Safety Aspects of Liquefied Gas Aerosol Propellants

Diversified CPC

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Advantages of Hydrocarbon Aerosol Propellants

- Economics - *Very Inexpensive*
- Stability & Purity
- Odorless !!
- Wide Range of Boiling Points
- Wide Range of Vapor Pressure
- Low Toxicity
- Versatility & Efficiency
- N a t u r a l !!!!!

Flammability, the principal disadvantage is controllable !

Control of
Flammable Aerosol Propellants

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Flammability of Common Aerosol Propellants

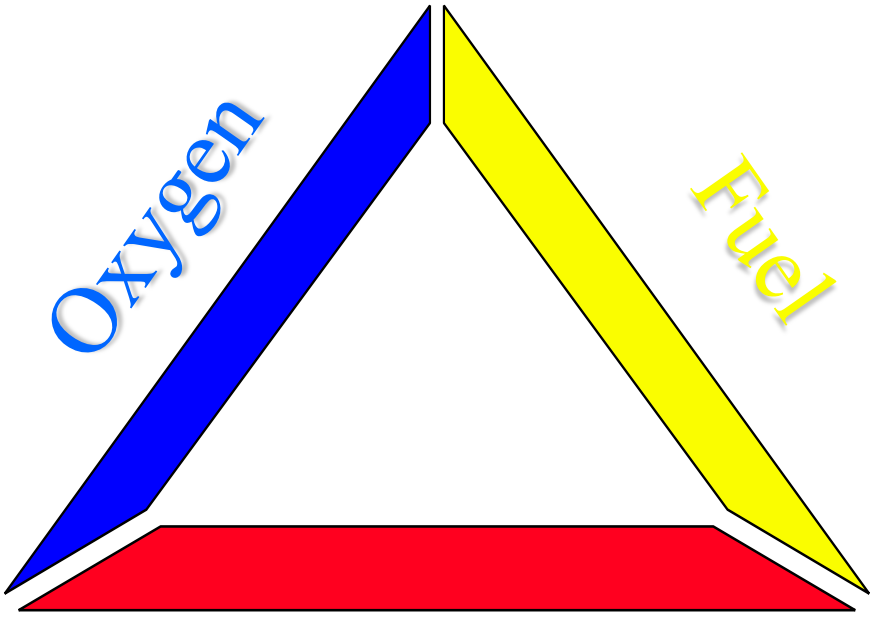
Physical Property

- Flammability is the principal hazard of common aerosol propellants. LEL and UEL (lower and upper explosive limits) are tabulated below **:**

Propellant	LEL	UEL
Propane	2.2	9.5
Isobutane	1.8	8.4
n-Butane	1.9	8.5
Dimethyl Ether	3.4	18.0
Dymel 152a	3.9	16.9
134a	**non-flammable**	

- Auto ignition temperatures range from 662 °F for DME to 940 °F for Propane. *Note: The temperature of an idly burning cigarette is over 1000 °F.*

The Fire Triangle



Source

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Exposure to Liquefied Gas Aerosol Propellants

- **Physical Property**

  Boiling points of liquefied gas aerosol propellants range from -44 °F to +31 °F.

- **Eye Contact**

  Can cause severe irritation, redness, tearing, blurred vision, and possibly freeze burns.

- **Skin Contact**

  Potential for severe frostbite depending upon propellant composition.

- **Personal Protective Equipment (PPE)**

  Insulated Gloves
  Protective clothing (no short sleeves or pants)
  Safety glasses or chemical goggles

