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Pharmaceutical calculation

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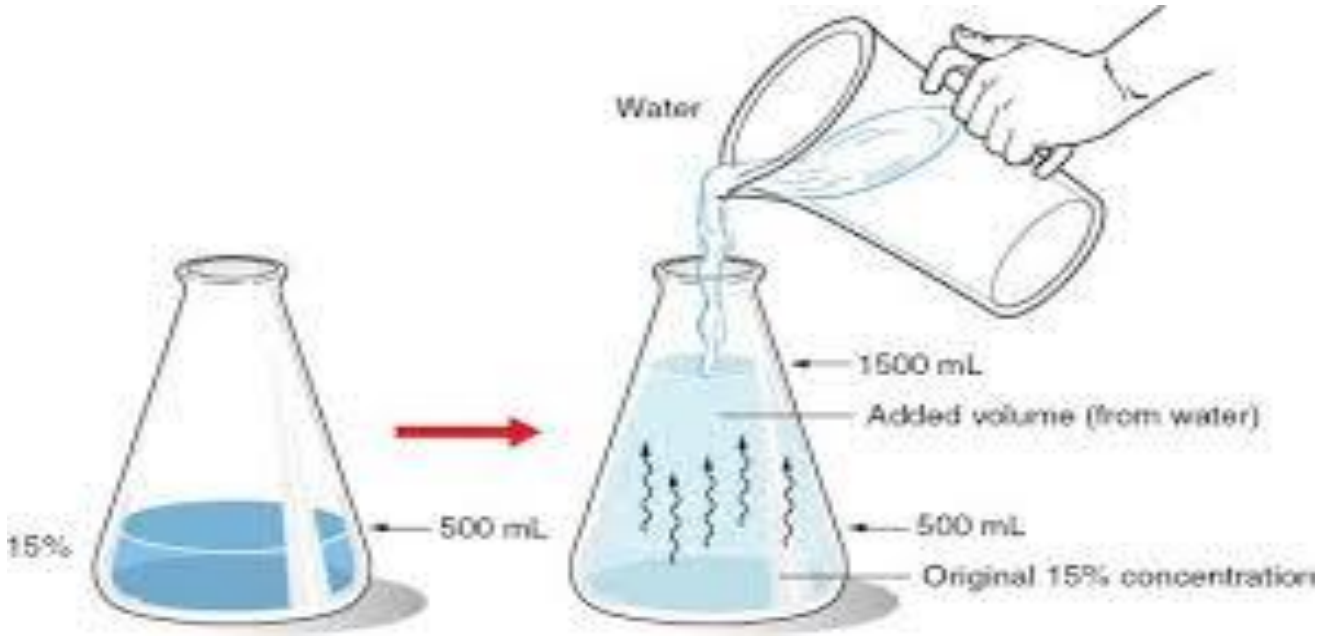
Dilution and concentration of pharmaceutical preparation lec1



The dilution of a liquid dosage form, as a solution or suspension, may be desired to provide a product strength more suitable for use by a particular patient (e.g., pediatric, elderly, those in disease states). The diluent is selected based on its compatibility with the vehicle of the original product; that is, aqueous, alcoholic, hydroalcoholic, or other. The dilution of a solid dosage form (as a powder or the contents of a capsule) or a semisolid dosage form (as an ointment or cream) also may be performed to alter the dose or strength of a product. Again, the diluent is selected based on its compatibility with the original formulation. Pharmacists also may find occasion to dilute concentrated acids, alcohol preparations, or very potent therapeutic agents,

The concentration of a liquid preparation, as through the evaporation of a portion of its solvent or vehicle, rarely is performed nowadays. However, the fortification of a liquid, solid, or semisolid dosage form, by the addition of a calculated quantity of additional therapeutic agent, remains a viable practice in pharmacy compounding

If a mixture of a given percentage or ratio strength is diluted to twice its original quantity, its active ingredient will be contained in twice as many parts of the whole, and its strength therefore will be reduced by one half. By contrast, if a mixture is concentrated by evaporation to one-half its original quantity, the active ingredient (assuming that none was lost by evaporation) will be contained in one half as many parts of the whole, and the strength will be doubled.

so, if 50 mL of a solution containing **10** g of active ingredient with a strength of **20**% or 1:5 w/v are diluted to 100 mL, the original volume is doubled, but the original strength is now reduced by one half to 10% or 1:10 w/v. If, by evaporation of the solvent, the volume of the solution is reduced to 25 mL or one half the original quantity, the **10** g of the active ingredient will indicate a strength of **40**% or **1:2.5** w/v.

