
Naturally propelled aerosols

Past, present and future

Cláudia Silva – Head of R&D



What?

- Naturally propelled aerosols are aerosols propelled by Nitrogen
- Nitrogen is a compressed gas
- 78% of the air is Nitrogen so nitrogen is not ozone depleting
- Nitrogen is inert. It is harmless and a non-flammable propellant.
- The price of nitrogen is almost negligible.
- The spray is almost silent

Examples of Products on the Market

Deodorants					Dry Shampoos		Face Sprays			
										
75ml	100g	100ml	125ml	3.2 Oz	142g	43g	50ml	150g	300ml	

Naturally propelled = Propelled by Nitrogen

Why?

Sustainability



Though we often think about human-induced climate change as something that will happen in the future, Ecosystems and communities around the world are being impacted today.

Quality & safety

P&G Recalled More Than 30 Dry Shampoo Sprays Due to Benzene Contamination

By [Michelle Llamas, BCPA](#)
Edited By [Sophia Clifton](#)
Last Modified: *March 11, 2022*

This page features
[3 Cited Research Articles](#)


Bayer Lotrimin® And Tinactin® Benzene Lawsuits

Posted: October 8, 2021

BAYER RECALLS SEVERE LOTS OF LOTRIMIN® AND TINACTIN® SPRAY PRODUCTS DUE TO BENZENE CONTAMINATION

Unilever Recalls Benzene-Tainted Antiperspirants, Cites Propellant

31 Mar 2022 | NEWS

 by [Ryan Nelson](#)
ryan.nelson@informa.com

Banana Boat Recalls Its Sunscreen Sprays Due to Benzene Contamination

The contamination has only affected a few batches of the Banana Boat Hair & Scalp Sunscreen Spray SPF 30.

 BY [GABI THORNE](#)
August 1, 2022

Cost

Nitrogen is inert. It is harmless and a non-flammable propellant. In the last year the cost of LPG more than doubled. The price of nitrogen is almost negligible



naturally propelled = Propelled by Nitrogen

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Why?

Access to certain markets with VOC restrictions

Consumer Products Regulation:

CARB looks to minimize harmful ingredients present specifically in consumer products. (For industrial applications, CARB defers to the air quality management districts under the Reducing Air Pollution - ARB Program described below.) For consumer products, the following California state legislation governs:

California Code of Regulations (CCR) Title 17, Division 3 Chapter 1 - Air Resources Board Subchapter 8.5 - Consumer Products

Article 1: Regulation for Reducing VOC Emissions from Antiperspirants and Deodorants

Article 1 covers only the antiperspirants and deodorants categories.

Article 2: Regulation for Reducing Emissions from Consumer Products

Article 2 covers numerous consumer products categories.

Article 2 is referred to as the **General Consumer Products Regulation**

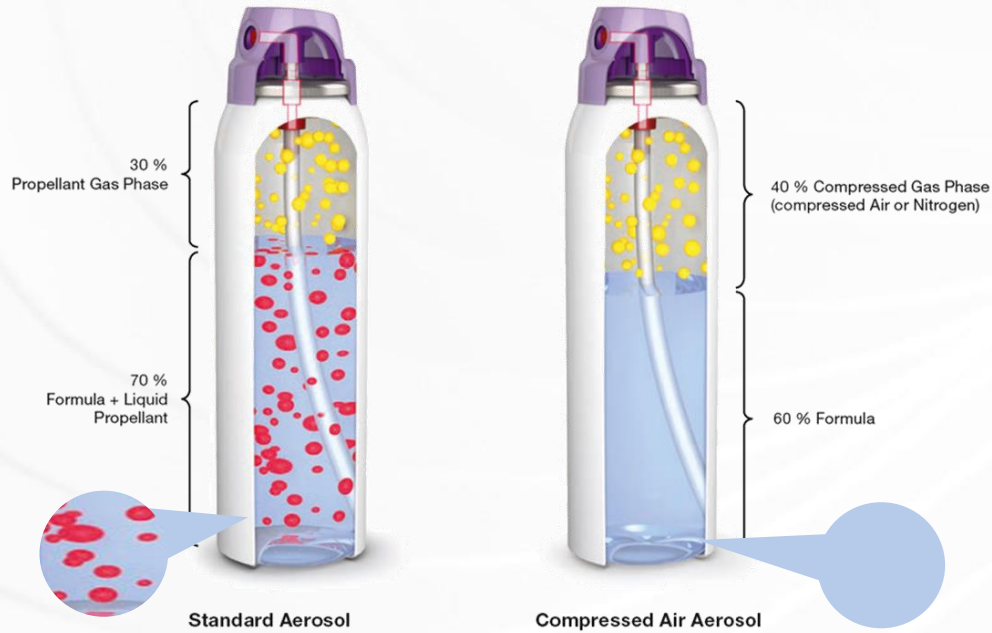
[Current Regulations](#) | [California Air Resources Board](#) | *naturallypropelled = Propelled by*

Opportunity to sell aerosols through e-commerce

Nitrogen is non-flammable

The screenshot shows an Amazon product page for 'SMELLS BEGONE Essential Oil Air Freshener Bathroom Spray'. The product is priced at \$9.45, down from \$9.95. The main image features a blue spray bottle with a white nozzle and a green label that reads '100% NATURAL PROPELLANT' and 'BREATHE HAPPY'. The product title is 'Febreze Air Freshener Spray, Heavy Duty Crisp Clean Scent, Odor Eliminator for Strong Odors, 8.8 Oz (Pack of 3)'. The product details section indicates the style is 'Heavy Duty' and the scent is 'Crisp Clean'. The page also shows a star rating of 4.5 out of 5 based on 22,953 ratings and 56 answered questions.

Comparison between Liquefied and compressed propellants



15-20% of can content is bulk

55-65 % of can content is bulk

More bulk filling needed and takes more time in use.

