Pills & Python

Pharmacy · Data · AI · Healthcare

BP504T

Pharmaceutical Dosage Forms II

Unit IV — Pressurized Dosage Forms (Aerosols, MDIs & DPIs)

B.Pharm · Semester V · Theory notes

Syllabus coverage: UNIT IV (6 hours).

From-zero teaching standard: every technical term is defined before use.

Instagram @pillsandpython · pillsandpython.com · YouTube @PillsAndPython

CHAPTER 5 — AEROSOLS, MDIS & DRY POWDER INHALERS

Chapter 5 · Aerosols, MDIs & Dry Powder Inhalers

Learning Objectives

1. Define aerosols and explain their concepts and advantages.
2. Classify propellants and explain propellant selection.
3. Describe valves and containers used in pressurised packs.
4. Describe formulation, manufacturing and QC of aerosols/MDIs (leak test, spray pattern, delivered dose, particle-size/aerodynamic performance).
5. Describe DPIs: containers, formulation, manufacturing and QC.

Key definitions

- Aerosol (pharmaceutical): a pressurised dosage form in which the drug is dispensed as a fine mist, foam or spray using a propellant.
- MDI (Metered-Dose Inhaler): a pressurised inhaler that delivers a fixed, metered dose of drug to the lungs with each actuation.
- Propellant: a liquefied gas that provides the pressure to expel the product and helps atomise it into fine droplets/particles.
- DPI (Dry Powder Inhaler): a device that delivers drug as a dry powder, using the patient's own inhalation breath as the energy source (no propellant).
- Actuation: one press/release of the inhaler delivering one dose.

Terminology at a glance

Term	Simple meaning
Metering valve	Valve that releases exactly one measured dose per puff
Continuous valve	Valve that sprays as long as pressed
Delivered dose	Amount of drug actually leaving the mouthpiece per actuation
Spray pattern	Shape/size of the spray plume on a target
Aerodynamic performance	How well particles fly and deposit in the lungs (fine particle fraction)
Leak test	Checking that the pressurised container does not lose propellant
Carrier	Inert powder (e.g., lactose) that carries tiny drug particles in DPIs

Explanations

5.4.1 Concepts and advantages

Pressurised packs deliver the drug directly to the site (lungs, skin, nose) in a fine, uniform spray. Advantages: rapid action (inhaled drugs reach blood quickly), targeted delivery with lower doses, no contamination of remaining product (sealed system), convenient and portable.

5.4.2 Propellant classification

1. Liquefied gases: exist as liquid under pressure inside the container and vapour above it (e.g., hydrofluoroalkanes — HFAs; earlier chlorofluorocarbons — CFCs, now phased out for ozone damage).
2. Compressed gases: remain as gas (e.g., nitrogen, carbon dioxide, nitrous oxide) — used where liquefied gases are unsuitable.

Simple picture: liquefied-gas propellants are like a sealed soda bottle — liquid below, fizz above, keeping pressure steady until the last puff.

5.4.3 Propellant selection

- Must be non-toxic and non-irritant for inhalation use.
- Must not react with the drug or container.
- Vapour pressure must suit the product (enough to atomise, not so high as to be unsafe).
- Environmentally acceptable (CFCs were replaced by HFAs because CFCs damaged the ozone layer).
- Boiling point and density compatible with the formulation.

5.4.4 Valves & containers

- Metering valves: deliver a fixed volume (e.g., 25–100 µL) per actuation — used in MDIs.
- Continuous valves: spray while pressed — used in topical sprays.
- Containers: metal (aluminium, tin-plated steel) or glass (for low pressure); must withstand internal pressure; inner coating prevents drug–metal interaction.
- Actuator/mouthpiece: shapes the spray and directs it.

5.4.5 Formulation

- Solution aerosols: drug dissolved in propellant/co-solvent.
- Suspension aerosols (most MDIs): micronised drug particles suspended in propellant with surfactants to prevent clumping.
- Excipients: co-solvents, surfactants, antioxidants, flavours (for oral MDIs).