The percentage or ratio strength (concentration) of a component in a pharmaceutical preparation is based on its quantity relative to the total quantity of the preparation. If the quantity of the component remains constant, any change in the total quantity of the preparation, through dilution or concentration, changes the concentration of the component in the preparation **inversely**. An equation useful in these calculations is

(1st quantity)x(1st concentration) =(2nd quantity)x(2nd concentration)

or **Q1 x C1 = Q2 x C2**

Example Calculations of the Dilution and Concentration of Liquids

If 500 mL of a 15% v/v solution are diluted to 1500 mL, what will be the percentage strength (v/v)?

$$Q1\ (\text{quantity}) \times C1\ (\text{concentration}) = Q2\ (\text{quantity}) \times C2\ (\text{concentration})$$

$$500\ (\text{mL}) \times 15\ (\%) = 1500\ (\text{mL}) \times x\ (\%)$$

$$x = 5\%,\ \textit{answer.}$$

If 50 mL of a 1:20 w/v solution are diluted to 1000 mL, what is the ratio strength (w/v)?

Note: A student may find it simpler in solving certain problems to convert a given ratio strength to its equivalent percentage strength

$$\text{Q1 (quantity)} \times \text{C1 (concentration)} = \text{Q2 (quantity)} \times \text{C2 (concentration)}$$
$$50\ (\text{mL}) \times 5\ (\%) = 1000\ (\text{mL}) \times (\%)$$
$$x = 0.25\% = 1{:}400, \textit{answer.}$$

Or,

50 mL of a 1:20 solution contains 2.5 g of solute

$$\frac{2.5\ (\text{g})}{1\ (\text{g})} = \frac{1000\ (\text{mL})}{x\ (\text{mL})}$$
$$x = 400\ \text{mL}$$
$$\text{Ratio strength} = 1{:}400, \textit{answer.}$$

Strengthening of a Pharmaceutical Product

The addition of active ingredient or by the admixture with a calculated quantity of a like-product of greater concentration

example calculations of product strengthening

- **If a cough syrup contains in each teaspoonful, 1 mg of chlorpheniramine maleate and if a pharmacist desired to double the strength, how many milligrams of that ingredient would need to be added to a 60-mL container of the syrup. Assume no increase in volume**

$$\frac{1\ \text{mg}}{5\ \text{mL}} \times 60\ \text{mL} = 12\ \text{mg chlorpheniramine maleate in original syrup}$$

To double the strength, 12 mg of additional chlorpheniramine maleate would be required, *answer*.

Stock Solutions

Stock solutions are concentrated solutions of active (e.g., drug) or inactive (e.g., colorant) substances and are used by pharmacists as a convenience to prepare solutions of lesser concentration

Example Calculations of Stock Solutions

How many milliliters of a 1:400 w/v stock solution should be used to make 4 liters of a 1:2000 w/v solution?

$$\frac{1/400}{1/2000} = \frac{4000\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 800\ \text{mL},\ \textit{answer}.$$

How many milliliters of a 1:400 w/v stock solution should be used in preparing 1 gallon of a 1:2000w/v solution?

$$1 \text{ gallon} = 3785 \text{ mL}$$
$$1:400 = 0.25\%$$
$$1:2000 = 0.05\%$$
$$\frac{0.25\ (\%)}{0.05\ (\%)} = \frac{3785\ (\text{mL})}{x\ (\text{mL})}$$
$$x = 757 \text{ mL, } \textit{answer.}$$

*How many milliliters of a 1% stock solution of a certified red dye should be used in preparing 4000 mL of a mouthwash that is to contain 1:20,000 w/v of the certified red dye as a coloring agent?*1

$$1:20{,}000 = 0.005\%$$

$$\frac{1\ (\%)}{0.005\ (\%)} = \frac{4000\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 20\ \text{mL},\ \textit{answer}.$$

How many milliliters of a 1:50 stock solution of phenylephrine hydrochloride should be used in compounding the following prescription?

℞ Phenylephrine HCl 0.25%
Rose Water ad 30 mL
Sig. For the nose.

$$1:50 = 2\%$$

$$\frac{2\ (\%)}{0.25\ (\%)} = \frac{30\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 3.75\ \text{mL},\ \textit{answer}.$$

How much drug should be used in preparing 50 mL of a solution such that 5 mL diluted to 500 mL will yield a 1:1000 solution?

1:1000 means 1 g of drug in 1000 mL of solution

$$\frac{1000\ (\text{mL})}{500\ (\text{mL})} = \frac{1\ (\text{g})}{x\ (\text{g})}$$

x = 0.5 g of drug in 500 mL of *diluted* solution (1:1000), which is *also* the amount in 5 mL of the *stronger* (stock) solution

How many milliliters of water should be added to a pint of a 5% w/v solution to make a 2% w/v solution?

$$1 \text{ pint} = 473 \text{ mL}$$

$$\frac{2\ (\%)}{5\ (\%)} = \frac{473\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 1182.5 \text{ mL}$$

And,

$$1182.5 \text{ mL} - 473 \text{ mL} = 709.5 \text{ mL}, \textit{answer}.$$

If the *quantity of a component* is given rather than the *strength of a solution*, the solution may be diluted to a desired strength as shown by the following example

How many milliliters of water should be added to 375 mL of a solution containing 0.5 g of benzalkonium chloride to make a 1:5000 solution?

