ANGUS® CHEMICAL COMPANY

Key Performance Advantages

- Improves performance in many products
- Highly functional molecule for organic synthesis

NITROMETHANE [NM™]

CH_3NO_2

CAS Reg. No. 75-52-5

EINECS No. 200-876-6

The versatility, functionality and effectiveness of nitromethane makes it a chemical additive of choice to improve product performance in a range of industries. Nitromethane is an efficient nitrogen donor, which makes it a highly functional molecule for organic synthesis for the development and manufacture of products such as pharmaceuticals and agricultural chemicals.

Nitromethane (NM™ Nitromethane) is made in the USA. As the global nitromethane supply leader, we're committed to its safe and effective use in the markets we serve. As one measure to help ensure safety and security, we have a rigorous qualification process that all ANGUS customers must go through in order to receive nitromethane shipments. We require that all customers repeat the qualification process every three years if they are to remain an ANGUS nitromethane customers. To receive nitromethane from ANGUS, customers must have approved applications and the appropriate safety and security measures in place. Before we approve a new customer, we review the end-use application, chemical compatibility, handling, storage, safety and security. As part of this commitment, we've developed this short guide to help ensure safe handling and storage of your nitromethane supply.

MANAGING RISK OF DETONATION

Nitromethane should only be handled, stored or used by trained personnel who fully understand the properties of nitromethane, and have read and fully understand this technical bulletin, as well as the product safety data sheet (SDS). Although unusual precautions are not generally necessary for handling drums of nitromethane, its hazardous properties must be understood, and unsafe conditions avoided. ANGUS is committed to help you manage the risk of detonation when handling and using nitromethane.

Nitromethane can detonate and cause serious harm to people and property.[1] A single 5-gallon can of nitromethane has a fatality range of 42 feet and can cause significant injury or damage at a range of 316 feet. A full 55-gallon drum of nitromethane has a blast radius of 92 feet and can cause significant injury or damage up to 700 feet away from the center of the blast.[2]

Nitromethane can be handled and used safely as long as its hazardous properties are understood and unsafe conditions are avoided. At ambient or normal room temperature, nitromethane is resistant to shock from rough handling. Numerous tests have been conducted which involved dropping full nitromethane drums from low-flying airplanes, and from heights of 50 feet onto other nitromethane drums, all without incidence of detonation. It is nevertheless recommended that careless and rough handling of drums be avoided.

Three Conditions to Avoid

The characteristics of nitromethane have been studied by ANGUS and by outside organizations, such as the US Army Chemical Corps and the California Institute of Technology.[3,4,5] These studies have identified three conditions under which nitromethane can be detonated.

- One condition is a very severe shock, in excess of that provided by a number eight blasting cap. Shock sensitivity varies, depending upon the degree of confinement and presence of other chemicals.
- Another is severe and very rapid compression under adiabatic conditions.
- And finally, heating NM under confinement to near its critical temperature can cause detonation.

It is important to note that sensitization of nitromethane through the addition of a few percent of certain compounds, particularly amines, can increase the ease of detonation by all of these mechanisms. Elevated temperatures can also increase ease of detonation; do not distill nitromethane.

Adiabatic heating can create a serious risk of nitromethane detonation. This occurs when heat, generated by compression, fire or other sources does not escape fast enough to the external environment. Dangerously high pressures can develop when a thick-walled nitromethane-filled container, such as a section of pipe between closed valves, is heated. Compressed pockets of gas reach temperatures sufficient to initiate monopropellant burning that leads to detonation.

It is critical that relief valves with maximum bursting pressure of 100 psig be used wherever nitromethane can be confined. Because nitromethane does not need oxygen or other oxidizers to burn—unlike gasoline, for example—it is a more serious risk under adiabatic compression conditions than many other organic compounds.