LPG: Max 90% brimful with liquid phase. Gen. 15-30% Bulk;

Compressed: Min. 55% brimful filled with Bulk

Max 65% brimful filled with Bulk



ADD 75/324/EEC; ISO 15008

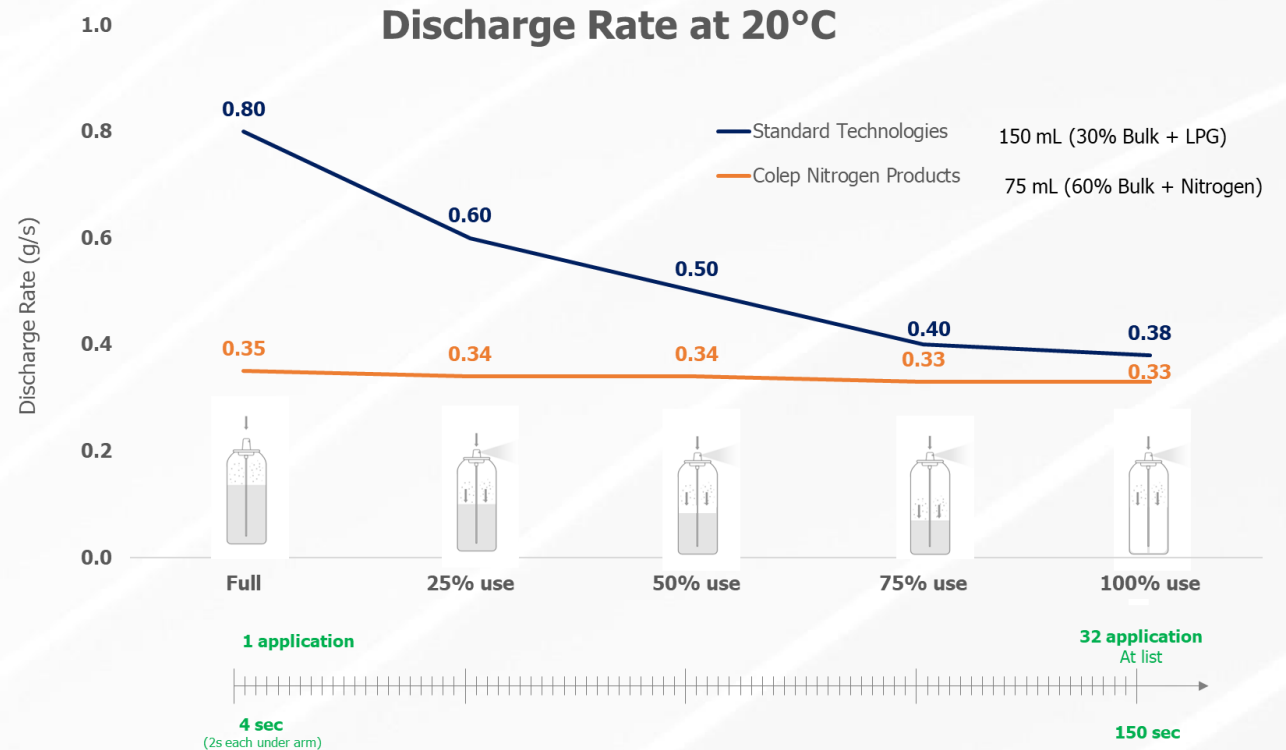
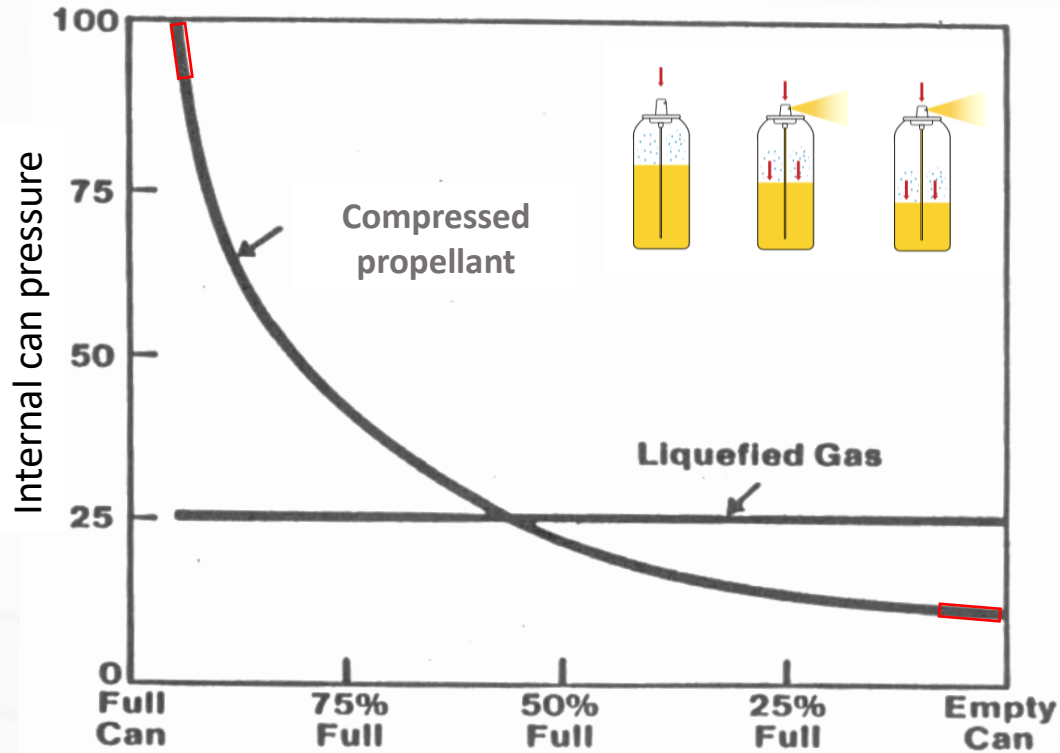
	LPG propellants	Compressed propellants
Mixture with the bulk	Mix with the bulk	Do not mix with the bulk
% Bulk	15-20%	55-65%
% Propellant	High	Very low
Pressure inside the can	Consistent Pressure through life of can.	Drop in pressure through life of can
Discharge rate	Reduces over time	Almost constant over time.
Effect of temperature on pressure	Large T changes affects pressure	T changes have little effects on pressure
Viscosity of the bulk	Low viscosity	Low viscosity
Cost	High and increasing cost	Negligible cost
Product use	We need to shake the can before use	No need to shake the can before use

Liquefied propellants (LPG): e.g. Chlorofluorocarbon (CFCs) Hydrocarbons, Butane, Propane, 152a, 134a, HFO1234ze

Compressed propellants: e.g. Nitrogen, Nitrous oxide, Carbon Dioxide

Comparison between Liquefied and compressed propellants

Pressure drop during discharge



This steady drop in pressure of nitrogen aerosols can be reduced:

- by using a higher initial pressure and
- by filling the can with little less bulk.

