Aerosols and Foams
Chapter 14
ANSEL'S Pharmaceutical Dosage Forms and Drug Delivery Systems
Eleventh Edition

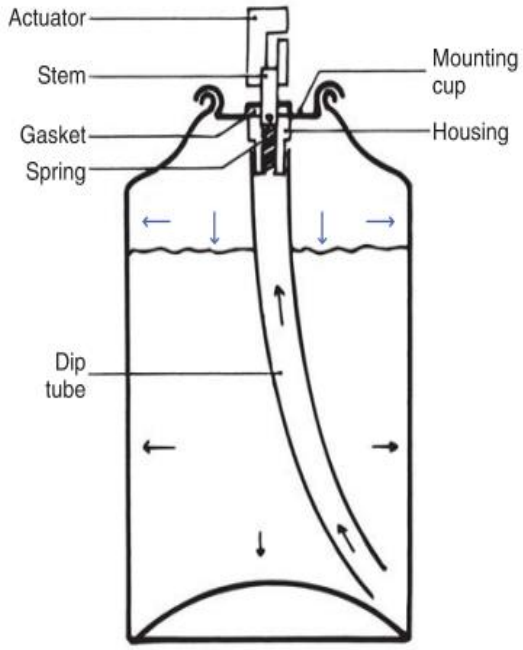
Objectives:
After reading this topic, the student will be able to:

- Define aerosols
- Understand the types and applications of aerosols
- Identify the main advantage of aerosols
- Define foams
- Explore the types and applications of foams
- Identify the main advantage of foams
- Differentiate between aerosols and foams

Pharmaceutical Aerosols

Pharmaceutical aerosols are **pressurized systems** that, **upon valve actuation**, emit a fine dispersion (either **continuous or metered)** of liquid and/ or solid materials containing one or more active ingredients in a gaseous medium.

Pharmaceutical aerosols are similar to other dosage forms because they require the same types of considerations with respect to formulation, product stability, and therapeutic efficacy. However, pharmaceutical aerosols unlike other dosage forms differ in their dependence upon the function of the container, its valve assembly, and an added component the propellant-for the physical delivery of the medication in proper form.



The term **pressurized product.**

- Pressure is applied to the aerosol system through the use of one or more liquefied or gaseous propellants.
- Upon activation of the valve assembly of the aerosol, the pressure exerted by the propellant forces the contents of the package out through the opening of the valve.
- The physical form in which the contents are emitted depends on the formulation of the product and the type of valve.

Aerosol products may be designed to expel their contents as a fine mist; a coarse, wet, or dry spray; a steady stream; or a stable or a fast-breaking foam. The physical form selected for a given aerosol is based on intended use.

There are two types of aerosols.

1. ***Space sprays***

Aerosols used to provide an **airborne** mist**.**

For example, **inhalation therapy,** as in the treatment of asthma or emphysema, must present particles in the form of a fine liquid mist or as finely divided solid particles. Particles less than 6 μm will reach the

respiratory bronchioles, and those less than 2 μm will reach the alveolar ducts and alveoli, also, room disinfectant's, room deodorizers fall in this list

The particle size of the released product is generally quite small, usually below 50 μm, and must be carefully controlled so that the dispersed droplets or particles remain airborne for a long time.

The valve opening is small, so the particle released are of small size.

The formulation is either solution or suspension.

2. ***Surface sprays* or *surface coatings.***

Aerosols intended to carry the active ingredient to a surface of the body (**dermatologic aerosols**). Included in this group many cosmetic preparations like personal deodorant sprays,

By contrast, the particle size for a dermatologic spray intended for deposition on the skin is coarser and generally less critical to the therapeutic efficacy of the product. Some dermatologic aerosols present the medication in the form of a powder. a wet spray, a stream of liquid (usually a local anaesthetic), or an ointment-like product.

Property	Space Sprays	Surface Sprays
Product Concentrate (%)	2 – 20	20 – 75
Propellant (%)	70 – 98	25 – 80
Pressure (psig at 20°C)	30 – 40	25 – 55
Particles (μm)	<1 – 50	50 – 200

Types of Aerosols According to The Route of Administration

1. Inhalation aerosols, commonly known as metered-dose inhalers (MDIs), are intended to produce fine particles or droplets for inhalation through the mouth and deposition in the pulmonary tree. The design of the delivery system is intended to release measured quantities and of the appropriate quality of the active substance with each actuation.
2. Nasal aerosols, commonly known as nasal MDIs, produce fine particles or droplets for delivery through the nasal vestibule and deposition in the nasal cavity. Each actuation of the valve releases measured mass and appropriate quality of the active substance.

3. Oral (buccal and sublingual aerosols are intended to produce fine particles or droplets for deposition on the surface of the tongue. The design of the delivery system releases one dose with each actuation.
4. Topical aerosols produce fine particles or droplets for application to the skin. Topical aerosol drug products may be designed, as needed. to deliver a metered amount of formulation upon actuation of the designed valve or continuous release of formulation during depressed status of the valve.