Adiabatic heating can also occur when high-energy projectiles strike a thick-walled nitromethane container. Under certain fill conditions, nitromethane in containers with 1/4-inch wall thickness have been exploded by the impact of a .50 caliber high-velocity bullet. However, under the same conditions, using a thin-walled container such as a standard 20/18 gauge 55-gallon (208 liter) drum, detonation did not occur because the containers ruptured, releasing the pent up energy.

Higher pressures can be tolerated by nitromethane in contact with nitrogen than with air or oxygen, probably because nitrogen cannot induce ignition and support combustion. Each drum of ANGUS nitromethane is shipped with a blanket of nitrogen gas to keep oxygen to a minimum.

Shipping

Although nitromethane can detonate under certain conditions, it does not meet the criteria of an explosive substance defined in the international and US domestic transportation regulations.

Nitromethane is classified as a hazard class 3 (Flammable Liquid) in the regulations issued by the US Department of Transportation (DOT) and in the International Air Transport Association's (IATA's) Dangerous Goods Regulations. It is classified as a class 3.3 in the International Maritime Dangerous Goods Code (IMDG).

Though the US Department of Transportation and International Civil Aviation Organization authorize air shipments of nitromethane through cargo aircraft only, the International Air Transport Association Dangerous Goods Regulations forbid air shipments of nitromethane through both passenger and cargo aircraft. ANGUS policy forbids shipment of any amount of nitromethane by air. ANGUS also does not ship nitromethane in bulk quantities.

When shipping nitromethane, always be sure that cargo areas are well-ventilated and free of excessive heat.

Storage

Drums of nitromethane should be handled and stored in much the same manner as any flammable liquid.

Nitromethane drums should be stored in the original containers in a dry, well-ventilated area that is free of excessive heat. All electrical equipment in the area should be consistent with the requirements for storage and handling of flammable liquids. Also, nitromethane storage areas should be segregated from corrosive materials, oxidizers, explosives, amines, strong acids and strong bases. Drums are preferably stored on end with the bungs up and without stacking.

In addition to safe storage practices, make sure to take steps to assure the security of the storage area itself to prevent theft or sabotage. Nitromethane has been diverted in the past by unscrupulous individuals, resulting in disastrous consequences. Security steps should include locking the nitromethane storage facility securely, tracking of inventory, and limiting access to authorized and trained personnel only. Buildings containing nitromethane should not be marked as containing this material.

When choosing an area to store nitromethane, you should consider the consequences of detonation. Nitromethane does not spontaneously detonate, nor has it done so in actual or simulated accidents involving storage in approved drums. Still, nitromethane storage areas should be chosen with regard to minimizing the potential for damage to facilities or injury to personnel in the unlikely event of detonation.

With this in mind, the American Insurance Association suggests that nitromethane be stored with a minimum distance between the storage area and plant structures or other areas in which people are present. See the following table for storage recommendations.

American Insurance Association Table of Distances

Maximum Quantity* of Nitromethane	Maximum No. of Drums	Minimum Distance to Occupied Structures
Less than 2,000 lb/909 kg		No restrictions
2,000 lb/909 kg	4	100 ft/30 m
10,000 lb/4545 kg	20	200 ft/61 m
20,000 lb/9091 kg	40	300 ft/91 m
40,000 lb/18182 kg	80	400 ft/122 m
80,000 lb/36364 kg	160	500 ft/152 m

*For intermediate quantities, determine the proper distance by interpolation.

ANGUS recognizes that the distances outlined by the American Insurance Association can be impractical for some nitromethane users. Based on detonation studies, when one container was purposely detonated in close proximity to another, a modified table of distance has also been developed. This table is based on the storage of nitromethane in clusters of drums with minimum distances between clusters and minimum distances to occupied areas.

