

TRANSITIONING TO LOW-GWP ALTERNATIVES in Aerosols

Background



This fact sheet provides current information on low global warming potential (GWP)¹ alternatives to high-GWP hydrofluorocarbons (HFCs) for use in consumer and technical aerosols (e.g., excluding metered-dose inhalers (MDIs)). HFCs are powerful greenhouse gases (GHGs) with GWPs hundreds to thousands

of times more potent per pound than carbon dioxide (CO₂); however, more low-GWP alternatives are becoming available.

Aerosols use liquefied or compressed gas to propel active ingredients in liquid, paste, or powder form in precise spray patterns with controlled droplet sizes and amounts. Typical aerosol products use a propellant that is a gas at atmospheric pressure, but is a pressurized liquid in the can. Some aerosols also contain a solvent. In some cleaning applications, the propellant disperses the solvent; in other applications, the solvent product and propellant solution are evenly mixed to improve shelf-life and product performance, such as by preventing dripping and ensuring uniform film thickness for spray paints. Typical product types of consumer and technical aerosols are listed below:²

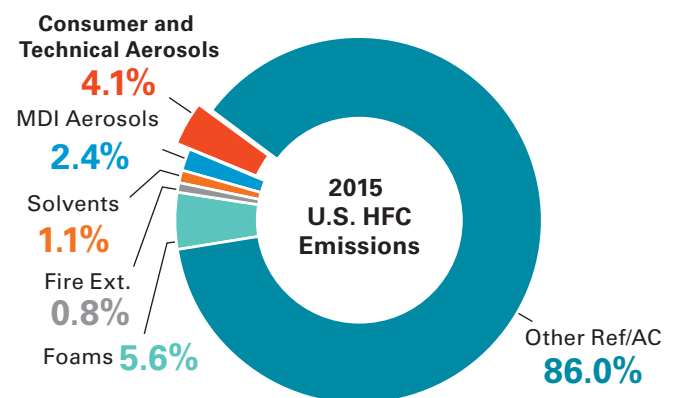
Consumer Aerosols

- Tire inflators/sealants
- Safety signal horns
- Animal repellents
- Personal care products (e.g., cosmetic aerosols, hairspray, deodorants)
- Food dispensing products
- Medical aerosols³ (e.g., wound care sprays,⁴ taping base⁵)
- Freeze sprays (e.g., food freezing, animal waste freezing, topical cooling sprays⁶)
- Spray paint
- Novelty aerosols (e.g., artificial snow, plastic string, noisemakers, cork poppers)
- Miscellaneous consumer aerosols (e.g., household cleaning products, brake cleaners,⁷ eyeglass and keyboard dusters, room fresheners, spray adhesives)

Technical Aerosols

- Dusters⁸ (e.g., for photographic negatives, semiconductor chip manufacture, specimens for observation under electron microscope)
- Cleaners (e.g., electronic contact cleaners,⁹ flux remover¹⁰)
- Pesticides (e.g., wasp and hornet sprays, aircraft insecticides)
- Miscellaneous technical aerosols (e.g., document preservation sprays, freeze sprays¹¹)

Although a large portion of the aerosol market has avoided HFC propellants and solvents by transitioning directly to low-GWP and “not-in-kind” (NIK) alternatives, in 2015, U.S. emissions of HFCs from aerosols were estimated at 11.0 million metric tons of carbon dioxide equivalent (MMT CO₂ Eq.), which is equivalent to the annual greenhouse gas emissions from approximately 2.3 million passenger vehicles. Sixty-three percent of this amount was from the consumer and technical uses described above.



U.S. HFC Emissions: 169 MMT CO₂Eq.
U.S. HFC Emissions in Consumer and Technical Aerosols: 6.9 MMT CO₂Eq.
Source: U.S. EPA (2016)

Low-GWP Alternatives & Market Trends

In the past, aerosol products used chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) such as CFC-12 and HCFC-22 as propellants and CFC-11, CFC-113, HCFC-141b, HCFC-225ca/cb, and methyl chloroform for solvents,¹² substances that both destroy the stratospheric ozone layer, which shields the Earth from the sun’s harmful ultraviolet radiation, and contribute to climate change. In response to the CFC phaseout and the ongoing phaseout of HCFCs, aerosol manufacturers transitioned to using non-ozone depleting propellants and solvents, some of which have high GWPs, such as HFC-134a, HFC-227ea, HFC-43-10mee, HFC-365mfc, HFC-245fa, as well as a variety of low-GWP alternatives.