Also for each nitrogen aerosol product there is a right balance between pressure and filling volume in order to reduce the jet-like ejection (post-drooling effect) and the % of product that remains in the can in the end of use.

Comparison between Liquefied and compressed propellants

A 125ml nitrogen propelled deodorant = 2x 150ml LPG propelled deodorant

- How does that work?

Nitrogen Propelled Deodorant; 125ml/100g

Average spray rate

0,29 g/s

Product Phase weight

100 g

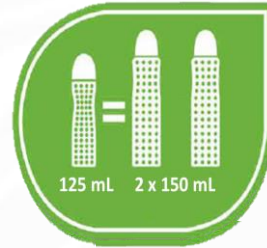
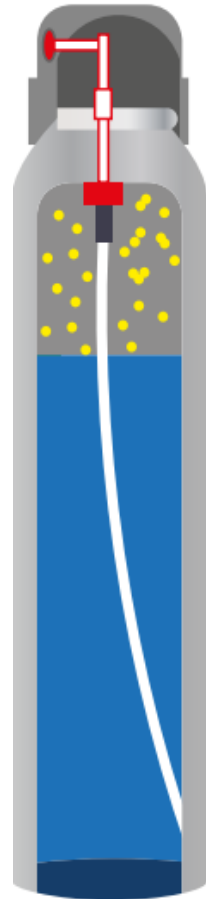
Estimated Time

$60.84s / 0.29 g/s = 209 \text{ sec}$
 $100 g / 0.29 g/s = 344 \text{ sec.}$

Estimated No. of Applications:

$344 \text{ sec} / 4 \text{ sec/app} = 86 \text{ applications}$
 Indicative Cost per application like **0.007€**

A 4 second application considers **2 seconds** under **each arm**



LPG Propelled Deodorant; 150ml/90g

Average spray rate

0,7 g/s

Product Phase weight

90g

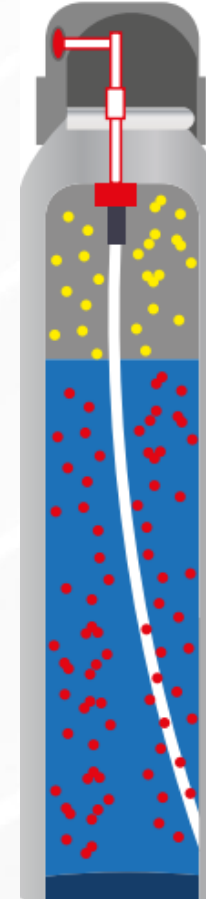
Estimated Time

$90g / 0.7g/s = 128 \text{ sec}$

Estimated No. of Applications:

$128 \text{ sec} / 4 \text{ sec/app} = 32 \text{ applications}$
 Indicative Cost per application like **0.01616€**

A 4 second application considers **2 seconds** under **each arm**



40% N₂

70% LPG

60% Bulk

30% Bulk



European ADD, Latam regulations

Comparison between Liquefied and compressed propellants

Spray Characteristics / Sensorial

LPG



Stronger and noisy spray
Faster drying
Cooling effect

Nitrogen



Gentle and almost silent mist;
Higher wet sensation
Not so cold sensation

Comparison between Liquefied and compressed propellants

Main technologies available for Compressed Propellants

The use of standard technologies with compressed propellants will result in a **non-consistent spray**. For this reason several suppliers have available technologies developed for compressed propellants.



- **Eco-Valve;**
- **Special Nozzle;**



- Regular Valve;
- **Special Nozzle;**



- Regular Valve;
- **Special Actuator;**
- **Special Nozzle;**
- **Special Dip Tube Device**

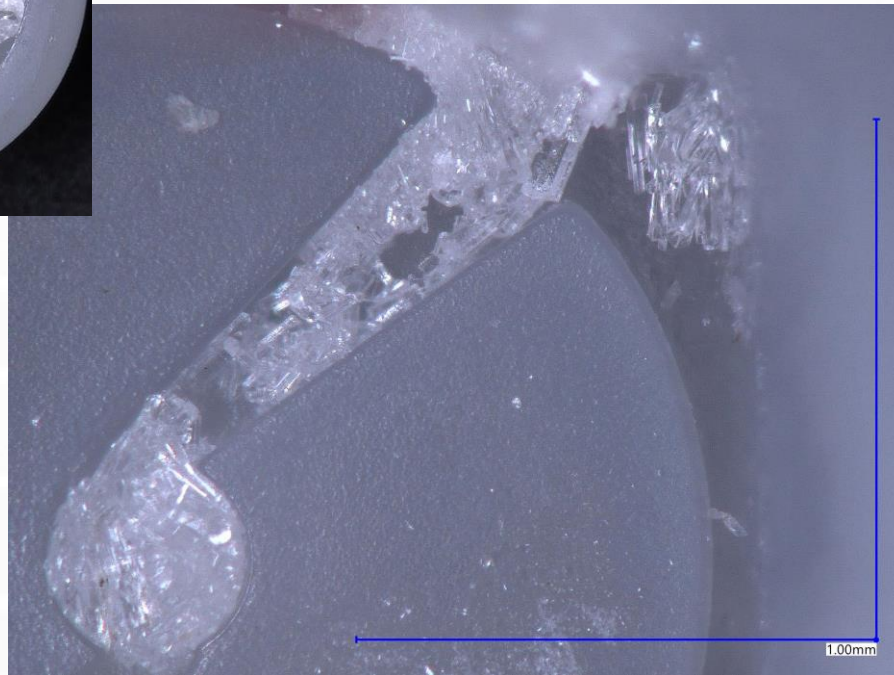
	LPG propellants	Compressed propellants
Orifice size of actuators	0.6 - 0.8 mm	0.15 - 0.20 mm



A small size orifice of the actuators is desired to reduce the particle size and the wet sensation.

