Products with non-flammable propellants, types of non-flammable propelants and their use in aerosol production.

Definition of aerosols:

products that depend on the power of a compressed or liquefied gas to expel the contents from the container**.**

Aerosol products are constituted by the packaging and filling. The packaging consists of four components (container, valve, applicator, cap). The filling is formed by the active substance (usually a mixture of chemical compounds) and a propellant (liquefied or compressed).

BENEFITS:

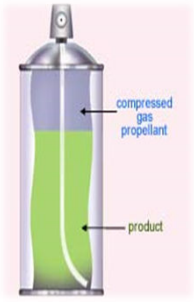
- easy and accurate dosing
- safe use and carrying
- no risk of spillage
- long-term durability thanks to seal the container and the impossibility of re-entry of microbial contamination during use
- recyclable packaging

Propellant:

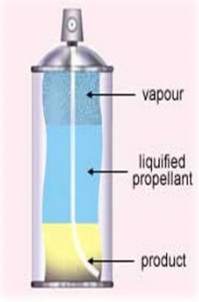
is responsible for developing the power pressure within the container and also expel the product when the valve is opened and in the atomization or foam production of the product.

Categories of Aerosol Propellants:

- **Compressed Gases**



- **Liquefied gas**



Typical compressed gases:

Name	Formula	V.P. @70°F (psia)	B.P. °F (1 atm)	Gas Density @70°F (g/mL)
Nitrogen	N_2	492	-320	0.97
Nitrous Oxide	N_2O	735	-127	1.53
Carbon Dioxide	CO_2	852	-109	1.53

Typical liquefied gases:

Hydrocarbons, DME, CFCs, HFCs

Hydrocarbons

- inexpensive, good solvents
- do not cause ozone depletion
- inflammable
- used in solvent based and water based formula
- create stable emulsions and can be used without hydrolysis in water systems
- have been the most common propellant in aerosols since the mid - 70s

DME

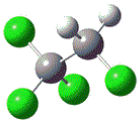
- was initially utilized in the US in the 1970s
- use in water and solvent based systems
- despite being flammable itself, when mixed with water it is not flammable
- certain disadvantage can be its higher price

CFCs

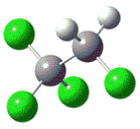
- deplete the stratospheric ozone layer and are powerful greenhouse gases
- greenhouse gases are gases that occur in the Earth's atmosphere, which contribute most to the so-called greenhouse effect
- greenhouse gases are, according to their potential contribution to the greenhouse effect of the atmosphere, classified by coefficients of global warming potential (GWP), the unit's contribution to the greenhouse effect of one molecule of CO2
- GWP compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide
- emissions of greenhouse gases are controlled by the Kyoto Protocol and the Framework Convention, use of halons and CFCs are controlled by the Montreal Protocol and its amendments
- 1989, the European aerosol industry voluntarily stopped the use of CFCs (ChloroFluoroCarbons).
- the aerosol industry no longer contributes to the creation of the so-called 'ozone hole'
- decrease emissions of greenhouse gases

- the European aerosol industry has primarily shifted to flammable liquefied propellants (hydrocarbons and dimethyl ether)
- additionally the aerosol industry has decreased its greenhouse impact related to Climate Change by 99% compared to the period prior to 1989
- still uses HFCs (HydroFluoroCarbons) - third generation fluorinated gases are less hazardous but remain greenhouse gases.

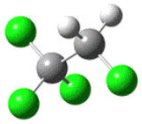
Tetrafluoroethane

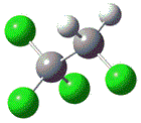


- colorless gas, which can be easily liquefied by pressure
- a faint ethereal odor that may go unnoticed by most individuals
- If liquid tetrafluoroethane removed from a pressure vessel and exposed to normal pressure, it boils at room temperature
- Tetrafluoroethane itself also has a relatively low toxicity
- nonflammable, noncorrosive and compatible with other materials

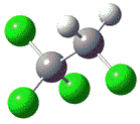


- 1,1,1,2-Tetrafluoroethane first appeared in the early 1990s as a replacement for dichlorodifluoromethane (R-12), which has ozone depleting properties
- its residence time in the atmosphere is shorter then the residence of the fully halogenated chlorofluorocarbons
- tetrafluoroethane, however, in contrast to CFC no destructive effect on the ozone layer, is a potent greenhouse gas
- its greenhouse effect (GWP) is the 1430 times the same amount of carbon dioxide based on a time horizon of 100 years



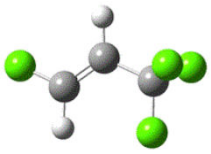


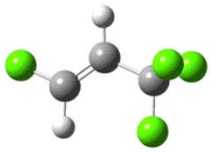
- yearly production is estimated at 175,000 tons
- use: residential refrigerant, component of refrigerant blends, foaming agent PS foams, fire extinguishant, medical propellants, aerosol propellants
- because of its high GWP, 1,1,1,2-tetrafluoroethane has been banned from use in the European Union, starting with cars in 2011 and phasing out completely in future



Tetrafluoropropene

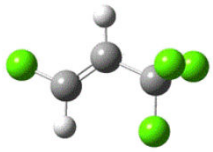
- nonflammable, aerosol propellant that has a low global warming potential (GWP) and low photochemical reactivity
- can serve as a replacement for liquefied gas propellants currently in use, with the potential to make significant reductions in greenhouse gas emissions and ground level ozone creation, can substantially reduce greenhouse gas emissions
- GWP less than 6,
- could save more than 14 million metric tons per year of carbon dioxide equivalent emissions





- full chemical name is trans- 1,3,3,3-tetrafluoroprop-1-ene (HFO-1234ze)
- it mixes with other common propellants such as 134a, dimethyl ether, butane, isobutane and propane
- It is also miscible and compatible with many commonly used solvents like the lower alcohols, ketones, halogenated solvents and hydrocarbons, providing a variety of formulation options

- it has been shown to be compatible with aluminum, tinplate aerosol cans and PET-lined aerosol cans
- has also been tested with aerosol valves and found to be compatible with common gasket materials including grades of butyl rubber, buna and neoprene
- the propellant is nonflammable and has a moderate vapor pressure of 49 PSIG (3.4 bars-gauge) at 70°F (21°C) and 147 PSIG (10 bars-gauge) at 130°F (54°C).



Property	**HFO-1234ze**	**HFC-134a**
Molecular Weight	*114*	*102*
Boiling Point (°C / °F)	*-19 / -3*	*-26 / -15*
Flashpoint (°C / °F)	*None*	*None*
GWP (100 yr horizon)	*6*	*1430*

New generation of non-flammable gases:

- easily implemented, with minimal changeover requirements to formulations
- be safe for health (suitable toxicological profile)
- offers good thermal and hydrolytic stability
- compatible with many common plastics and elastomers
- propellant may be used in various aerosol applications
- price – widely commercially available

Thank you for your attention!