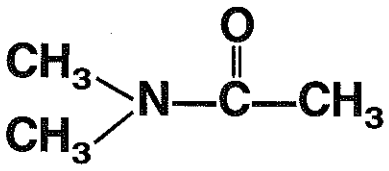
DU PONT

DATA SHEET

DIMETHYLACETAMIDE



N,N-Dimethylacetamide (DMAC) is a powerful and versatile industrial solvent featuring wide organic and inorganic solubility, water miscibility, high boiling point, low freezing point and good stability. DMAC is not "photochemically reactive" as defined in Los Angeles County's Rule 66, Section k.* Some states control all volatile organic compounds irrespective of their photochemical reactive nature. Consult the appropriate state pollution control regulations.

The Chemical Abstracts index name for DMAC is acetamide, N,N-dimethyl-, (CAS Registry Number 127-19-5). Du Pont offers high purity DMAC for industrial use only. Table I lists specifications and typical analyses of Du Pont DMAC. Du Pont also sells a closely related amide solvent, N,N-dimethylformamide (DMF).

PROPERTIES

Solvency—DMAC is an essentially neutral, nonhydroxylic, aprotic solvent with a high dielectric constant. Its solvent power is due in part to having three pairs of available electrons for hydrogen bonding.

Solubility—DMAC is completely miscible in water, ether, esters, ketones and aromatic compounds. DMAC is generally soluble in unsaturated aliphatic compounds and more soluble than DMF in saturated aliphatics.

*Equivalent to Rule 102 of the Southern California Air Pollution Control District.

Stability—Dimethylacetamide is stable up to its atmospheric boiling point in the absence of acidic and alkaline materials. It distills essentially unchanged with no color or acid formation. Above 350°C (662°F), degradation to dimethylamine and acetic acid occurs.

TABLE I
SPECIFICATIONS* AND TYPICAL ANALYSES
DU PONT DIMETHYLACETAMIDE
TECHNICAL GRADE

	Specifications	Typical Analyses**
Water, %	0.05 max	0.02
Color (APHA)	10 max	2
Conductivity, 25°C (77°F) 20% aq sol'n micromhos/cm	25 max	12
Distillation range for 1 to 95 vol %, (at 760 mm Hg and includes 166.0°C ± 0.2°C), °C	2.0 max	0.6
pH at 25°C (77°F), 20% aq sol'n	4.0-7.0	4.7

*Specifications are based on official Du Pont analytical procedures available on request.

**This column gives typical analyses based on historical production performance Du Pont does not make any express or implied warranty that all future production will demonstrate or continue to possess these typical properties.

Hydrolysis—DMAC shows only a slight tendency to hydrolyze in aqueous solutions at elevated temperatures. The hydrolysis rate increases in the presence of acids or alkalis.

NOTICE: DMAC is harmful if inhaled or absorbed through the skin. Rapidly absorbed through skin. May cause liver and kidney damage. Causes skin and eye irritation. See Personal Safety and First Aid on page 2 and the Caution For Distributors, Resellers, Formulators and Users of DMAC on page 6.

Solvolysis—Like other aprotic solvents (e.g. tetrahydrofuran, dimethylformamide, dimethyl sulfoxide), DMAC is capable of influencing substitution and elimination reactions. DMAC strongly stabilizes cations through dipole-cation interactions and minimizes the electrostatic attraction between anion and cation. Its electrical insulating action retards ion aggregation.

Hazardous Chemical Reactions—With halogenated compounds, DMAC acts as a dehydrohalogenation reagent. With certain highly halogenated compounds like carbon tetrachloride or benzene hexachloride, the reaction is highly exothermic and may become violent, particularly in the presence of iron. It is recommended that mixtures of DMAC and halogenated compounds never be used or stored in metal containers without first testing the particular system. Mixtures of DMAC and sodium hydride have been reported to generate heat and should be considered potentially hazardous.

Extreme caution must be exercised if strong oxidizing agents are to be mixed with DMAC. Use of DMAC as a reaction solvent is known to increase the rate and heat evolution of many organic reactions. It is therefore recommended that any evaluation of DMAC be initially carried out on a small scale, with gradual scale-up to thoroughly familiarize operating personnel with the characteristics of a particular reaction. Furthermore, once safe operating conditions have been established, care must be taken to see that they are not altered without first evaluating the new conditions on a small scale.