Pressure of Liquefied Gas Aerosol Propellants

Physical Property

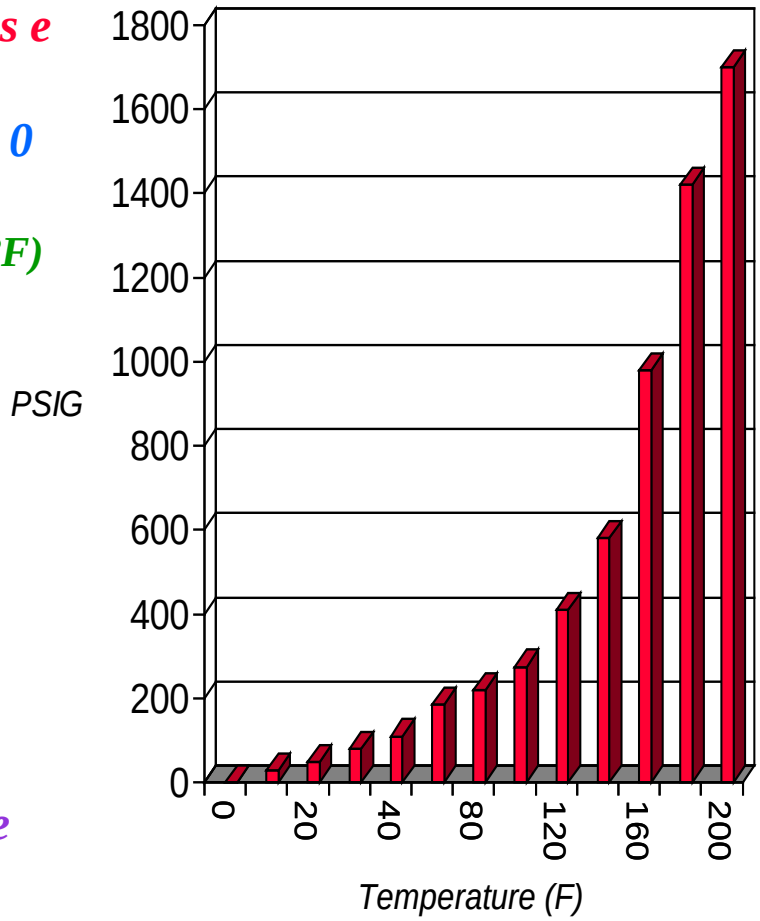
- Vapor pressures of liquefied gas aerosol propellants range from 17 psig to 110 psig @ 70 °F. {39 psig to 175 psig @ 100 °F}
- During pumping operations the product pressure can be considerably higher!

Pressure Related Hazards

- Possible Container Rupture (includes aerosol cans , accumulators , storage tanks , etc).
- Transfer System Failures (includes piping and hoses).
- Transfer System Disconnection - while still pressurized can lead to skin or eye contact by the expelled material and release of large quantities of flammable gas or liquid.
- Transfer Hose Disconnection - while still pressurized this can cause a hose to snake/whip which may cause severe injuries and release of large quantities of flammable gas or liquid.

Pressure Rise in a Constant Volume Tank

- ***Pressure Increase (from 24 to 1800 psig) as temperature rises from 0 to 200 °F (Basis-100% Propane Liquid Full at 130 °F)***



- ***To prevent hydrostatic conditions and overpressuring of piping systems --- thermal or hydrostatic valves are installed between two or more shutoff valves where liquid propellant may be trapped.***

Theoretical Maximum Release
of Liquefied Flammable Gas

The theoretical maximum release of 3 different hydrocarbon propellants @ 70 °F to the atmosphere through a 0.25” diameter opening has been calculated to be:

Hydrocarbon	Pressure (psig)	Vapor (ft3/sec)	Liquid (gal/min)
P r o p a n e	**108**	**12.20**	**28.60**
I s o b u t a n e	**31**	**5.94**	**14.39**
n - b u t a n e	**17**	**4.66**	**10.50**

Note the magnitude of the release and the effects of the pressure !

Resistance to flow caused by viscosity and flashing of the propellants may result in actual flow rates that are approximately 20% to 30% lower !

VAPOR DENSITIES
of Liquefied Gas Aerosol Propellants (@70 °F)

Liquefied Gas Propellant	*Vapor (lb/ cu.ft)*	*Liquid (lb/ cu.ft)*	*Vapor/Liq Ratio*	*Vapor/Air Ratio*
Propane	0.116	28.41	245	1.55
Isobutane	0.154	32.36	210	2.05
N-butane	0.155	33.44	216	2.07
DME	0.119	41.18	346	1.59
Dymel 152a	0.171	56.78	332	2.28
R-134a	0.264	76.26	289	3.52
Air @ 70F	0.075	N / A	N / A	1.00

Liquefied gas propellants expand substantially from a liquid to a gas when released to the atmosphere. Vapors are heavier than air.

Safe Handling of Liquefied Gas Aerosol Propellants

General Recommendations:

- Avoid inhalation of excessive concentrations of propellant vapors in the air.
- Avoid contact or propellant liquid with skin and eyes. Insulated rubber gloves and goggles are highly recommended.
- Slowly bleed down hoses, pipes, etc. before disconnecting.
- Use only approved hoses and pipes rated for the proper pressures for handling various propellants. Storage containers for liquefied gas aerosol propellants must be pressure tested at 150% of vapor pressure of the highest pressure product the vessel is intended to handle @ 100F.

  Note: The recommended design pressure rating for liquefied gas aerosol propellant storage tanks is 250 psig.
- Avoid open flames or sparks in areas where propellants are stored or transported. All sources of ignition should be eliminated.

Transfer Hoses for Liquefied Gas Aerosol Propellants

For Liquefied Petroleum Gases (LPG)

- Use only approved hoses.
- Hoses should be rated for a working pressure of 350 psig and a burst pressure of 1,750 psig. Hose connections must be capable of withstanding test pressures of at least 700 psig.
- Hoses should be chemically resistant to LPG.
- Rubber hoses should not be used where temperatures can exceed 125 °F.

