SECTION
1

Pharmaceutical Calculations

DILUTION METHODS

Dilution is the process of reducing the concentration of a solution by adding a suitable diluent, usually purified water or another compatible solvent. Dilution methods are widely used in pharmacy to prepare solutions of desired strengths from concentrated stock solutions. These methods are essential in pharmaceutical compounding, dispensing, quality control and manufacturing processes.

Pharmacists frequently encounter situations where commercially available solutions are either too concentrated or not available in the required strength. In such cases, dilution calculations help determine the exact quantity of stock solution and diluent needed to prepare the desired formulation accurately.

Example of dilution method: Prepare 100 mL of 10% solution from a 25% stock solution.

Using $C_1V_1 = C_2V_2$

$25 \times V_1 = 10 \times 100$

$V_1 = 40$ mL

Therefore:

- 40 mL of 25% solution
- Add water up to 100 mL (60 mL water)

Importance of Dilution Methods in Pharmaceutical Calculations

Dilution methods are useful for:

- Preparing solutions of specific concentrations for dispensing.
- Adjusting the strength of pharmaceutical preparations.
- Preparing paediatric and geriatric dosage forms.
- Formulating antiseptic and disinfectant solutions.
- Preparing intravenous admixtures.
- Manufacturing pharmaceutical products with uniform potency.
- Reducing medication errors through accurate calculations.

Common Dilution Methods

a. Simple dilution method ($C_1V_1 = C_2V_2$)

Used when a concentrated solution is diluted to obtain a desired concentration.

b. Ratio and proportion method
Used to determine the amount of stock solution and diluent required.

c. Alligation method
Used when two solutions of different strengths are mixed to obtain a desired intermediate strength.

ALLIGATION METHOD

Alligation method is a simple calculation technique used in pharmacy to prepare a solution or formulation of a desired strength by mixing two preparations of different strengths. It helps pharmacists determine how much of each preparation should be mixed to obtain the required concentration. For example, if a pharmacist has a 25% solution and wants to prepare a 10% solution, the alligation method helps calculate how much of the 25% solution and how much water should be mixed together.

Why is alligation method used

- To prepare solutions of required concentration.
- To dilute strong solutions.
- To mix two solutions of different strengths.
- To prepare ointments, creams and powders of desired potency.
- To simplify pharmaceutical calculations.

Principle

The alligation method is based on the principle that the desired concentration must always lie between the concentrations of the two available preparations being mixed. In this method, the difference between the concentration of the stronger preparation and the desired concentration determines the number of parts of the weaker preparation required. Similarly, the difference between the desired concentration and the concentration of the weaker preparation determines the number of parts of the stronger preparation required. By using these differences, the correct ratio of the two preparations can be calculated easily, enabling the preparation of a solution, ointment, cream or other pharmaceutical formulation with the desired strength accurately and efficiently.

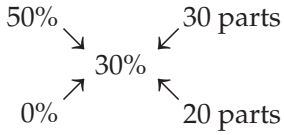
Advantages of Alligation Method

- Simple and quick calculation method
- No complex mathematical formulas required
- Reduces calculation errors
- Useful in pharmaceutical compounding
- Widely used in dispensing and manufacturing

Difference between Dilution Method and Alligation Method

- **Dilution method:** This method is used when a concentrated solution is diluted with a diluent (usually water) to obtain a lower concentration.
- **Alligation method:** This method is used when two preparations of different strengths are mixed together to obtain a desired intermediate concentration

Example 1: Prepare 100 mL of 30% solution from 50% solution and water



Ratio = 30: 20 = 3: 2
For 100 mL:
Volume of 50% solution

$$\frac{3}{5} \times 100 = 60 \text{ mL}$$

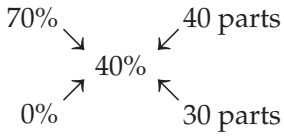
Volume of water

$$\frac{2}{5} \times 100 = 40 \text{ mL}$$

Answer: Mix 60 mL of 50% solution with 40 mL of water to obtain 100 mL of 30% solution

Example 2: Preparation of 40% alcohol from 70% alcohol and water
Available strengths:
- Strong solution = 70%
- Weak solution = 0%
- Desired strength = 40%

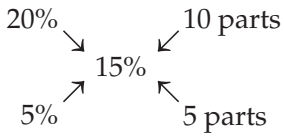
Alligation



Ratio = 40:30
= 4:3
Therefore, mix:
- 4 parts of 70% alcohol
- 3 parts of water

Example 3: Preparation of 15% ointment from 20% and 5% ointments
Available strengths:
Strong ointment = 20%
Weak ointment = 5%
Desired strength = 15%

Alligation



Ratio = 10:5
= 2:1

Therefore, mix
- 2 parts of 20% ointment
- 1 part of 5% ointment

Applications of Alligation Method in Pharmacy

- Preparation of diluted alcohol solutions.
- Preparation of antiseptic and disinfectant solutions.
- Compounding ointments and creams of desired potency.
- Preparation of paediatric formulations.
- Adjustment of syrup concentrations.
- Preparation of IV fluids and nutrient solutions.
- Pharmaceutical manufacturing and quality control laboratories.