PERSONAL SAFETY AND FIRST AID

Health Hazards

DMAC is capable of producing systemic injury when inhaled or absorbed through the skin in sufficient quantities over a prolonged period of time. Symptoms of overexposure are nausea, headache and weakness. The principal effect is cumulative damage to the liver and kidney. DMAC has a low order of acute toxicity when swallowed or upon brief contact of the liquid or vapor with the eyes or skin. The LD_{50} (oral, rats) for DMAC is 4300 mg/kg.

Although DMAC is not a skin sensitizer, it is irritating to the skin and eyes.

In laboratory tests, application of DMAC to the skin of pregnant rats has caused fetal deaths when the dosages were close to the lethal dose level for the mother. Embryonal malformations have been observed at dose levels 20% of the lethal dose and higher. However, when male and female rats were exposed to mean concentrations of DMAC at 31, 101 and 291 ppm for 6 hours per day over several weeks, no reproductive effects were observed.

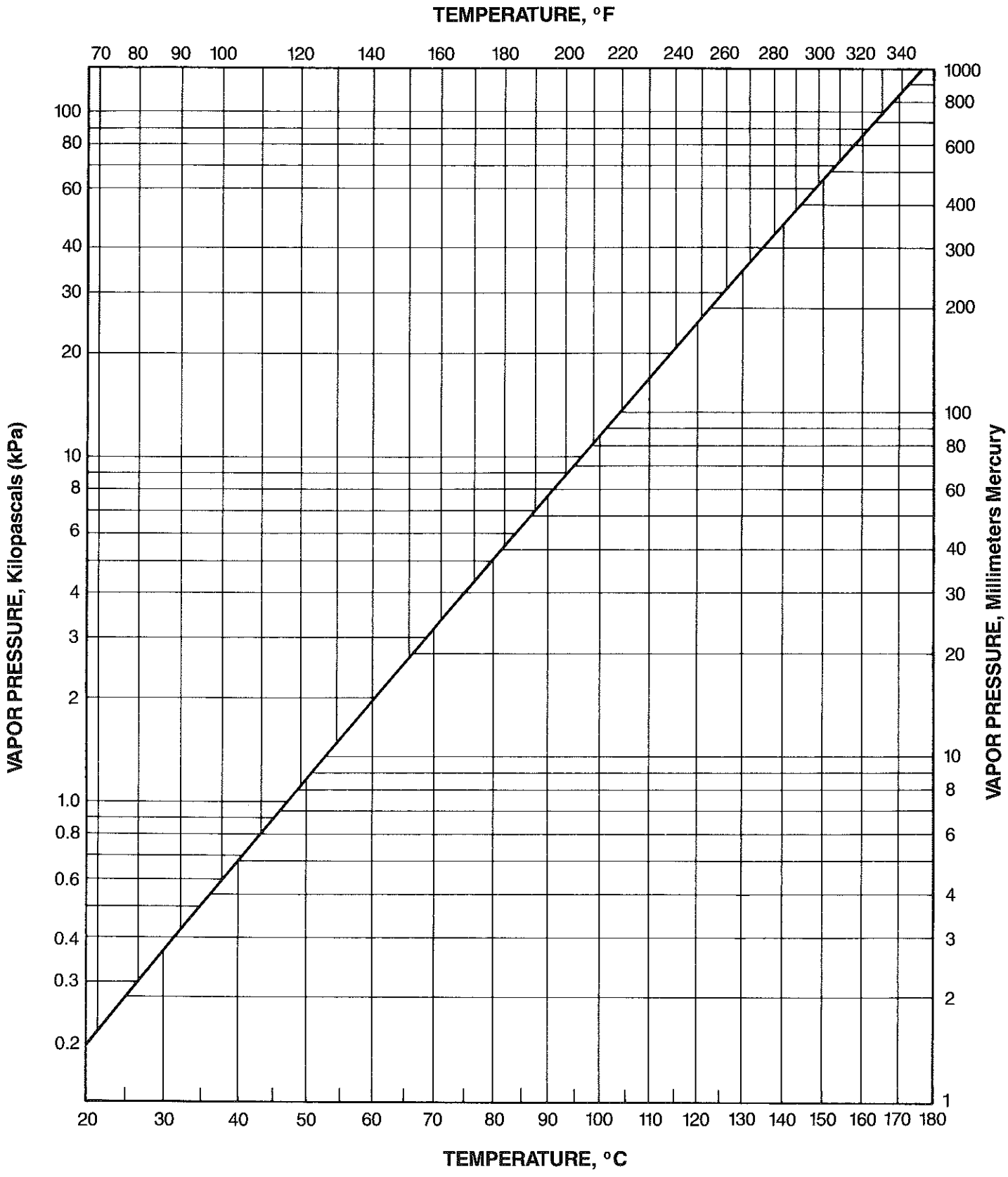
TABLE II
PROPERTIES* OF
DIMETHYLACETAMIDE (DMAC)