Table of Distances for Storage by "Clusters"

Number of Drums per Cluster	Minimum Distance to Occupied Structure		Minimum Distance Between Clusters	
	(meters)	(feet)	(meters)	(feet)
4	30.5	100	1.7	5.6
6	34.3	112.5	2.1	6.8
8	38.1	125	2.4	7.9
12	45.8	150	3.0	9.7
16	53.4	175	3.4	11.1
20	61.0	200	3.8	12.4
24	67.1	220	4.2	13.6

You can obtain further protection against detonation by using barriers to contain or direct the force of possible detonations. These barriers can be as simple as earthen embankment or as sophisticated as a building specifically designed to direct the force of a detonation away from occupied areas.

Approved drum storage in original containers is the preferred storage method for nitromethane, and we strongly discourage bulk storage of undiluted nitromethane. If bulk storage is unavoidable, contact ANGUS for best practice guidelines.

De-Sensitizers

The risk of detonating nitromethane **decreases** significantly when certain materials are added to it. The effect of these "desensitizers" is roughly proportional to the amount added to nitromethane. It should be noted that blends of nitromethane with toluene, ethanol and furfural have not been tested thoroughly for non-detonability, and are not certified by the US Department of Transportation (DOT) as safe for bulk shipment.

Minimum Amount to Desensitize Nitromethane

Cyclohexanone	25%
1,2-Butylene Oxide	4%
Methanol	40%
1-Nitropropane	48%
Toluene	25%
Ethanol	50%
Furfural	60%

Piping and Material Capability

Nitromethane should be transferred in dedicated lines to avoid contamination, particularly from sensitizing chemicals that can increase the likelihood of detonation.

Ordinary steel piping can be used to transfer dry nitromethane (<0.2% wt. water) to processing areas. Because of the potential for detonation discussed earlier, use the minimum diameter pipe possible. Make sure that nitromethane piping is physically separated from storage and piping of other flammables. Lines should be placed in channels and protected with a sprinkler system when located in areas where there is a risk of creating one of the three conditions known to cause nitromethane detonation. Nitromethane lines can also be run underground. Please feel free to contact ANGUS for best practice guidelines if you wish to construct an appropriate nitromethane piping system.

Aluminum or stainless steel construction is recommended for handling wet nitromethane. In the presence of 0.2 percent by weight water or more, nitromethane is slightly corrosive to steel. Contact with moisture can be minimized by storing/handling nitromethane under a dry inert gas such as nitrogen.

Solutions containing nitromethane should not be exposed to copper, brass, or bronze without thorough pre-testing. The presence of acidic materials may cause nitromethane to become highly corrosive to copper and its alloys after several weeks of contact. Lead and its alloys should never be used with nitromethane.

A number of synthetic polymeric materials can be used with nitromethane. The actual choice depends upon the degree of exposure, the presence of fillers or plasticizers and the importance of color. Materials that are generally satisfactory include Teflon, polyethylene, polypropylene, polyester fiberglass, vinylidene chloride copolymers and nitrile rubber. Nevertheless, pre-testing of all materials is advised. Natural rubber, synthetic rubber, Viton, Hypalon, Nordel and silicon rubber are **not** suitable for use with nitromethane.

Flammability

Nitromethane has a flash point of 96°F (35°C) by Tag Closed Cup (TCC). If nitromethane is ignited under heavier confinement than that provided by approved drums, or where it could become confined while burning, immediately clear the area and do not attempt to extinguish the fire. Such a condition could create a significant blast and have disastrous consequences.

When nitromethane is ignited, it burns with a lazy, almost invisible flame that often self-extinguishes. Nitromethane fires can be extinguished with water. Unlike gasoline and oil fires, water, when carefully applied, will not spread nitromethane fires, so you may use water as an extinguisher. Nitromethane fires may also be extinguished with carbon dioxide or foam. Dry-chemical tri-class extinguishers that contain only ammonium phosphate are suitable for small nitromethane fires. It's important to clarify, though, that **dry chemical extinguishers containing sodium or potassium bicarbonate should not be used on nitromethane fires.** These chemicals appear to put out the fire when first applied, but can then cause the fire to reignite.