Advantages of Aerosols

The main advantages of aerosols are:

1. The use of aerosols provides the patient a means of applying the drug in a convenient manner, to the desired surface area **without the use of the fingertips,** making the procedure less messy than with most other types of topical preparations. The rapid evaporation of the propellent also provide cooling and refreshing effect
2. The drug is withdrawn from the container without contamination or expose of the remaining material. If the product is sterile, sterility can be maintained throughout the product's shelf life.
3. Protect the medicinal agent from environment oxygen and light because the container is opaque
4. The formulation and the valve control may affect the physical form and particle size of the emitted product therefore the efficacy of the aerosol especially in MDI
5. Application is a clean process (no need for wash after application)

The Aerosol principle

An aerosol formulation consists of two components:

1. The **product concentrate** is the active drug combined with additional ingredients or co-solvents required to make a stable and efficacious product. The concentrate can be a solution, suspension, emulsion, semisolid, or powder, in addition to solvents and surfactant and antioxidants to prepare a stable and efficient product.
2. The **propellant** provides the force that expels the product concentrate from the container and additionally is responsible for the delivery of the formulation in the proper form.
    A. Provide the driving force to expel the product from the container
    B. Responsible for developing proper pressure inside the container

Types of propellent

Type I - Propellent A Liquefied Gas

a- Oral and Inhalation (fluorinated HC) Cl_3 F C, Cl_2 F_2C

b- Topical Pharmaceutical Aerosol (HC) propane, butane

When the propellant is a liquefied gas or a mixture of liquefied gases, it can also serve as the solvent or vehicle for the product concentrate.

They are immiscible with water and have a density less than 1.

When the propellant is in the external phase, foams are not created but sprays or wet streams result.

The propellent exist as liquids under pressure, but also as gas in the head space. As the valve is opened some of the liquid propellent turn to gas to keep the head space full of gas. The pressure in the container remains essentially constant.

Type II Propellent B Compressed Gas N_2, CO_2

Compressed gas propellent occupy the head space above the liquid in the container. When the aerosol valve is opened the gas pushes the liquid out of the container

The amount of gas in the headspace remains the same but it has more space and as a result the pressure will drop during the life of the product

Spray performance is maintained by careful choice of the aerosol valve and actuator.

Aerosol container and valve assembly

The effective of a pharmaceutical aerosol depends on achieving the proper combination of formulation, container, and valve assembly.

A. **Containers are** made of a) glass b) metals tin plated steel, aluminium, stainless steel and c) plastic
   Selection depends formula compatibility, ability to sustain the required pressure, and cost.
B. **Valve assembly** allows expulsion of the contents in the desired form at the desired rate and for metered valves the proper amount, **they are two types**
   Continuous used in topical applications
   Metered used for inhalation of potent medication

Pump spray

Pump spray means a packaging system in which the product ingredients within the container are **not under pressure** and in which the product is expelled only while a pumping action is applied to a button, trigger or other actuator **manually** on the pump to deliver the product in the form of a spray.

Use of special actuator according to the site of administration

Pharmaceutical Foams

A foam is a coarse dispersion of a **gas in a liquid.**

Foams are emulsified systems packaged in special dispensing devices that contain dispersed gas bubbles, usually in a liquid continuous phase, that when dispensed has a fluffy, semisolid consistency. The foams are generally o/w emulsions resembling light creams. They are water miscible and non-greasy.

The product **concentrate** in an emulsion consists of the active ingredient, aqueous and/or non-aqueous vehicles, and a surfactant.

Foams are produced when the product concentrate is dispersed throughout the propellant and the gas is in the internal phase, i.e., the emulsion behaves like o/w emulsions.

Advantages of foams

Probably the most convincing argument for the use of foams

1) Foam formulations are generally easier to apply, are less dense, and spread more easily than other topical dosage forms,
2) Used **without the use of fingertips** especially for places hard to reach (vagina, rectal) or that cause irritation when applied (for burn dressing)
3) Patient and consumer acceptance because it is easy to use.
4) Foams may be formulated in various ways to provide emollient or drying functions to the skin, depending on the formulation constituents.

Product concentrate

In addition to the formula components, the main constituents that differentiate foams are surfactants such as:

1. Anionic surfactants: Fatty acids saponified with triethanolamine,
2. Nonionic surfactants: such as the Polyoxyethylene fatty esters, Polyoxyethylene sorbitan esters (Tweens) , alkyl phenoxy ethanol, and alkanolamide.

The nonionic surfactants are present fewer compatibility problems because they charge no electronic charge

Types of Foams

1) Foam Type 1 Breaking Foam

- A quick **breaking foam** creates a foam when emitted from the container but the foam collapses in a relatively short time.
- This type of foam is used to apply the product concentrate to a large area without having to manually rub or spread the product. Also, the

active drug is more rapidly available because the foam quickly collapses.

2) **Foam Type 2 Stable Foam**
   Depending on the components, the emitted product can be a stable foam (shaving cream type)
   Stable foams are produced when surfactants are used that have limited solubility in both the organic and aqueous phases.
   Surfactants concentrate at the interface between the propellant and the aqueous phase forming a thin film referred to as the "lamella." It is the specific composition of this lamella that dictates the structural strength and general characteristics of the foam.
   Thick and tightly layered lamellae produce very structured foams, which are capable of supporting their own weight.

Site of application of foams

A. Topical Foams
B. Vaginal Foams
   The foams are used intravaginally in the same manner as for creams, using a special type of applicator
   The aerosol package contains an inserter that is filled with foam and the contents placed in the vagina through activation of the plunger.
C. Rectal Foams are usually stable foams.

Packaging of foams

Foam valves have only one orifice that leads to a single expansion chamber. The expansion chamber also serves as the delivery nozzle or applicator. The chamber is the appropriate volume to allow the product concentrate to expand into a ball of foam. Foam valves are used for viscous product concentrates such as creams and ointments because of the large orifice and chamber. Foam valves also are used to dispense rectal and vaginal foams. If the size of the orifice and expansion chamber are appropriately reduced, a product concentrate that would produce a foam will be emitted as a solid stream. In this case, the ball of foam begins to develop where the stream impinges on a surface.

Types of packaging

a) Aerosol Foam pressurised containers which contain propellent which aid in expulsion of the product concentrate
b) Foam Pump without the use of propellent but special type of valve and actuator