Molecular weight		87.12
Boiling point (760 mm Hg),	°C	166.1
	°F	331
Freezing point,	°C	−20
	°F	−4
Vapor pressure, 25°C (77°F),	mm Hg	2.0
(See Figure 1)	psia	0.04
	kPa	0.27
37.8°C (100°F),	mm Hg	4.4
	psia	0.09
	kPa	0.59
Density, 15.6°C (60°F),	g/mL (Mg/m^3)	0.945
(See Figure 2)	lb/gal	7.88
Viscosity, 25°C (77°F), cP (mPa•s)		0.92
Surface tension, 30°C (86°F), dyn/cm (mN/m)		32.43
Refractive index, n_D^{25}		1.4356
Specific Heat, liquid, 25°C (77°F),	cal/g°C (Btu/lb°F)	0.49
	kJ/Kg•K	2.05
Heat of vaporization (at bp),	kcal/g•mol	10.36
	Btu/lb	214
	kJ/kg	498
Heat of combustion ($-\triangle H°_c$), 20°C (68°F)		
	kcal/g•mol	608
	Btu/lb	12,562
	MJ/kg	29.20
Thermal conductivity, 22.2°C (72°F)		
	kcal•m/m^2•h•C	0.1579
	Btu•ft/ft^2•h•F	0.1005
	W/m•K	0.1742
Flash point (TOC),	°C	70
	°F	158
(TCC),	°C	63
	°F	145
Autoignition temperature,	°C	490
	°F	914
Flammability limits in air, vol %		
lower, 100°C (212°F)		1.8
200°C (392°F)		1.5
upper, 160°C (320°F)		11.5
Critical temperature,	°C	385
	°F	725
Critical pressure,	atm	39.7
	MPa	4.02
Dielectric constant, ϵ, 10 kHz, 25°C (77°F)		37.8
Dipole moment, μ, 20°C (68°F) Debye units		4.60
Solubility parameter, δ		10.8
Hydrogen-bonding index, ∂		6.6

*These property data are drawn from various Du Pont and literature sources. Du Pont does not make any express or implied warranty that the commercial product will have these properties.

The U.S. Department of Labor (OSHA) has ruled that an employee's exposure to dimethylacetamide in any8-hour work shift of a 40-hour work week shall not exceed a time-

FIGURE 1 VAPOR PRESSURE OF DIMETHYLACETAMIDE



weighted average of 10 ppm DMAC vapor in air by volume or 35 mg of DMAC per cubic meter of air. They also caution that, since both the liquid and vapor of DMAC are capable of penetrating the skin and mucous membranes, control of vapor inhalation alone may not be sufficient to prevent absorption of an excessive dose (29 CFR 1910.1000 Air Contaminants).[a]

If there is significant potential for skin contact with DMAC, biological monitoring should be done to measure the level of DMAC metabolites in urine specimens collected at the end of the shift. It is Du Pont practice to limit end-of-shift DMAC metabolites in urine of individuals below 40 ppm expressed as N-methylacetamide (MMAC) and to control average DMAC metabolites in urine levels for similar job classifications below 20 ppm expressed as MMAC. For additional information contact the appropriate Du Pont source on the back cover.