EPA’s Significant New Alternatives Policy (SNAP) program ensures the smooth transition to alternatives that pose lower overall risk to human health and the environment. Under SNAP, EPA has listed many low-GWP alternatives as acceptable for use as aerosol propellants, including: hydrocarbons (HCs), oxygenated organic compounds, compressed gases, NIK alternatives, and HFC-152a, and aerosol solvents, including: HCs, oxygenated organic compounds, *trans*-1,2-dichloroethylene, some hydrofluoroethers (HFEs), and unsaturated fluorinated compounds, such as hydrofluoroolefins (HFOs).

A SNAP rulemaking published in July 2015 lists various aerosol propellants as unacceptable in aerosol products starting in 2016. Table 1 shows the time frame for when the changes in listing status will become effective.

Table 1. GWPs and Changes in SNAP Listing Status for Substitutes in Aerosols

Substitute	GWP*	Decision
HFC-125	3,500	Unacceptable as of January 1, 2016
HFC-134a	1,430	Unacceptable as of July 20, 2016 except for uses listed as acceptable, subject to use conditions
HFC-227ea and blends of HFC-227ea and HFC-134a	3,220	Unacceptable as of July 20, 2016 except for uses listed as acceptable, subject to use conditions

* GWP values are from the Intergovernmental Panel on Climate Change Fourth Assessment Report: Climate Change 2007.

HCs

- Propane, butane, and isobutane are widely used as propellants; hexane, heptanes, and other HCs are widely used as solvents
- Used in technical and some consumer aerosols; however, high flammability of HCs may hinder adoption in certain technical applications
- Local use restrictions may apply due to concerns over volatile organic compound (VOC) emissions

Significant New Alternatives Policy (SNAP) Program Facts

- Program authorized under Clean Air Act Title VI
- Evaluates substitutes and lists as acceptable those that reduce overall risk to human health and environment; lists acceptable with use conditions if needed to ensure safe use; or lists as unacceptable.
- Industrial sectors include: Refrigeration and Air Conditioning, Foam Blowing, Solvent Cleaning, Fire Suppression, Aerosols, Sterilants, Adhesives, Coatings and Inks, and Tobacco Expansion.
- Since it was established in 1994, SNAP has reviewed over 400 substitutes.
- SNAP considers:
 - Ozone Depleting Potential (ODP)
 - Global Warming Potential (GWP)
 - Flammability
 - Toxicity
 - Occupational and Consumer Health/Safety
 - Local Air Quality
 - Ecosystem Effects

Oxygenated Organic Compounds

- Dimethyl ether (DME) has long been used as a propellant in consumer and some technical aerosols, while esters, ethers, alcohols, and ketones have been used in these applications as solvents
- Flammability concerns may hinder adoption in certain technical applications
- Local use restrictions may apply due to concerns over VOC emissions

NIK

- Finger/trigger pumps, powder formulations, rollers, brushes, bag-in-can/piston-can system, wipes, sand-blasting, brushing, and abrasion have been successfully adopted in place of aerosolized products in technical and consumer aerosol applications since the mid-1990s.
- Mixing balls and dip tubes are also used in place of high-GWP solvents in technical aerosols, although propellants are still required

Compressed Gases (CGs)

- CO₂, air, nitrous oxide (N₂O), and nitrogen have long been used as propellants in some technical and consumer applications (e.g., dusters)
- N₂O is commonly used in food dispensing aerosols

HFEs

- Several HFEs have been successfully adopted as solvents for use in technical aerosols, including HFE-7100, HFE-7200, HFE-7000, and HFE-347pcf2
- Non-flammable

HFC-152a

- Although an HFC, HFC-152a has a GWP that is 91% lower than that of HFC-134a
- A commonly used propellant in consumer aerosols, particularly in areas where VOCs are restricted
- Moderate flammability