But....there is a much higher risk of clogging when using compressed propellants.
Safety risk (Inhalation)

Risk of Clogging with Solid Particles



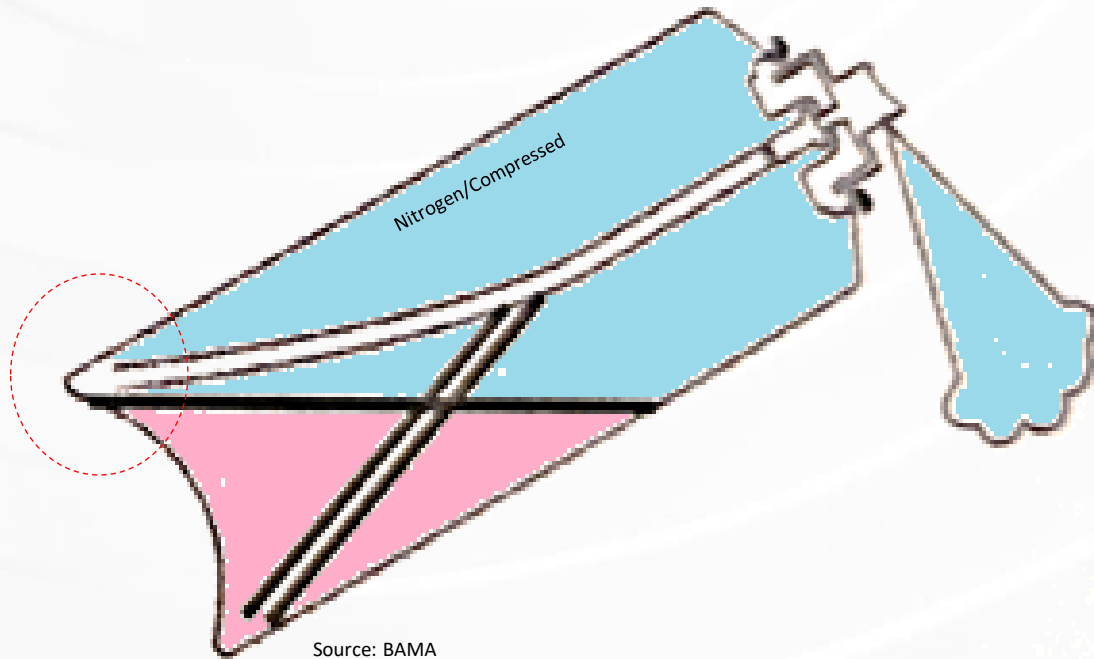
How to prevent clogging in naturally propelled aerosols?

- Not use powders in the bulk
- Avoid raw materials that can induce crystallization and /or use raw materials that prevent crystallization
- Avoid Polymers

Naturally propelled aerosols – current limitations

Risk of misuse by dip-tube inversion

- Aerosol cans can be used **upright** and with some special technologies can be used in a **180° application**.
- If the can is **sprayed obliquely or horizontally**, a large amount of gas can be lost through the valve “in advance” and the amount lost will not allow a good spraying and the residual pressure may not be sufficient for the consumer to finish the can.
- This can be prevented by putting very clear instructions on the label of the cans.

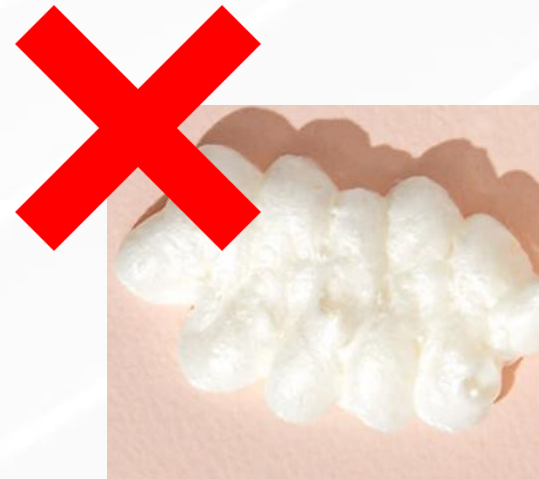


Naturally propelled aerosols – current limitations

Current technologies also do not yet allow to have:

Foams propelled by nitrogen

Viscous products propelled by nitrogen

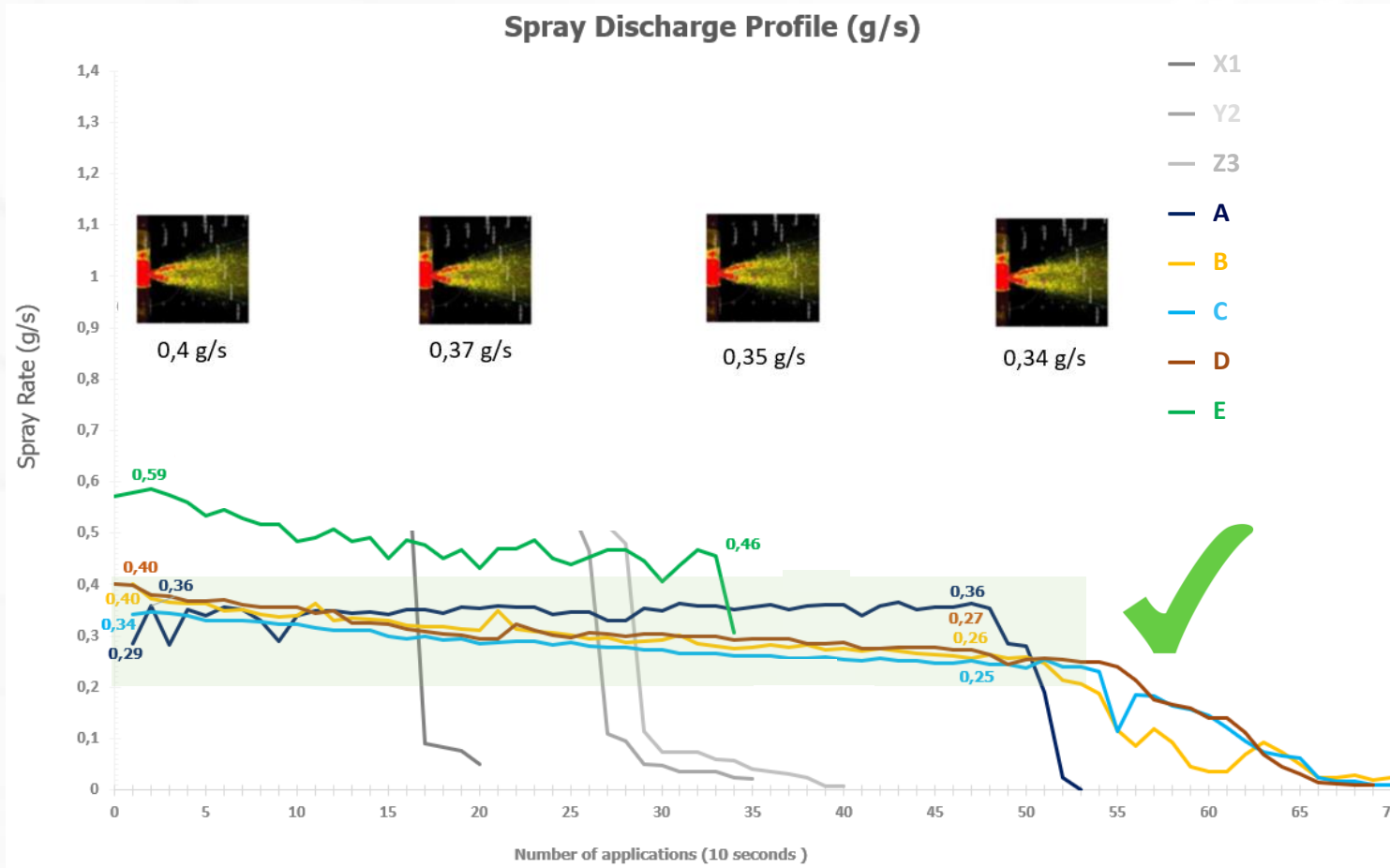


Naturally propelled aerosols – acceptance criteria

- **Spray Rate Profile** – Capacity to deliver actives and same sensorial during use of product;
- **Spray Pattern Profile** – Capacity to deliver the same sensorial during all product life and dryness;
- **Particle Size distribution** – Stable during use and non smaller than 10 microns;
Less than 10% smaller than 10 μm <PSD< No more than 100 μm ;
- **Residue inside the can** at the end of pressure;
Less than 3%
- **Number of applications** claim;
At list 2X same product size in LPG or equivalent to double filling volume in LPG (eg.: 75mL=150mL)

Naturally propelled aerosols – R&D @ Colep

Different technologies were evaluated, using the same bulk (Colep CP deo product)



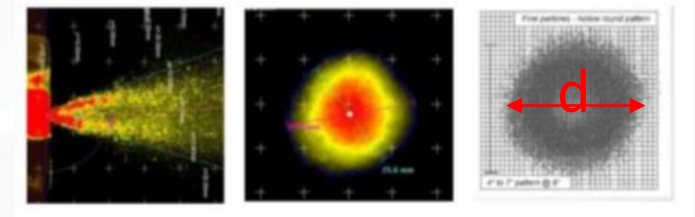
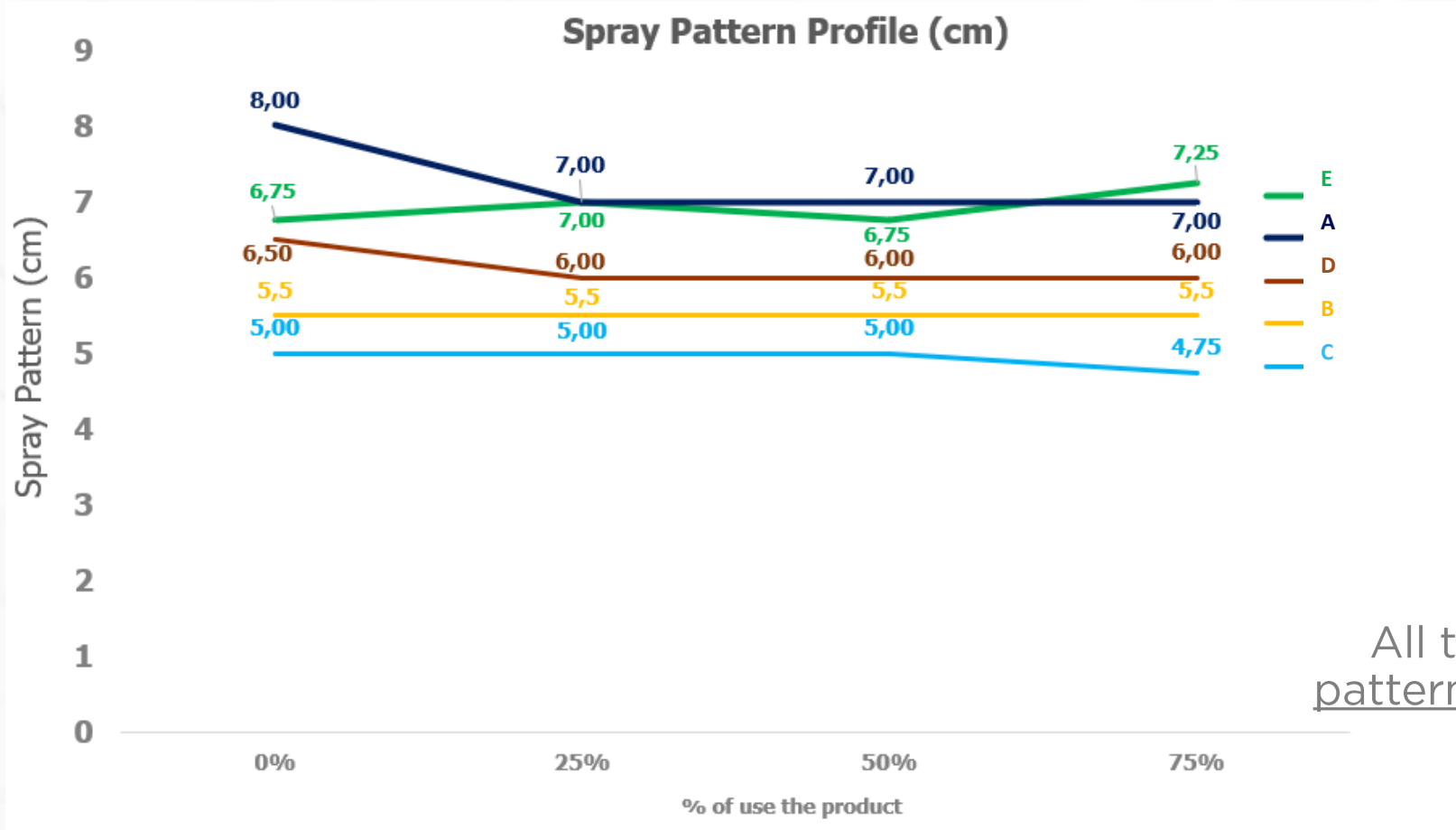
Stable sensorial and actives delivery during all use: **A-E**



Not stable delivery with technologies **X1; Y2; Z3**

Technologies **X1; Y2; Z3** were discarded. Technologies **A-E** were selected for further studies.