5.4.6 Manufacturing

1. Prepare the drug concentrate (solution or suspension).
2. Fill concentrate into open containers; crimp the valve.
3. Pressure-fill or cold-fill the propellant through/under the valve.
4. Check weight; leak-test; label and pack.

Strict controls: moisture exclusion (for suspension MDIs), cleanliness, and accurate valve crimping.

5.4.7 QC tests

1. Leak test: filled containers are checked for weight loss over time (propellant leakage) — often by storing in a water bath and watching for bubbles, or by precise weighing.
2. Spray pattern: the shape and uniformity of the spray on a target plate; must be consistent.
3. Delivered dose uniformity: each actuation must deliver the labelled dose within limits (tested at beginning, middle and end of container life).
4. Particle-size / aerodynamic performance: measured with cascade impactors; the fine particle fraction (particles small enough to reach the deep lung, roughly < 5 µm) must meet specification.

5. Number of actuations: container must deliver at least the labelled number of doses.
6. Appearance, assay, microbial limits as applicable.

Worked numerical:

An MDI is labelled 120 actuations, 100 µg per actuation. Total drug = 120 × 100 µg = 12,000 µg = 12 mg. If QC finds the average delivered dose is 95 µg, the percentage of label claim = (95/100) × 100 = 95%.

5.4.8 Dry Powder Inhalers (DPIs)

- Concept: the patient breathes in forcefully; the airflow fluidises and de-aggregates the powder, carrying it to the lungs. No propellant, no coordination of press-and-breathe needed (easier for many patients).
- Containers: capsules, blisters, or reservoirs holding pre-metered powder doses; device includes a piercing/opening mechanism.
- Formulation: micronised drug blended with a coarse carrier (usually lactose) which improves flow and helps the tiny drug particles detach during inhalation; sometimes engineered particles without carrier.
- Manufacturing: micronization, ordered blending with carrier, filling into capsules/blisters under low-humidity control, device assembly.
- QC: delivered-dose uniformity, aerodynamic particle-size distribution (fine particle fraction), moisture content (critical — moisture ruins powder flow), device resistance/function, number of doses.

MDI vs DPI comparison

Feature	MDI (pressurised)	DPI
Energy source	Propellant	Patient's breath
Coordination needed	Press and breathe together	Breathe in hard
Propellant	Yes (HFA)	None
Moisture sensitivity	Moderate	High (powder must stay dry)
Cold/Freon effect	Possible throat sensation	None

Classifications

- Aerosols by use: inhalation, nasal, topical, oral.
- Propellants: liquefied gases vs compressed gases.
- Valves: metering vs continuous.
- Inhalers: MDI vs DPI.

Mechanism / how it works

- MDI actuation: pressing opens the metering chamber; propellant flashes to vapour, atomising the drug into fine droplets that evaporate to leave respirable particles.
- DPI dispersion: inspiratory airflow lifts the powder bed; carrier–drug agglomerates collide with device grids, stripping drug particles off the carrier into the airstream.

Diagram to draw

1. MDI cross-section: canister, metering valve, actuator, mouthpiece; label the metering chamber.
2. DPI: capsule/blister, piercing pins, airflow path, mouthpiece.
3. Cascade impactor: stages collecting progressively smaller particles.

Process flow

MDI manufacture:

Prepare concentrate -> fill into cans -> crimp valve -> fill propellant (pressure/cold fill) -> check fill weight -> water-bath leak test -> label -> QC (spray pattern, delivered dose, aerodynamic performance) -> pack.

One-glance summary

One-glance summary

PRESSURISED DOSAGE FORMS — one glance

- Aerosol/MDI: drug + propellant (HFA) in a sealed can · metered valve = fixed dose per puff
- [EXP] Propellants: liquefied gases (HFA) vs compressed gases (N_2, CO_2) · CFCs phased out (ozone)
- [QC] QC: leak test · spray pattern · delivered-dose uniformity · fine particle fraction · actuation count
- DPI: no propellant · patient's breath disperses powder · drug on lactose carrier · keep DRY
- [TARGET] Target: particles < ~5 µm reach deep lung

Tables

Test	What it checks
Leak test	Propellant/container integrity (weight loss, bubbles)
Spray pattern	Plume shape and uniformity
Delivered-dose uniformity	Each puff = label claim, through container life
Aerodynamic performance	Fine particle fraction via cascade impactor
Actuation count	At least the labelled number of doses
Moisture (DPI)	Powder flow and dispersion quality

Examples

1. Salbutamol MDI: relieves asthma attacks within minutes.
2. Topical antifungal spray: covers skin evenly without touching.
3. Capsule-based DPI: patient loads a capsule, pierces and inhales.

