FACT SHEET 14
Aerosols

1. Description of market sector

This market sector includes various types of aerosols used in many different applications. Some aerosols use an HFC propellant. Aerosols are intrinsically an emissive HFC application i.e. when an aerosol is used the propellant is always emitted to the atmosphere.

Market sub-sectors

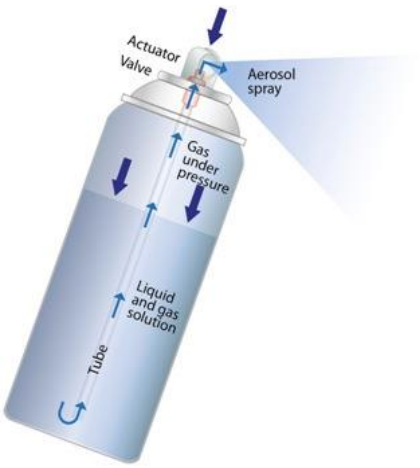
The aerosol market can be split into three main sub-sectors:

1) **Consumer aerosols**, including cleaning products, personal hygiene products, decorative spray paints, novelty aerosols, food products
2) **Technical aerosols**, used in applications such as lubricant sprays, air dusters and safety horns
3) **Metered dose inhalers (MDIs),** medical aerosols used for delivering drugs directly into the lungs (for treating respiratory diseases such as asthma). There are also other medical aerosols e.g. nasal and topical aerosol sprays.

Metered dose inhaler (MDI)

Alternative technologies

In a number of aerosol applications there are competing products based on "not-in-kind" technologies, such as hand-pumped sprays, roll-on liquid products (e.g. for deodorants) and non-sprayed products (e.g. for polishes and lubricating oil). Aerosols are often favoured because of ease of use, even though they may be more expensive than some competing technologies. In the medical field, drugs for respiratory diseases can be delivered either by aerosols (MDIs) or through inhaled powders. Most drugs available as an MDI aerosol are also available as a dry powder inhaler (DPI).



Typical aerosol configuration

Changes driven by ODS phase-out

Prior to 1990, CFC-12 was widely used as an aerosol propellant in all three market sub-sectors. The aerosol market was the dominant source of ODS emissions. A significant part of the aerosol market migrated to non-fluorocarbon alternatives, mainly hydrocarbons (HCs) and dimethyl ether (DME). These alternatives are lower cost than HFCs and they now dominate the consumer aerosol market and are used in technical aerosols where a flammable propellant is safe to use. A small proportion of non-medical aerosols, including some technical aerosols, novelty aerosols (e.g. silly string and artificial snow) and one component foam (OCF, used in the building trade) required a non-flammable propellant and migrated to HFC propellants – mainly HFC-134a. All MDIs migrated to HFCs after extensive product development and toxicity testing during the 1990s.

Technical aerosol

HFC aerosol propellants: The main HFCs currently used as propellants in the manufacture of aerosols are summarised in Table 1.

Table 1: HFC Aerosol Propellants

Propellant	GWP[1]	Flammability	Types of aerosol product
HFC-134a	1430	Non-flammable	Various technical and consumer aerosols MDIs and some other medical aerosols
HFC-152a	124	Flammable	Technical and consumer aerosols that can use a moderately flammable propellant
HFC-227ea	3220	Non-flammable	MDIs

The majority of aerosols using HFCs require a non-flammable propellant. In GWP-weighted terms HFC-134a is the dominant HFC propellant used in both medical and non-medical applications.

In non-medical applications that cannot use the highly flammable HC or DME propellants, HFC-152a can sometimes be used. This has a significantly lower GWP than HFC-134a and a lower level of flammability than HCs. There is a significant metric tonnage of HFC-152a use in non-medical applications, but with a GWP of only 124 this use is small in GWP-weighted terms.

A small proportion (around 5%) of MDIs use HFC-227ea which has a much higher GWP than HFC-134a. It is not used in non-medical applications because of cost and high GWP.

Some of the above HFCs are used in blends. For example HFC-152a can be blended with HFC-134a to create a reduced GWP non-flammable blend. HFC-152a can also be blended with HCs or DME to slightly reduce the flammability of a pure HC or DME propellant.

2. Alternatives to currently used HFC propellants

Lower GWP alternatives to HFC propellants are summarised in Table 2. It should be noted that:

a) Most of the alternatives have very low GWP (most are below 10). This is different to the refrigeration and air-conditioning market, where many alternatives being considered have GWPs in the 200 to 1000 range.

b) Some of the alternatives have high flammability

c) HCs and DME are VOCs (volatile organic compounds). Emissions of VOCs are regulated in some regions.

d) Compressed gas products and NIK alternatives have different technical characteristics to conventional aerosols. This may reduce the ease of use.