Safety Precautions

Do not get in eyes, on skin or on clothing. Avoid breathing DMAC vapors. Wear appropriate protective equipment (see "Personal Protective Equipment"). It is important to note that DMAC can rapidly penetrate the skin, leading to an overexposure. Contact with mixtures or solutions containing even small amounts of DMAC can also result in an overexposure. Wash thoroughly after handling DMAC.

First Aid

If inhaled, remove to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse and destroy contaminated shoes.

If swallowed do not induce vomiting. Immediately give two glasses of water, or activated charcoal slurry. Call a physician. Never give anything by mouth to an unconscious person.

Note: To prepare activated charcoal slurry, suspend 50 gm of activated charcoal in 400 mL of water in a plastic bottle and shake well.

Personal Protective Equipment

The following personal protective equipment should be available and worn as needed:

- Hard hat with brim
- Safety spectacles (side shields preferred)
- Chemical splash goggles
- Full length face shield
- DMAC-resistant butyl rubber gauntlet gloves[b]
- DMAC-resistant butyl rubber apron
- DMAC-resistant rubber boots
- Appropriate respiratory protection

A full DMAC-resistant butyl rubber suit (jacket, pants and hood) with breathing air supply will provide protection from DMAC contact and inhalation. This suit must be worn not only in emergencies but also when performing work where there is substantial possibility of direct repeated contact with DMAC.

Neoprene is abrasion resistant, and therefore, neoprene gloves are recommended for DMAC area operations. However, neoprene coated cotton gloves offer only limited protection from DMAC. Neoprene coated gloves which have contacted liquid DMAC should be discarded.

Butyl rubber gloves such as Norton Style B-161R or B-324R[b] are resistant to DMAC solvency and offer good protection from DMAC. Butyl rubber gloves should be worn in all operations where contact with liquid DMAC is likely. These gloves are designed to protect against accidental contact and are not intended for routine immersion in DMAC or continuous handling of DMAC-wetted parts. Butyl rubber is not very resistant to cuts or abrasion. Therefore, butyl gloves should be frequently inspected and discarded when they show cuts, tears, pinholes or signs of wear.

Design of DMAC facilities should avoid routine gloved contact with DMAC liquid or parts wetted with DMAC.

Special Safety Facilities

The following safety facilities should be readily accessible in all areas where DMAC is handled or stored:

- **safety showers**—or water hoses connected to spigots with quick opening valves which stay open
- **eye wash fountains**—or other means for washing the eyes with a gentle flow of filtered, moderately warm tap water.