Low-GWP Fluorinated Compounds

- HFO-1234ze(E) propellant is now commercially available in the United States for technical and some consumer aerosol applications; it is also being used as a near drop-in replacement for HFC propellants
- Solstice™ 1233zd(E) and Methoxytridecafluoroheptene (MPHE) isomers can be used as aerosol solvents for technical aerosols
- Some fluorinated compounds have lower solvency and may need to be mixed with other, more flammable compounds with higher solvency to improve the effectiveness of the product
- Some HFOs exhibit low flammability, others are non-flammable

U.S. Adoption of Selected Low-GWP Fluorinated Compounds

Although many consumer aerosols products avoided transitioning to HFCs from CFCs through reformulation or replacement with a variety of NIK substitutes (e.g., pump sprays or solid and roll-on deodorants), the technical aerosols industry often relied on HFCs (e.g., HFC-134a) as the propellant of choice to address product-related performance and flammability/VOC concerns, particularly in highly specialized and niche products. Low-GWP alternatives, including HFOs, are becoming viable options for these applications.

HFO-1234ze(E) was added to EPA's SNAP list of acceptable aerosol propellants in January 2011 and is now commercially available in the United States. Duster products that were previously manufactured in the United States with HFC-134a propellant are now being manufactured with HFO-1234ze(E). Additionally, Solstice™ 1233zd(E) and MPHE were added to the SNAP list of acceptable aerosol solvents in August 2012 and July 2014, respectively.

Future Outlook

Together, the suite of known alternative chemicals, new technologies, and better process and handling practices can significantly reduce HFC use in both the near and long term. Although some work remains to fully adopt these low-GWP alternatives, and some unknowns still remain, the aerosol industry and chemical manufacturers are working on developing new alternatives. Over the next few years, EPA is expecting to finalize rules potentially adding several options for new, low-GWP aerosol propellants and solvents.

Table 2. GWPs of Propellants and Solvents for Aerosols

Chemical	GWP*
Propellant	
CFC-12	10,900
HCFC-22	1,810
HFC-134a	1,430
N ₂ O	298
HFC-152a	124
HFO-1234ze(E)	6
Butane	4
Propane	3.3
Isobutane	3
CO ₂	1
DME	1
Solvent	
CFC-113	6,130
CFC-11	4,750
HFC-43-10mee	1,640
HFC-245fa	1,030
HFC-365mfc	794
HCFC-141b	725
HCFC-225cb	595
HFE-347pcf2	580
HFE-347mcc3 (HFE-7000)	530**
HFE-449s1 (HFE-7100)	297
Methyl chloroform	146
HCFC-225ca	122
HFE-569sf2 (HFE-7200)	59
Oxygenated Organic Compounds	< 20
Solstice™ 1233zd(E)	4.7-7
<i>trans</i> -1, 2-dichloroethylene	< 5
Hexane	3
Heptane	3
MPHE	2.5

Note: Chemicals in gray shading are no longer used in new equipment because of their ozone depletion potential.

* GWP values are from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report: Climate Change 2007.

** GWP value is from the IPCC Fifth Assessment Report: Climate Change 2013.

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¹ GWP is a measure of a substance's climate warming impact compared to CO₂.

² Several aerosol products—such as pesticides, cleaners, and spray adhesives—can be classified as either technical or consumer aerosols depending on their application.

³ Medical aerosols can be considered as a separate product category but are not for the purposes of this fact sheet.

⁴ Wound care sprays include germicides.

⁵ Taping base is used on injuries for helping secure tape, underwrap, and elastic wraps.

⁶ Topical coolants used by athletes that evaporate from the skin, lowering the surface temperature.

⁷ Brake cleaners remove oil, dirt, and other debris from vehicle braking systems. Brake cleaners previously used methyl chloroform and successfully avoided use of high-GWP HFCs by transitioning directly to perchloroethylene or carbon dioxide as a solvent/propellant.

⁸ Duster sprays are compressed gases used to blow off dust or dirt, particularly from computers and electronic equipment.

⁹ Electronic contact cleaners are used to dissolve and remove oil, grease, flux, condensation, and other contaminants quickly from delicate electronic circuitry and instrumentation.

¹⁰ Flux removers are used to clean excess flux and solder residue from circuit boards and electrical components.

¹¹ Among other uses, freeze sprays are used to test electrical conductivity of components on circuit boards.

¹² In the United States, the use of HCFCs in aerosols was banned for products where HCFCs were determined to be nonessential in 1994. Only a few types of products were allowed to use HCFCs, primarily for technical aerosols.