Transfer Hoses for Liquefied Gas Aerosol Propellants

For HydroFluoroCarbons (HFCs) and/or DiMethylEther (DME)

- Hoses should be rated for a working pressure of 350 psig and a burst pressure of 1,750 psig. Hose connections must be capable of withstanding test pressures of at least 700 psig.

- Hoses should be chemically resistant to HFCs or DME
  Note: For DME, use only stainless steel hoses with Teflon gaskets.

- Hoses should NOT be used where temperatures can exceed 125 °F.

Transport Unloading of Liquefied Gas Aerosol Propellants

- Locate transports a minimum of 10 feet from the storage tanks.
- Transports must be properly grounded.
- Transport wheels must be chocked to restrict forward and reverse motion.
- Clearance from any major buildings should be a minimum of 25 feet.
- The transport should be attended at all times while connected.
- A "Transport Unloading Procedure" should be created and used. Unloading personnel should be thoroughly trained in the use of the procedure and in the proper handling of liquefied gas aerosol propellants.
- There should be no ignition sources nearby.
- No smoking, open flames, or sparks are to be present.
- A fire extinguisher should be accessible nearby.

Safety in the Storage Tank Farm

- Storage tanks must have the proper pressure rating.
- Storage tanks must be fitted with properly sized safety relief valves set to discharge at container design pressure.
- Storage tanks must have liquid level gauges.
- Liquid and vapor connections must be fitted with excess flow or back flow check valves as appropriate.
- Hydrostatic relief valves must be present between isolation valves.
- There must be emergency shut off valves and protective bulkheads at transport loading and unloading stations.
- At least one 20 lb BC type portable fire extinguisher should be located at the storage area.
- Adequate means for Fire protection is required for storage tanks.
- Electrical equipment and connections must be explosion proof.
- There must be proper clearances between propellant storage containers, buildings, and flammable liquid storage areas (refer to NFPA #58).
- Security fencing with at least two separate access gates should be present.

SAFETY in the Gassing Room

- Adequate ventilation.
- Safety shut off valves.
- Interlocks on doors.
- Gas detection system interlocked to ventilation system and safety shut off valves. Sensing heads calibrated periodically and properly maintained.
- Proper grounding.
- Gassing room isolated from production building (preferably) and only connected to the production building by conveyor.
- Walls constructed to withstand a minimum of 100lb/ft2.
- Sprinkler system for fire water.
- Explosion proof installation.
- Explosion venting panels.
- Explosion suppression system.
- Panic hardware on doors.
- Panic buttons both inside and outside gassing rooms.

Regulations for Storage and Use of Liquefied Flammable Gas Cylinders Inside Buildings

• 29 CFR 1910.110	Storage and Handling of Liquefied Petroleum Gases
• NFPA 30B :	Code for the manufacture and Storage of Aerosol Products
• NFPA 45 :	Fire Protection for Laboratories using Chemicals
• NFPA 55 :	Compressed and Liquefied Gases in Portable Cylinders
• NFPA 58 :	Standard for the Storage and Handling of Liquefied Petroleum Gases
• **Aerosol Propellants:** Considerations for Effective Handling in the Aerosol Plant and Laboratory	Considerations for Effective Handling in the Aerosol Plant and Laboratory (Consumer Specialty Products Association CSPA)

General Safety Practices for the Aerosol Laboratory

- Smoking is prohibited in the Lab!
- Personnel shall be properly trained in the safe and efficient operation of fire extinguishers , safety showers , and other safety equipment.
- Personnel shall be properly trained in the proper use and handling of liquefied flammable gases, cryogenic gases, and flammable or combustible liquids.
- Proper clothing such as 100% cotton lab coats should be worn to prevent static accumulation or discharge.
- Proper personal protective equipment such as safety glasses or goggles, face shields, and protective gloves or clothing shall be used as required by the Plant Safety Policy.
- Safety Checklists should be used for start-up, operation and shut-down of equipment. This is especially important where mechanical gassing equipment is used in the aerosol laboratory.