1:5000 means 1 g in 5000 mL of solution

$$\frac{1\ (g)}{0.5\ (g)} = \frac{5000\ (mL)}{x\ (mL)}$$

x = 2500 mL of 1:5000 (w/v) solution containing 0.5 g of benzalkonium chloride

And,

2500 mL − 375 mL = 2125 mL, *answer.*

If 15 mL of a 0.06% ATROVENT (ipratropium bromide) nasal spray were diluted with 6 mL of normal saline solution, what would be the final drug concentration?

$$15\ (\text{mL}) \times 0.06\ (\%) = 21\ (\text{mL}) \times x\ (\%)$$
$$x = 0.043\ \%,\ \textit{answer}.$$

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Dilution of alcohol

When water and alcohol are mixed, there is a physical contraction such that the **resultant volume** is **less** than the **total of the individual** volumes of the two liquids. Thus, to prepare a *volume-in volume* strength of an alcohol dilution, the alcohol "solute" may be determined and water used to "q.s." to the appropriate volume. Because the contraction of the liquids does not affect the *weights* of the components, the *weight of water* (and from this, the *volume*) needed to dilute alcohol to a desired *weight-in-weight* strength may be calculated

How much water should be mixed with 5000 mL of 85% v/v alcohol to make 50% v/v alcohol?

$$\frac{50\ (\%)}{85\ (\%)} = \frac{5000\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 8500\ \text{mL}$$

Therefore, use 5000 mL of 85% v/v alcohol and enough water to make 8500 mL, *answer*

How many milliliters of 95% v/v alcohol and how much water should be used in compounding the following prescription?

℞	Xcaine	1 g
	Alcohol 70%	30 mL
	Sig. Ear drops.	

$$\frac{95\ (\%)}{70\ (\%)} = \frac{30\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 22.1\ \text{mL}$$

Therefore, use 22.1 mL of 95% v/v alcohol and enough water to make 30 mL, *answer.*

Dilution of acids

The strength of an official undiluted (*concentrated*) acid is expressed as percentage weight-in weight. For example, Hydrochloric Acid, NF, contains not less than 36.5% and not more than 38.0%, by weight, of HCl. However, the strength of an official *diluted* acid is expressed as percentage weight-in-volume. For example, Diluted Hydrochloric Acid, NF, contains, in each 100 mL, not less than 9.5 g and not more than 10.5 g of HCl. It is necessary, therefore, to consider the specific gravity of concentrated acids in calculating the volume to be used in preparing a desired quantity of a diluted acid

How many milliliters of 37% w/w hydrochloric acid having a specific gravity of 1.20 are required to make 1000 mL of diluted hydrochloric acid 10% w/v?

$1000\ g \times 0.10 = 100\ g$ of HCl (100%) in 1000 mL of 10% w/v acid

$$\frac{37\ (\%)}{100\ (\%)} = \frac{100\ (g)}{x\ (g)}$$

$$x = 270\ g \text{ of } 37\% \text{ acid}$$

270 g of water measure 270 mL

$$270\ (mL) \div 1.20 = 225\ mL, \textit{answer.}$$

How many milliliters of 85% w/w phosphoric acid having a specific gravity of 1.71 should be used in preparing 1 gallon of 1/4% w/v phosphoric acid solution to be used for bladder irrigation?

1 gallon = 3785 mL

3785 (g) × 0.0025 = 9.46 g of H_3PO_4 (100%) in 3785 mL (1 gallon) of ¼% w/v solution

$$\frac{85\ (\%)}{100\ (\%)} = \frac{9.46\ (g)}{x\ (g)}$$

x = 11.13 g of 85% phosphoric acid

11.13 g of water measures 11.13 mL

11.13 (mL) ÷ 1.71 = 6.5 mL, *answer.*

Dilution and Fortification of Solids and Semisolids

The dilution of solids in pharmacy occurs when there is need to achieve a lower concentration of an active component in a more concentrated preparation (e.g., a powdered vegetable drug).

There also is a type of diluted pharmaceutical preparation, termed a ***Trituration*** (are dilutions of potent medicinal substances. They were at one time official and were prepared by *diluting one part by weight of the drug with nine parts of finely powdered lactose.* They are, therefore, *10%* or *1:10 w/w* mixtures). Reducing or enhancing the strengths of creams and ointments is a usual part of a compounding pharmacist's practice to meet the special needs of patients. The dilution of semisolids is a usual part of a compounding pharmacist's practice in reducing the strengths of creams and ointments to meet the special needs of patients

Example Calculations of Solid and Semisolid Dilutions

If 30 g of a 1% hydrocortisone ointment were diluted with 12 g of Vaseline, what would be the concentration of hydrocortisone in the mixture?

$$30\ \text{g} \times 1\% = 0.3\ \text{g hydrocortisone}$$

$$30\ \text{g} + 12\ \text{g} = 42\ \text{g, weight of mixture}$$

$$\frac{0.3\ \text{g}}{42\ \text{g}} \times 100 = 0.71\%\ \text{(w/w), } \textit{answer.}$$


THANK
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