SYNOPSIS QUESTIONS

1. What is the dilution method? Explain its applications in pharmacy.
2. What is the alligation method? Explain its principle.
3. Differentiate between dilution and alligation methods.
4. Explain the dilution equation ($C_1V_1 = C_2V_2$) with its significance in pharmaceutical calculations.
5. Discuss the importance of dilution and alligation methods in pharmaceutical compounding and dispensing.

VIVA VOCE QUESTIONS

1. Define dilution.
2. Define alligation.
3. State the dilution formula ($C_1V_1 = C_2V_2$).
4. What is the principle of the alligation method?
5. What is meant by a stock solution?
6. What is a diluent?
7. What condition must be satisfied before applying the alligation method?
8. What are the advantages of the alligation method?
9. How would you prepare a 10% solution from a 25% stock solution?
10. Mention any two pharmaceutical applications of dilution and alligation methods.

PHARMACEUTICAL SOLUTIONS

A pharmaceutical solution is a clear, homogeneous liquid dosage form containing one or more chemically dissolved substances in a suitable solvent system intended for administration by various routes.

Pharmaceutical solutions are one of the oldest and most widely used dosage forms in pharmacy. A solution is a homogeneous liquid preparation in which one or more substances (solutes) are completely dissolved in a suitable solvent or mixture of solvents. Because the drug is already in dissolved form, solutions provide rapid onset of action, uniform distribution of the drug and ease of administration. Solutions are commonly used for oral, topical, ophthalmic, otic, nasal and parenteral administration.

The preparations strong solution of ammonium acetate – IP, cresol with soap solution – IP and Lugol's solution – IP are examples of pharmaceutical solutions prepared in pharmacy laboratories. These formulations illustrate different principles of solution preparation such as neutralization, solubilisation and complex formation.

Characteristics of Pharmaceutical Solutions

- Homogeneous system.
- Drug is completely dissolved.
- Uniform distribution of ingredients.
- Rapid absorption and onset of action.
- Easy to administer and measure.
- Suitable for patients who have difficulty swallowing solid dosage forms.

Types of Pharmaceutical Solutions Based on Route of Administration

a. **Oral solutions:** Prepared for administration through the mouth, e.g., strong solution of ammonium acetate – IP.
b. **Topical solutions:** Applied externally on the skin, e.g., cresol with soap solution – IP.
c. **Ophthalmic solutions:** Sterile solutions intended for the eyes, e.g., eye drops.
d. **Nasal solutions:** Administered into the nasal cavity, e.g., nasal decongestant solutions.
e. **Otic solutions:** Used in the ear canal, e.g., ear drops.
f. **Parenteral solutions:** Sterile solutions administered by injection, e.g., intravenous fluids.

Excipients Used in Pharmaceutical Solutions

Category	*Function*	*Examples*
Solvents	Dissolve drug substances	Purified water, alcohol
Co-solvents	Improve solubility	Glycerine, propylene glycol
Preservatives	Prevent microbial growth	Methyl paraben, sodium benzoate
Buffers	Maintain pH	Acetate buffer, phosphate buffer
Antioxidants	Prevent oxidation	Sodium metabisulphite
Sweeteners	Improve taste	Sucrose, sorbitol
Flavours	Improve palatability	Peppermint oil, orange oil
Colorants	Improve appearance	Approved food colour
Solubilizers	Increase solubility	Soap, surfactants

Preparation Methods of Pharmaceutical Solutions

a. **Simple dissolution method:** The solute is directly dissolved in a suitable solvent with stirring, e.g., Lugol's solution – IP.

   Procedure: Potassium iodide is first dissolved in a portion of purified water with continuous stirring until a clear solution is obtained. Iodine is then added gradually to the potassium iodide solution while stirring continuously to facilitate its dissolution. Stirring is continued until all the iodine has completely dissolved and a clear, homogeneous solution is formed. Finally, sufficient purified water is added to make up the volume to the required quantity and the solution is mixed thoroughly to ensure uniformity.

b. **Chemical reaction method:** The desired product is formed by a chemical reaction between ingredients, e.g., strong solution of ammonium acetate – IP.

   Procedure: Dissolve ammonium carbonate in purified water and stir until clear. Add acetic acid slowly with continuous stirring to allow neutralization and formation of ammonium acetate. Finally, make up the volume with purified water and mix thoroughly to obtain a uniform solution.

c. **Solubilisation method:** An otherwise insoluble substance is dissolved using a solubilizing agent, e.g., cresol with soap solution – IP.

   Procedure: Dissolve the soap in a portion of purified water with stirring. Add cresol gradually while continuously stirring until a uniform solution is obtained. Finally, make up the volume with purified water and mix thoroughly to ensure complete dispersion.