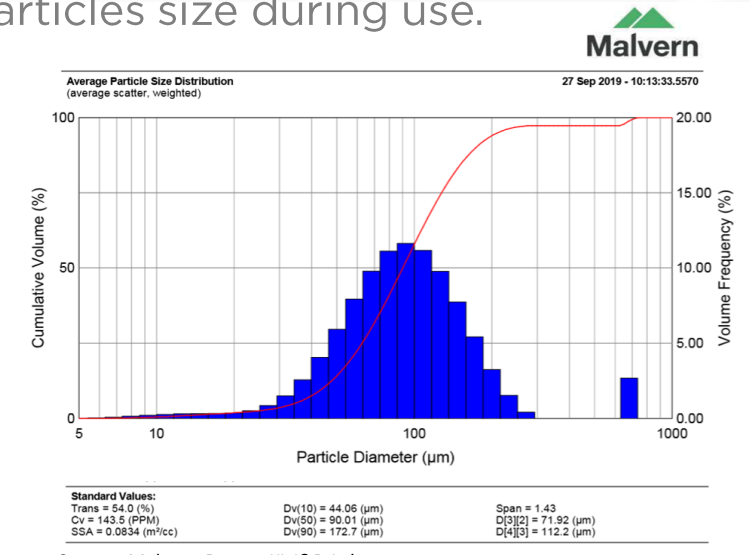
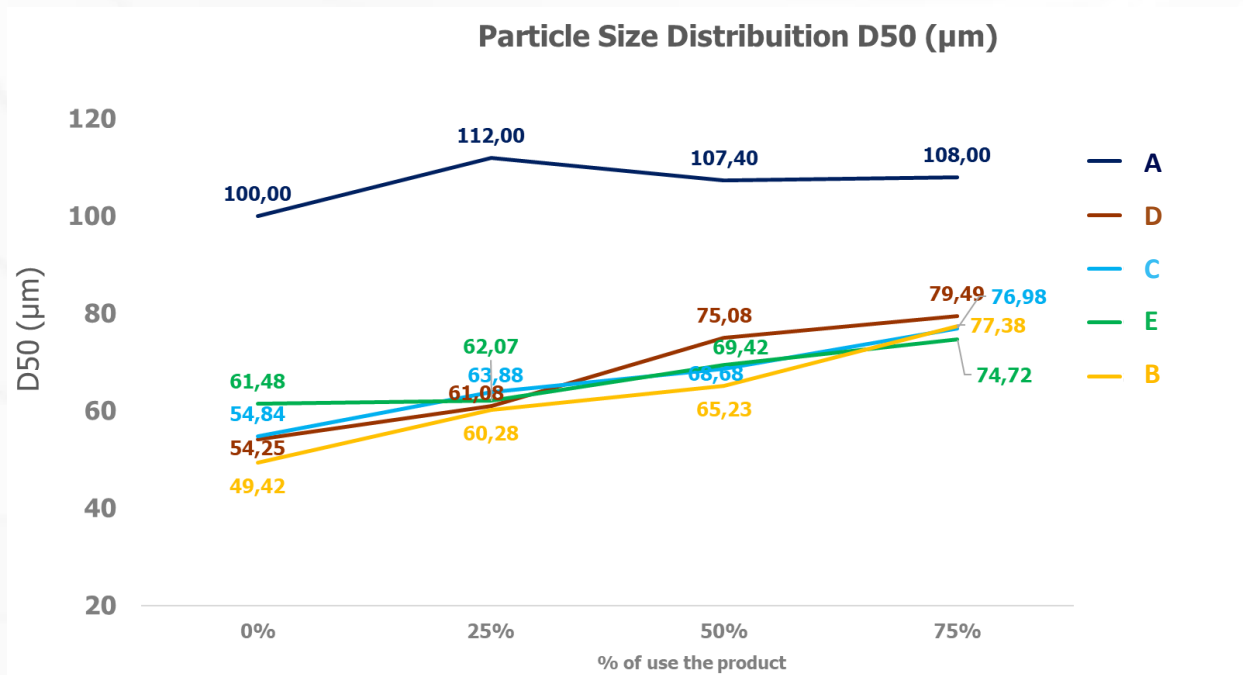
Spray Pattern Profile (Cone Diameter)



All technologies gave a stable spray pattern without post-drooling or jet mist.

Particle Size Distribution – Dryness Sensorial

All technologies demonstrated the capacity to keep stable the spray particles size during use.