SAFE HANDLING & DISPOSAL

For further information and precautions regarding the handling, storage and disposal of nitromethane products, please consult the current Safety Data Sheet (SDS) for this product

Handling

Nitromethane is a clear, odorless, liquid which is flammable. The chemical must be kept away from static, heat, sparks and flame. Vapors are heavier than air and may travel long distances and accumulate in low-lying areas, so the potential exists for ignition and flash-back. The lower flammable limit for nitromethane vapor in air is 7.3% by volume at atmospheric pressure and at 33°C (91°F). Such a concentration of nitromethane vapor is not easily obtainable in air at lower temperatures. Flammable concentrations of vapor can accumulate at temperatures above the flash point (96°F, 36°C).

Avoid mixing nitromethane with strong alkalis or amines, as previously discussed. Nitromethane can tautomerize from the nitro form (CH_3NO_2) to the enol (aci-form) (CH_2=NOOH) which is called nitronic acid. The nitronic acid is weakly ionized and forms salts when neutralized by strong base. In aqueous or alcohol solutions, the salts are sufficiently stable that they may be used as intermediates to prepare derivatives of nitromethane. When dry, the salts of nitromethane can be extremely unstable and highly sensitive to shock—**avoid isolation of the salts in a dry state.**

Weak bases, such as organic amines, usually do not produce identifiable crystalline salts of nitromethane. However, the addition of amines to nitromethane can result in compositions sensitive to detonation. Also, amine-sensitized nitromethane in contact with mercuric oxide reacts vigorously and may explode spontaneously. Therefore, avoid mixtures containing nitromethane and both amines and heavy metal oxides, such as those of mercury, silver or lead.

If you intend to mix nitromethane with other additives, pigments or dyes, reactants or catalysts, ANGUS can discuss the details of your particular situation. We recommended that care be taken when new additives or dyes are considered for use with nitromethane.

Avoid breathing vapor. Nitromethane may cause central nervous system depression and respiratory tract irritation similar to the effects seen with many other organic solvents. Provide general and/or local exhaust ventilation to control airborne levels below the relevant exposure guidelines which have been set for nitromethane. If exposure to nitromethane vapors above the exposure guideline is anticipated, such as inside a tank or as a result of spillage, use a positive-pressure supplied air respirator. Organic vapor canister gas masks should never be used for protection from nitromethane vapors.

Do not use air pressure for transferring product. Do not use positive displacement pumps unless it can be assured that the discharge pressure will not exceed 100 psig. As previously described, the product should never be compressed or confined between closed valves. Thermostated pumps set to shut off at 49ºC (120ºF) are recommended.

Disposal of Drums

After drums have been emptied, they may still contain explosive vapors; observe all warnings and precautions listed for the product. Do not cut, drill, grind, puncture or weld on or near the containers.

Used drums should be rinsed several times with water to remove remaining nitromethane. Drums should be air dried, with bungs removed, prior to disposal. Strong caustic or alkaline solutions should never be used to clean or recondition nitromethane drums.

As a service to its customers, ANGUS can provide names of resources to identify waste management companies and other facilities that recycle, reprocess or manage chemicals, and that manage used drums. Please contact ANGUS for further details.

