10-12	38-45
Range Cattle		3.8 L/kg dry feed
Feeder Calves	4-6	15-23
Finishing Calves	8-10	30-38
Dairy cow- lactating		3-4 L/L of milk prod.
	12-36	45-136
Dairy Calves		
4-8 weeks	1-1 ½	3.8-5.6
12-20 weeks	2-4 ½	7.6-17
6 months	4	15
Sow- pregnant	3 ½ - 4 ½	13-17
Sow- lactating	5-6	19-23
Swine- growing		
30 pounds	0.6-1.0	2.3- 3.8
60-80 pounds	0.8	3
75- 125 ponds	2.0	7.6
200-230 pounds	1 ½ -3 ½	5.7 -13
Sheep		
Lamb	0.8	3
Ewe	1.0	3.8
Ewe Lactating	1.5	5.7
Hens- nonlaying	5.0 gal/ 100 birds	19 L/100 birds
Hens- laying	5-7 ½ gal/ 100 birds	19-28 L/100 birds
Chicken		
4 weeks	2.0 gal/ 100 birds	7.6 L/ 100 birds
8 weeks	4.1 gal/ 100 birds	15.5 L / 100 birds
12 weeks	5.5 gal/100 birds	21 L / 100 birds

Table 4: Equivalents, Constants and Prefixes. (Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.15.) Permission granted by author, 3/16/2016.

Length	Capacity – Liquid
1 inch= 2.54 centimeters	1 ounce = 29.57 milliliters
1 foot = 30.48 centimeters	1 quart = 0.946 liters
1 yard = 91.4 centimeters	1 quart= 57.75 cubic inches
1 furlong = 660 feet	1 gallon = 3.785 liters
1 mile = 5280 Feet	1 cubic foot= 7.48 gallons
1 mile = 1609.3 meters	1 cubic foot= 59.84 pints
1 centimeter = 0.3937 inch	1 cubic foot= 28.32 liters
1 meter= 39.37 inches	1 bushel = 9.309 gallons
1 meter= 3.2808 feet	1 barrel (US liquid) = 31.5 gallons
1 micron = 1 x 10^{-6} meter	1 acre-foot = 3.259 x 10^{5} gallons
1 micron = 1 x 10^{-3} = 0.001 millimeter	1 liter= 1.057 quarts
1 angstrom = 1 x10^{-5} = 0.0001 micron	1 liter = 33.81 ounces
	1 liter = 0.264 gallons
	1 liter = 61.03 cubic inches
Area	1 liter = 1000 milliliters
1 acre = 43,560 square feet	1 teaspoon = 5 milliliters
1 acre = 4,047 square meters	1 tablespoon = 15 milliliters
1 hectare = 2.471 acres	
1 hectare = 10,000 square meters	
1 square mile = 640 acres	
Weight	**Capacity- Dry**
1 grain = 64.8 milligrams	1 bushel = 8 gallons
1 ounce = 28.35 grams	1 bushel = 35.24 liters
1 pound = 453.59 grams	1 bushel = 1.24 cubic feet
1 short ton = 2000 pounds	1 cubic foot = 0.804 bushels
1 short ton = 907.18 kilograms	1 cubic foot = 28.316 liters
1 long ton = 2240 pounds	1 cubic foot = 25.714 quarts
1 long ton = 1016.05 kilograms	1 quart = 1.101 liters
1 metric ton = 1000 kilograms	1 liter = 0.908 quarts
1 metric ton = 2204.6 pounds	1 liter = 61.03 cubic inches
1 gram = 15.43 grains	1 cubic meter = 35.314 cubic feet
1 kilogram = 2.205 pounds	1 cubic inch = 16.387 milliliters
Miscellaneous	
Degrees Centigrade = (°F – 32) x 0.55	
Degrees Fahrenheit = (°C x 1.8) + 32	
1 Calorie = 0.003968 BTU	
1 BTU = 252 Calories (Gram) (15°C)	
1 atmosphere = 33.90 feet of water	
1 atmosphere 29.92 inches of mercury	
1 atmosphere = 14.7 pounds/ square inch	
1 gallon of water = 8.3453 pounds	

Table 5: Prefixes applied to Metric System Units. Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. p.16. Permission granted by author, 3/16/2016.

Multiples	**Prefix**	**Symbol**
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	Giga	G
10^{6}	mega	M
10^{3}	Kilo	k
10^{2}	hecto	h
10	deka	da
10^{-1}	deci	D
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Useful Links

- Medicated Feed Additives for Beef Cattle and Calves- www.bookstore.ksre.ksu.edu/pubs/mf2043.pdf
- Ingredient Bulk Density Table- http://www.sawyerhanson.com/uploads/Brabender%20Ingredient%20bulk%20density%20table.pdf
- Evaluating Feed Components and Finished Feeds- https://www.bookstore.ksre.ksu.edu/pubs/MF2037.pdf
- *The National Academy Press*, Nutrient Requirement of Multiple Livestock Species- http://www.nap.edu/topic/296/agriculture/animal-health-and-nutrition
- Water Requirements of Livestock- http://www.omafra.gov.on.ca/english/engineer/facts/07-023.htm
- Food and Water Requirements of Livestock http://www.clemson.edu/extension/ep/food_water_req.html
- Livestock Water Requirements www.ag.ndsu.edu%2Fpubs%2Fansci%2Flivestoc%2Fas1763.pdf&usg=AFQjCNGlRdnjvHprrWZHOhAlevghbkzztw&sig2=RmRSzdzq_AMU5mhoQsmkPA&cad=rja

Citations:

1. Osweiler, Gary D., et al. *Clinical and diagnostic veterinary toxicology*. Kendall/Hunt Publishing Company, 1985. Third Edition. pp. 9-13. (Examples and equations used with permission granted by author, 03/16/2016)
2. Ward, D, McKague, K. *Water Requirements of Livestock*., Factsheet, Ontario Ministry of Agricultural Food and Rural Affairs, 2007.
3. Herrman, Timothy J., Scott Baker, and Gerald L. Stokka. "Medicated feed additives for beef cattle and calves." 1995. (Examples and equations used with permission granted by author, 03/22/2016)
4. "Toxicology Math Tutor: Estimating Dosages When Exposure is Based on Consumption of Green Forage that has been Sprayed". The Ohio State University, College of Veterinary Science. http://www.vet.ohio-state.edu/assets/courses/vm640/toxmathtutor/TOCconc.html