Determination of DMAC in Air

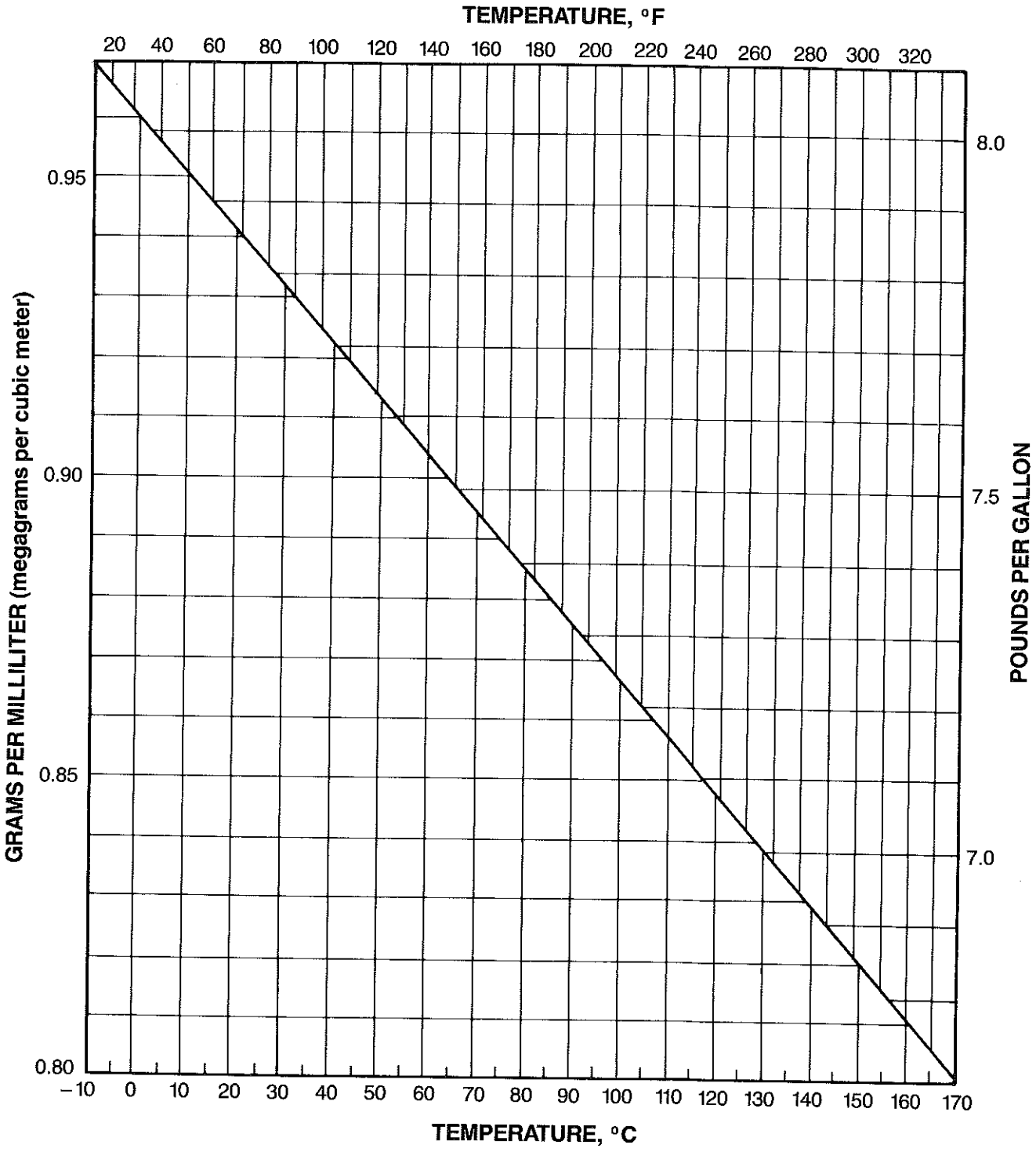
The measurement of DMAC in air can be accomplished by collection on charcoal or silica gel with gas chromatography analysis, and by passing a known amount of air through water in a gas-scrubbing vessel and analyzing the solution chemically or by gas chromatography.

---

[a]Due to changing government regulations such as those of the Department of Transportation, Department of Labor, U.S. Environmental Protection Agency and the Food and Drug Administration, references herein to government requirements may be superseded. Each user should consult and follow the current government regulations, such as Hazard Classifications, Labeling, Food Use Clearances, Worker Exposure Limitations and Waste Disposal Procedures for the up-to-date requirements for dimethylacetamide.

[b]Available from NORTON SAFETY PRODUCTS DIVISION, 2000 Plainfield Pike, Cranston, RI 02920.

FIGURE 2 DENSITY OF DIMETHYLACETAMIDE



DMAC in air can also be measured by infrared absorption or by colorimetric analysis of a pyrolyzed air sample. The colorimetric technique measures concentrations of 5–80 ppm DMAC in air using the Mine Safety Appliances Company's Samplair® pump (equivalent to the discontinued MSA Universal-Tester), available from Mine Safety Appliances Company, 600 Penn Center Blvd., Pittsburgh, PA 15235.

USES

DMAC is a uniquely versatile and powerful solvent with the following properties:

- Wide Liquid Range
- Thermal Stability
- Chemical Stability
- Water Miscibility
- Wide Organic and Inorganic Solvency
- High Polarity

Many hard-to-dissolve materials are soluble in DMAC. In some cases, the material is dissolved in a relatively small amount of DMAC and then the mixture is taken up in a large volume of second solvent. Sometimes the final solution contains only a small percentage of DMAC. But even when DMAC is only a minor ingredient in the solution, the cautionary information covered in the PERSONAL SAFETY and FIRST AID section above still applies.

DMAC in Mixtures and Consumer Products—DMAC is sold by Du Pont for industrial use only. It should *not* be used in consumer products.