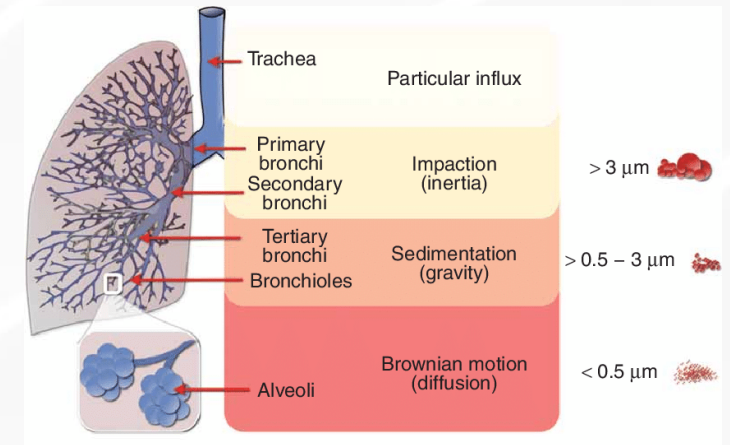
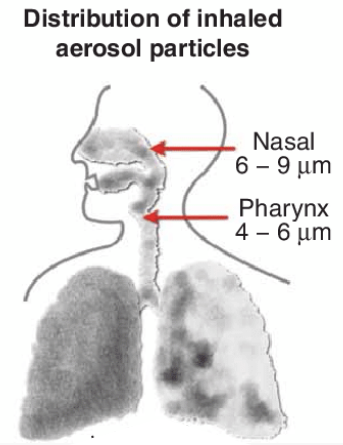
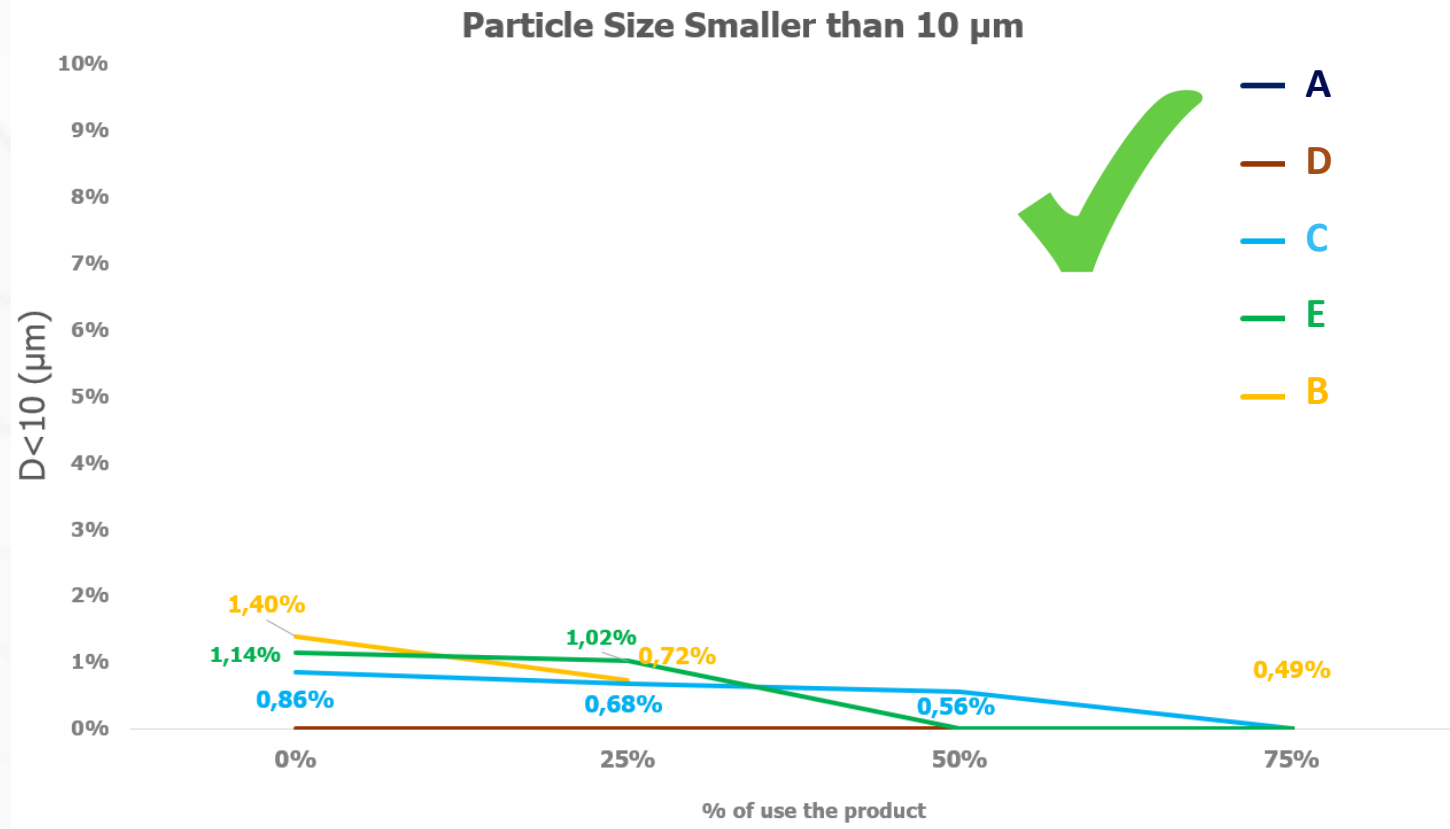
Source: Malvern Report KL I&D Lab

Technology A was the one with a higher particle size distribution – higher particle size, higher wet sensation