Think of it this way

- An MDI is like a deodorant spray — press, and a measured mist comes out.
- A DPI is like blowing the fluff off a dandelion — your breath does the work.
- The metering valve is like a fixed-size spoon that always scoops the same amount.

Pharmacy relevance

Pharmacists must teach inhaler technique (shake MDI, breathe out, seal lips, press-and-breathe slowly, hold breath; for DPI, breathe in hard and fast) — wrong technique is the commonest cause of treatment failure.

India context

Asthma and COPD inhalers are widely prescribed in India; pharmacists demonstrating correct technique at dispensing measurably improves disease control.

Key points

1. Aerosols/MDIs use propellants (HFAs) to deliver metered doses as fine sprays.
2. Propellant choice: non-toxic, compatible, right vapour pressure, eco-friendly.
3. Valves: metering (MDI) vs continuous (sprays); containers must withstand pressure.
4. QC: leak, spray pattern, delivered dose, aerodynamic performance, actuation count.
5. DPIs use the patient's breath; drug on lactose carrier; moisture is the enemy.

Common confusions

- MDI vs DPI: MDI needs press-and-breathe coordination and contains propellant; DPI needs a hard fast inhalation and has no propellant.
- Delivered dose vs metered dose: metered dose is what the valve measures; delivered dose is what actually exits the mouthpiece (slightly less).

Common mistakes

1. Not shaking a suspension MDI before use.
2. Storing DPIs in humid bathrooms.
3. Firing an MDI into the air to "test" it repeatedly (wastes doses).

Mnemonics

- "Leak-Spray-Dose-Size-Count" — aerosol QC tests.
- "Breathe HARD for DPI, press-BREATHE slow for MDI" — technique.

Exam summary

Pressurised dosage forms deliver drugs as fine sprays using propellants. HFAs replaced CFCs. Metering valves give fixed doses; containers withstand pressure. QC covers leak, spray pattern, delivered-dose uniformity, aerodynamic performance and actuation count. DPIs are propellant-free, breath-actuated devices with drug on a carrier, where moisture control is critical.

One-minute revision

MDI = propellant + metered valve + shake + press-breathe. QC: leak, spray, dose, particle size, count. DPI = breath-powered, lactose carrier, keep dry. Fine particles <5 µm reach lung.

Exam questions

Short answers:

1. Define MDI and DPI with one example use each.
2. Classify propellants with examples.
3. What factors guide propellant selection?
4. List the QC tests for MDIs.
5. Why is moisture critical in DPIs?

Long answers:

1. Describe the formulation, manufacturing and quality control of metered-dose inhalers.
2. Write notes on: (a) propellants, (b) dry powder inhalers.

MCQs:

1. CFCs were replaced by HFAs because CFCs: (a) Are costly (b) Damage the ozone layer (c) Are weak (d) Taste bad — Answer: (b)
2. A metering valve delivers: (a) Continuous spray (b) A fixed dose per actuation (c) Powder (d) Gas only — Answer: (b)
3. The energy source in a DPI is: (a) Propellant (b) Patient's breath (c) Battery (d) Spring — Answer: (b)
4. Fine particle fraction is measured by: (a) pH meter (b) Cascade impactor (c) Thermometer (d) Viscometer — Answer: (b)
5. Lactose in DPIs acts as a: (a) Drug (b) Carrier (c) Propellant (d) Preservative — Answer: (b)

Viva:

1. Why must suspension MDIs be shaken before use?
2. What is the "cold Freon effect"?

Application-based:

1. A patient's asthma remains uncontrolled despite regular MDI use. List the technique checkpoints you would assess and correct.

References