In combinations of DMAC with other solvents and chemicals, the partial vapor pressure of DMAC will be lower than for pure DMAC and the rate of absorption through the skin may be slower than for pure DMAC. Nevertheless, it must be recognized that even when DMAC is a relatively minor component of a formulation, it may in some circumstances still contribute more than 10 ppm vapor to the air (exceeding the OSHA limit) and can still be absorbed through the skin in case of skin contact. This is especially pertinent if the formulation is spread in a thin film, over a large surface area having limited ventilation. Processing at elevated temperatures also requires special attention to adequate ventilation.

Other factors to be considered by formulators are whether the formulation or mixture containing DMAC is likely to be used by the general public and whether spills or splashing of the product are likely to be encountered in normal use.

CAUTION: Distributors, resellers, formulators and users of DMAC and mixtures or products containing DMAC have the responsibility of providing adequate information on safety, toxicity, and safe handling procedures to their employees and customers. This information is contained in this bulletin, in the Du Pont DMAC Properties, Uses, Storage and Handling bulletin, and in the Du Pont DMAC Material Safety Data Sheet.

Resin and Polymer Solvent—DMAC's strong solvent action makes it particularly useful in the manufacture of films and fibers and as a booster solvent in coating and adhesive formulations. Polymers containing over 50% vinylidene chloride are soluble to 20% at elevated temperatures in DMAC. In many cases DMAC solutions have higher solids content at practical working viscosities, resulting in more economical formulations than are possible with lower cost but less powerful solvents. DMAC may be useful for dissolving:

- Polyacrylonitrile
- Polyvinyl chloride
- Polyamides
- Polyimides
- Cellulose derivatives
- Styrenes
- Linear polyesters

Reaction Catalyst and Medium—DMAC is useful as a reaction medium because it is an excellent solvent for a variety of organic and inorganic compounds. Due to its high dielectric constant and solvating ability, DMAC may participate in the reaction mechanism and frequently the effect is catalytic. This often results in higher yields under less vigorous conditions than is possible with other solvents. The products frequently may be isolated by adding water to the reaction mixture. Typical of reactions that may benefit by the use of DMAC are:

- Elimination reactions such as dehydrohalogenation and dehydrogenation
- Cyclizations
- Halogenations
- Preparation of nitriles
- Alkylations
- Interesterifications
- Phthaloylations
- Preparation of organic acid chlorides.

Crystallization and Purification Solvent—The unusual solvent power of DMAC has been found useful in the purification by crystallization of aromatic dicarboxylic acids such as terephthalic acid and p-carboxyphenylacetic acid. DMAC and dibasic acids form crystalline complexes containing two moles of the solvent for each mole of acid.

Electrolytic Solvent—The use of DMAC as a non-aqueous electrolytic solvent is promising because salts are moderately soluble in DMAC and appear to be completely dissociated in dilute solutions.

STORAGE AND HANDLING

Persons handling DMAC in drums or in bulk quantities should be thoroughly familiar with DMAC hazards and safe handling practices. Refer to the Du Pont bulletin "Dimethylacetamide (DMAC)—Properties, Uses, Storage and Handling" for more detailed information. This publication is available from Du Pont sources listed on the back page.

Storage—DMAC is stored and handled in steel equipment and is usually handled at ambient temperatures. DMAC freezes at −20°C (−4°F). It is combustible and is thermally stable below 350°C (662°F) if uncontaminated.

Aluminum or stainless steel equipment is recommended for handling DMAC where stringent color or iron contamination requirements are present. Mild steel is *not* recommended for high temperature service or for handling water solutions containing less than 83 percent DMAC. Many plastics are dissolved or softened by DMAC. White asbestos or TEFLON® TFE or FEP fluorocarbon resins are the preferred materials for gaskets and packing.

DMAC is hygroscopic and should be stored and handled in equipment designed to minimize moisture pickup.

Fire Hazard—DMAC is a Class IIIA combustible liquid as defined by OSHA regulations. Its flash point, 63°C (145°F), is above the temperature at which it is normally stored and handled. However, DMAC should be stored and used in areas protected from flame, sparks, or excessive heat. Storage tanks and equipment should be electrically grounded.