Particle Size Distribution - Safety

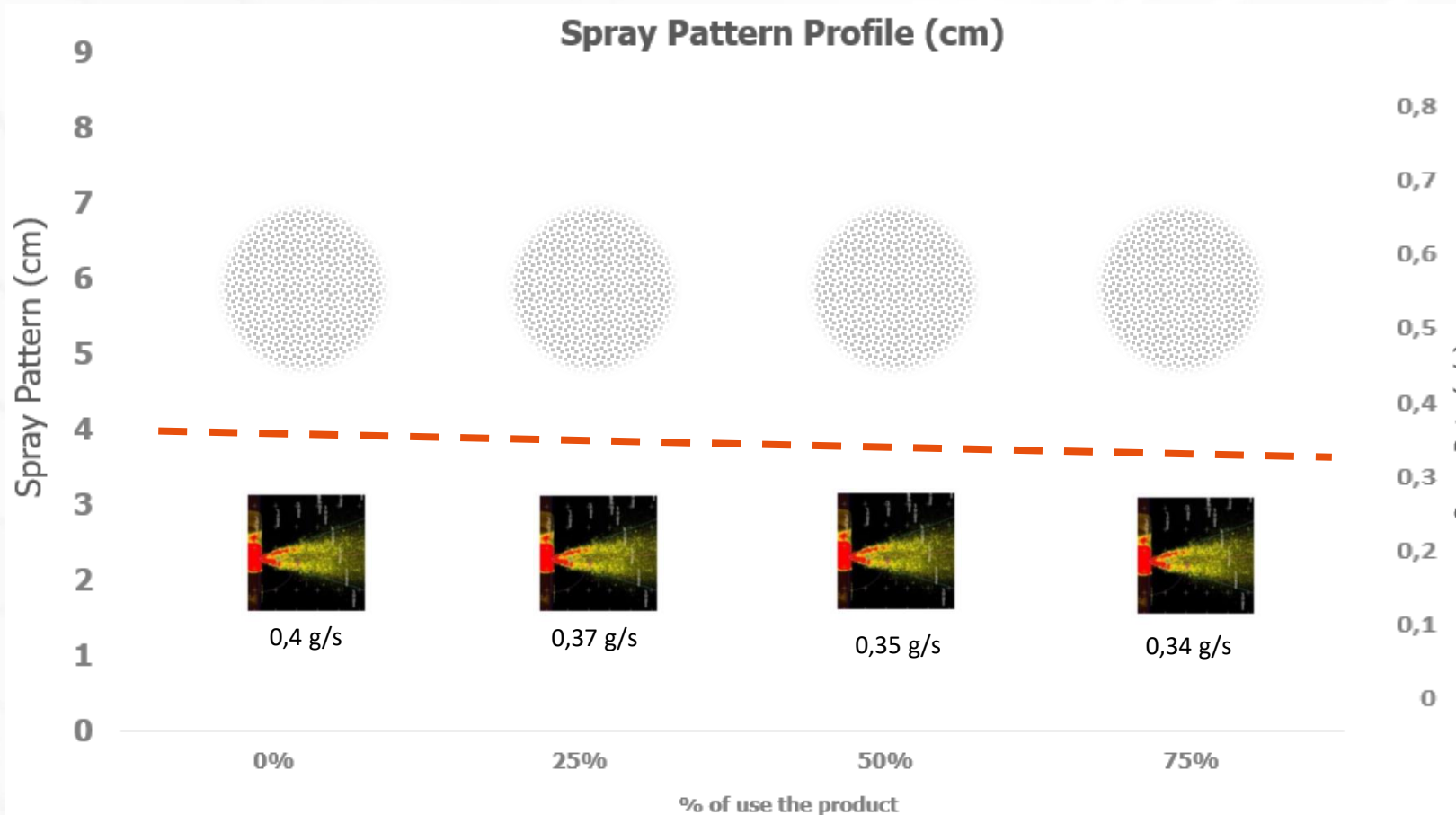
Only a maximum of 10% of particles with less than 10µm are allowed due to safety reasons.



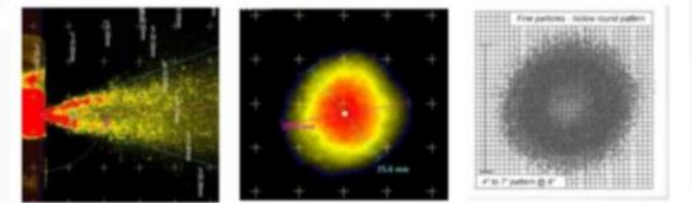
All technologies allow us to comply with the safety regulations.

Naturally propelled aerosols – R&D @ Colep

Stable Spray Pattern and Spray Rate was obtained with the selected technology (technology C)










Spray Rate (g/s)



Stable sensorial during the use and with similar Spray Pattern during use.

Naturally propelled aerosols - comparison between benchmarks

	Ushuaya L'oreal	Dove Unilever	Avène Pierre Fabre Dermo	Love Planet Unilever	Nivea Beiersdorf	Alterra Rossmann	Colep deo	Notes and conclusions
								
Region	Europe	Europe	Europe	USA	Europe	Europe	Europe	
Claim	Deo Brume	Eco Spray	Eau Thermale	Dry shampoo	Eco Deo	Natural Deo	Deo	
% Bulk	58%	55%	60%	15%	60%	55%	55%	
Content	125 mL	75ml	300 mL	45mL	125 mL	75ml	75mL	
Spray Delivery Rate Speed of delivery product per second	0.8 g/s	0.58 g/s	0.78 g/s	0.84 g/s	0,4 - 0,5 g/s	0.47 g/s	0.35 g/s	Higher spray rate provides stronger spray but wetter sensorial (more product delivered). Colep product is the one with the smaller wet sensation.
Total Discharge Time Spray until empty	220 seconds	100 seconds	480 seconds	50 seconds	330 seconds	140 seconds	150 seconds	
PSD AVG Particle Size Distribution D50	140 µm	120 µm	140 µm	160 µm	70 µm	70 µm	50 µm	Smaller particles help to reduce the wetting sensation. Colep product is the one with smaller PSD AVG - smaller wet sensations

Naturally propelled aerosols – What do we need to move to the next level?

Packaging suppliers

- New valves for: powders, foams and viscous products.

Raw materials suppliers

- Liquid versions of powder raw materials
- New raw materials able to increase the speed of drying upon application.

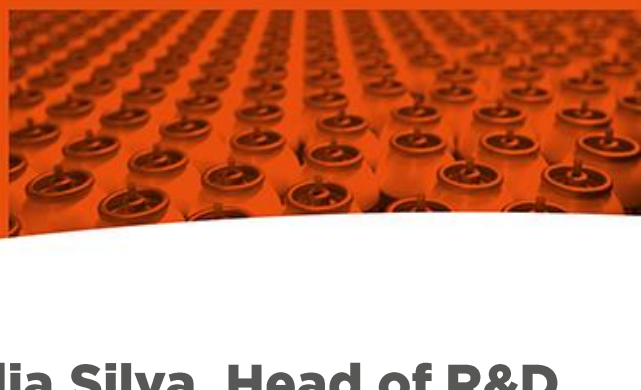
Summary/conclusions

- Currently NITROGEN, as a propellant, is a **sustainable** option for aerosols. Because it's a **compressed gas**, a nitrogen propelled product lasts up to **3 times longer** than a standard LPG product (depending on the product).
- Naturally propelled aerosols **are already a robust alternative** to LPG standard aerosol sprays because they already provide:
 - excellent spray performance
 - stable delivery rate
 - controlled spray rate tolerances
- In order to obtain good results we need to combine knowledge about formula, packaging and have access to the most recent technologies.





colep consumer products



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www.colep-cp.com