[1] All GWP values are based on the IPCC 4th Assessment Report

Table 2: Lower GWP alternatives for aerosol propellants

Propellant	GWP	Flammability	Types of aerosol
Hydrocarbons			
Various blends of: Propane n-butane iso-butane	 3 3 3	Higher flammability	Any aerosol that can use a higher flammability propellant
Oxygenated Hydrocarbons			
Dimethyl ether	1	Higher flammability	Any aerosol that can use a higher flammability propellant
HFOs (hydro-fluoro-olefins, also referred to as unsaturated HFCs)			
HFO-1234ze	7	Lower flammability	Aerosols requiring a very low flammability propellant
Compressed gases			
CO_2 Air Nitrogen	1 0 0	Non-flammable	Some technical and consumer aerosols
N_2O	298	Non-flammable	Some food products (e.g. cream; cheese)
Not-in-kind (NIK) Alternatives			
Hand pumped sprays Hand pumped liquids Roll-on liquids / sticks Powders	0	Non-flammable	e.g. air dusters e.g. lubricating oils e.g. deodorants e.g. dry powder inhalers (DPIs)

Hand pumped air dusters

Dry powder inhaler for respiratory drugs

3. Discussion of key issues

Safety and practicality

A key issue related to the selection of a low GWP alternative to HFC aerosol propellants is flammability. If a flammable propellant can be used, there are a range of low cost alternatives including HCs and DME. A significant proportion of consumer aerosols have used HCs and DME since the 1980s (e.g. personal products such as hair sprays).

Examples of aerosols using non-flammable HFCs are novelty aerosols and OCF (one component foam). Novelty aerosols can be used in circumstances where ignition sources are present. OCF is often used in large quantities (e.g. a whole aerosol discharged within a minute), creating a large cloud of propellant. The use of HFC-134a in both these applications has been banned in the EU since before 2010. The response to the bans was different for each market:

1) Most novelty aerosols are now sold using HFO-1234ze. This provides a very low flammability option that is safe for the user.

2) Most OCF aerosols are now formulated with HCs or DME. The aerosols have been re-engineered to minimise the safety risk and safety instructions alert users on how to avoid ignition.

These examples illustrate that in some markets the current use of HFCs can be switched to a low cost flammable alternative. In other markets, where the risk of ignition is high or the consequences of ignition are severe, it remains important to use a non-flammable propellant. HFO-1234ze is non-flammable under most test conditions and is a suitable propellant for various technical aerosols.

The pressure characteristics of an aerosol propellant affect the usability, especially in cool weather conditions. HFO-1234ze operates at a lower pressure than HFC-134a, so may not be an appropriate propellant in very cold conditions. HCs can be selected to provide a range of pressure characteristics (by using different blends of propane and butane).

For MDIs there is currently no safe propellant option commercially available other than HFC-134a and HFC-227ea. Because an MDI propellant is breathed directly into the lungs, it must undergo extensive toxicity testing that can take up to ten years to complete. One company in Argentina is undertaking research and development to use iso-butane as the propellant.

Commercial availability

All of the low GWP propellant options listed in Table 2 are commercially available. HCs and DMEs are widely available in all regions. HFO-1234ze has been available in some regions for around 5 years and availability is expected to grow significantly over the next few years.

Some of the NIK technologies (e.g. hand pumped air dusters) are widely available, although better designs may be required to broaden the use of such products over aerosols.

Dry powder (DPI) alternatives to MDIs are widely available. There is a considerable variation in the split between MDI and DPI usage in different regions. In some regions MDIs represent about 80% of respiratory drug sales, in others MDIs represent only about 10%. This illustrates there is good availability of DPIs and that the choice between DPIs and MDIs is more influenced by “doctor / patient preference” than by effectiveness.

Cost

HCs and DME are lower cost propellants than HFCs (hence the voluntary switch to these propellants for many aerosol products).

HFO-1234ze is more expensive than HFC-134a but in most cases it will be used in high value products (e.g. for industrial applications) or in discretionary products (e.g. novelty aerosols). In some cases, the HFO propellant may only add a small amount to the cost of such products.

The costs of MDI and DPI drugs vary due to complex pricing and purchasing procedures in the health sector. For drugs still under patent, the drug cost dominates the total cost – MDI and DPIs are often sold at the same price for the same drug. However, for generic drugs, where the patent has expired, the market is more competitive and there is some evidence that MDIs are cheaper.

Energy efficiency

Energy efficiency is not an issue in the aerosol market.

Applicability in high ambient

There are few issues related to the use of lower GWP aerosol propellants in high ambient temperature. There is a risk of an aerosol exploding if left in a very hot location (e.g. inside a car parked in sunshine). This risk is higher for HFC-134a than for HC or HFO-1234ze propellants due to their pressure-temperature characteristics.

Training

The training issues for aerosols are different to those in other HFC markets. In the aerosol market there is a requirement for training of factory personnel that handle flammable propellants in aerosol filling facilities. There is also a significant need for “end user education”, for example:

1) Where HFCs are replaced with a flammable propellant, end users need to be given information to ensure safe use

2) Where NIK alternatives are available (e.g. pumped air dusters; DPIs instead of MDIs) the person responsible for purchase (or for prescribing a drug) needs to be given information about why NIK alternatives can be considered, and how they should be used. Education is also necessary for users of HFC MDIs, where patient training is important.

Minimising emissions from existing HFC aerosols

The majority of HFCs in an aerosol are emitted during use. There is a small quantity of HFC left in a finished aerosol. Old aerosol cans can be processed to recover the metals used. It is technically feasible to capture and destroy any remaining propellants, although this may not be cost effective. It is more cost effective to recover propellants from full or partly full aerosols – these may be collected by manufacturers (e.g. for rejected products) or by pharmacies (when patients return unused or out-of-date drugs). Each country should consider what infrastructure is available to process old aerosols and whether this includes recovery of propellants. The majority of aerosols in the waste stream use HCs or DME with only a small percentage containing HFCs.