Lab Safety Practices (continued)

- Propellant gas supply cylinders must be maintained in a protected outside area and should be brought into the Laboratory only for appropriate reasons and for brief periods under the supervision of the Laboratory Director. The largest size propellant cylinder allowed in the Aerosol Laboratory is a 5 gallon capacity (20# propane) cylinder.
- Cylinders must be chained or strapped in place, and must be capped when not in use unless otherwise protected.
- Always ground propellant cylinders when in use.
- Mechanical gassing installations must have gas detection and ventilation exhaust systems. Pilot Laboratories must meet the requirements of NFPA 30B.
- Propellant gases (liquids under pressure) must always be handled in a sealed system that is checked periodically for signs of leakage.
- Strictly control the accumulation of discarded or leaking aerosol containers. Provide proper exhaust ventilation to prevent accumulation of flammable vapors.
- Filled aerosol cans should be checked for possible leakage. The hot water bath used to test aerosol dispensers should have an exhaust hood above it to capture any released vapors. A perforated or wire metal mesh cover above the bath should be strong enough to withstand foreseeable container rupture.
- Aerosol Retain storage rooms must have adequate air circulation.

Lab Safety Practices (continued)

- Routes of egress must be kept clear and free from accumulations of corrugate, filled cans, and other products.
- The amount of flammable material stored and handled should be kept to a minimum. The smaller the amount of fuel, the smaller the fire in case of an accident.
- Ventilation is the best general precaution against fires resulting from flammable gases or vapors.
- All sources of ignition should be eliminated or controlled where possible.
- Hoods that fail to meet manufacturers' standards should be cleaned out or otherwise repaired. A good, efficient, explosion-proof exhaust hood should be used for routine operations such as the exhausting of aerosol cans, provided that flammable gases and liquids are not introduced to the environment at an excessive rate.
- Refrigerators, cold rooms, and deep-freeze cabinets should be explosion-proof. Doors should be held shut be magnetic studs, so that they can readily blow open if a flash fire or explosion does take place inside the enclosure.
- Aerosol Formulation and Product Development Laboratories may be considered Pilot Labs and may require further engineering controls including additional exhaust ventilation, explosion relief vent panels, Class 1, Division 1 or 2 electrical code, gas detection systems, sprinkler systems, etc. Consult NFPA 30B for additional information

Recommendations for Burette Pressure Filler Operations

- Only Trained Personnel shall operate the Burette Pressure Fillers.
- Bond and Ground Nitrogen Cylinder, Propellant Cylinder and Burette Pressure Filler.
- Assure that the Burette Pressure Filler is properly mounted and secured.
- Secure Nitrogen and Propellant tanks with chains or straps.
- Never use Liquid Nitrogen to pressurize a Burette Pressure Filler. Liquid Nitrogen is at a temperature of 320 degrees BELOW zero F (-160 C) under normal atmospheric pressure. This low temperature will shatter carbon steel, glass, etc. and cause severe burns.
- Always wear Safety glasses (or Goggles) and Full Face Shield when operating a Burette Pressure Filler.
- Inspect the Burette for visible damage prior to use. Replace the Burette if there is evidence of nicks or chips in the glass.

Burette Safety Practices (continued)

- Transfer of Propellants must be performed:
  - a) Gas House or Charging Room
  - b) Aerosol Pilot plant - or - Pilot Lab
  - c) Outdoors in a ventilated area - away from sources of ignition
  - d) In a well ventilated Lab Hood equipped with Combustible Gas Sensors (where allowed)
- Never turn on the Nitrogen Supply directly to the Burette without first verifying that the Pressure Reducing Regulator is functioning properly.
- Be certain that the aerosol can is fully crimped prior to filling with the propellants.
- While filling the Burette with Propellant Liquid - it may be necessary to vent off some vapors. SLOWLY vent the Propellant vapors to avoid accumulation of flammable vapors.
- Make sure that you are transferring an accurate volume of propellant into the aerosol can by weighing the can after filling.
- Do not completely empty the Burette of Propellant Liquid when filling the aerosol can, as the Nitrogen gas may enter the can and affect the properties of the propellant in the aerosol package.
- Use common sense and caution when operating a Burette Pressure Filler.

Take your time - and - BE SAFE !

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Safe Handling of Aerosol Propellants

In Summary:

- Understand the physical and chemical properties of the aerosol propellants that are stored and handled at your plant.
- Respect the flammable nature of many of the common aerosol propellants used today.
- Incorporate applicable codes and standards when designing or modifying a system to store or handle liquefied gas propellants. Facilities should be designed only by experienced engineers or consultants.
- Develop and Follow written safe operating and maintenance procedures. If your plant handles more than 10,000 pounds of flammable aerosol propellants, compliance with OSHA Process Safety Management Standard is required.
- Proper Training is critical for employees working in areas where aerosol propellants may be present.

SAFETY FIRST !!!

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Management's Responsibility:

It is the responsibility of management to provide the system; a total system designed and engineered in accordance with the best possible practices.

The commitment to safety originates with management, and the end result is directly proportional to the continuing efforts of management's vigorous enforcement of safety standards. If management relaxes, then employees relax, and that is when a problem is born.

Thank you for your concern and attention to safety in our industry !

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