PHYSICAL AND THERMODYNAMIC PROPERTIES OF PURE NITROMETHANE

Molecular weight (calculated)	61.04
Boiling point @ 760 mm Hg	101.2°C (214.2°F)
Freezing point	-28.6°C (-19.4°F)
Vapor pressure @ 20°C/68°F @ 40°C/104°F @ 60°C/140°F	 27.3 mm Hg (3.6 kPa) 74.8 mm Hg (9.9 kPa) 177.8 mm Hg (23.7 kPa)
Density @ 0°C/32°F @ 20°C/68°F @ 30°C/86°F @ 50°C/122°F	 1.1621 g/mL 1.1382 g/mL 1.1244 g/mL 1.098 g/mL
Coefficient of expansion per °C per °F	 0.00122 0.00068
Isothermal compressibility factor of liquid @ 0°C/32°F @ 30°C/86°F @ 60°C/140°F	 0.000060/atm 0.000076/atm 0.000088/atm
Change in pressure with temperature of confined liquid, 0-40°C	17.5 atm/°C (257 psi/°C)
Surface tension @ 20°C	37.48 dynes/cm (37.48 mN/m)
Refractive index, *n* @ 25°C/77°F @ 50°C/122°F	 1.3796 1.3675
Viscosity @ 10°C/50°F @ 25°C/77°F	 0.73 cp (0.73 mPa•s) 0.61 cp (0.61 mPa•s)
Heat of vaporization at boilingpoint	8.225 kcal/mole
Heat of formation @ 25°C	-27.03 kcal/mole
Heat of combustion @ 25°C, liquid	-169.3 kcal/mole
Heat capacity @ 30°C, liquid	25.76 cal/mole•°C
Critical temperature	315°C (599°F)
Critical pressure	62 atm (915 psia) (6282 kPa)
Critical density	0.352 g/mL
Dielectric constant @ 30°C	35.87
Electrical conductance @ 25°C	5 x 10-9 mho/cm
Dipole moment in gas phase	3.5 Debye units
Solubility of NM in water @ 20°C/68°F @ 25°C/77°F @ 70°C/158°F	 10.5% by wt 11.1% by wt 19.3% by wt
Solubility of water in NM	
@ 20°C/68°F	1.8% by wt
@ 25°C/77°F	2.1% by wt
@ 70°C/158°F	7.6% by wt
Azeotrope with water: Boiling point @ 1 atm NM in azeotrope	 83.6°C (182.4°F) 76.4% by wt

TYPICAL PROPERTIES OF COMMERCIAL-GRADE NITROMETHANE

The following are typical properties of nitromethane. They are not to be considered product specifications.

Distillation range @ 1 atm (90% min)	100-103°C
Vapor density (air = 1)	2.11
Density @ 15°C/59°F @ 35°C/95°F	 1.140 g/mL 1.112 g/mL
Change of density with temperature, 0-50°C	0.0014 g/(mL•°C)
Weight per U.S. gallon @ 20°C/68°F	9.4 lb
Flash point, Tag open cup Tag closed cup	 44°C/112°F 35°C/96°F
Abel Pensky	34°C/93°F
Lower limit of flammability @ 33°C	7.3% by vol
Ignition temperature	418°C/785°F
Evaporation rate (n-butyl acetate = 100)	139
Evaporation number (diethyl ether = 1)	9
Solubility parameter Δ	12.7
Nitromethane content*	98.0%/by wt
Total nitroparaffins*	99.0%/by wt
Specific gravity @ 25/25°C	1.124-1.135
Acidity as acetic acid	<0.1% by wt
Water	<0.1% by wt
Color	<20 APHA

*Determined by gas chromatograph.

Product Stewardship

ANGUS encourages its customers to review their applications of ANGUS products from the standpoint of human health and environmental quality. To help ensure that ANGUS products are not used in ways for which they are not intended, ANGUS personnel will assist customers in dealing with environmental and product safety considerations. For assistance, product Safety Data Sheets, or other information, please contact your ANGUS representative at the telephone numbers provided at the end of this document. When considering the use of any ANGUS product in a particular application, review the latest Safety Data Sheet to ensure that the intended use is within the scope of approved uses and can be accomplished safely. Before handling any of the products, obtain available product safety information including the Safety Data Sheet(s) and take the necessary steps to ensure safe use.

References

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The information and data contained herein are believed to be correct. However, we do not warrant either expressly or by implication the accuracy thereof. In presenting uses for this product, no attempt has been made to investigate or discuss any patent situations which may be involved.

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