Fire Fighting: In case of fire, immediately take steps to stop the flow of DMAC liquid or vapor to the involved area. Use water to protect personnel handling the shut-off and to cool equipment, tanks and lines not yet burning. Use a carbon dioxide or dry chemical extinguisher to put out small fires. Large fires are best extinguished with "alcohol-resistant" foam. Water spray may be ineffective in extinguishing DMAC fires unless used under favorable conditions by trained firefighters experienced in fighting flammable liquid fires.

Smoke and fumes from burning DMAC may be harmful upon inhalation or skin contact and must therefore be avoided. When contact with smoke is not avoidable, wear full protective equipment with breathing air supply.

NOTE: Firefighters' protective clothing provides no chemical resistance to DMAC. Chemical resistant suit with hood and self-contained breathing apparatus (SCBA) should be worn where liquid contact with DMAC could occur. Decontaminate all equipment used in firefighting efforts before returning to service.

Engineering Control of Hazards—DMAC storage and handling facilities and operating areas should include the following key elements:

- Store and handle DMAC in totally enclosed equipment where possible, or in systems designed to avoid human contact. If contact cannot be avoided, personnel must wear proper personal protective equipment because DMAC is readily absorbed through the skin.
- Unloading and process facilities must isolate DMAC from chemicals with which it reacts violently. See Hazardous Chemical Reactions on page 2.
- DMAC is a combustible liquid and should be stored and used in areas protected from flames, sparks and excessive heat.
- Storage tanks and equipment should be electrically grounded.
- Electrical equipment, wiring and fixtures must meet the requirements of the National Electrical Code, Article 500.[c]
- Vents and pressure relief devices must be designed to handle pressure limitations and volumes of vapor that could be expected in emergency conditions.
- The process and storage tank vents should be located so that toxic, flammable vapors given off during fires or emergency conditions will not harm personnel or increase the fire hazard.
- Dikes, waste drains, and collection facilities must be provided to contain possible spills or leaks during unloading and other transfers. DMAC spills, leaks and rinsings must be safely collected for later disposal or recovery.
- The storage and process layout must include provisions for more than one escape route in the event of a fire, explosion or release of toxic vapors or liquid.
- The following safety facilities should be provided: readily accessible safety showers, fire extinguishers and other fire fighting equipment, water hydrants or hoses with spray nozzles for flushing and other emergency equipment such as chemical-proof suits and respiratory apparatus.
- In addition to engineering controls, thorough operator training, written operating instructions, safety rules, check lists, work permit and flame permit procedures are required to assure safe operation.

[c]Available from National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

Spills—Spills or leaks of DMAC should be cleaned up promptly. They should be contained where possible in a suitable collection system (tank or sump) designed to minimize personnel exposure and pollution. Spills or leaks may be dammed with sand or earth. Dry sand or other non-flammable absorbents may be used to soak up the liquid. Shovel wet absorbents into steel drums with lids for disposal. Wash down the area with water to remove final traces of DMAC. Wear full protective equipment including breathing air during clean-up operations. Rope off and evacuate areas affected by spills or leaks.

When disposal of DMAC is necessary, waste disposal measures must comply with Federal, State and local air and water pollution regulations.

SHIPPING CONTAINERS

DMAC is available in 55-gallon (430-lb, 195-kg net) steel drums and in tank truck and tank car quantities.

Dimethylacetamide is regulated as a Hazardous Material by the Department of Transportation (DOT). The DOT Hazard Class is COMBUSTIBLELIQUID (49 CFR 172.101, Hazardous Materials Table). Combustible Liquids are not regulated by DOT in containers having a capacity of 110 gallons or less (49 CFR 173.118a, Exceptions for combustible liquids). The DOT Identification Number is NA1993.

Du Pont Company • Wilmington, Delaware 19898

U.S. Sales and Services

For placing orders or requesting additional product information, please use our convenient 24-hour toll-free telephone number. If you prefer, you can write to us.

By Phone

Toll-free in continental U.S.
(except Delaware)
(800) 441-9442

In Delaware
(302) 774-2099

By Mail

Du Pont Company
Chemicals and Pigments
Customer Service Center
Wilmington, DE 19898

International Sales Offices

CANADA
Du Pont Canada Inc.
Box 660
Montreal S, P.Q. H3C 2V1
(514) 861-3861

Du Pont Canada Inc.
P.O. Box 2300
Streetsville Postal Station
Mississauga, Ontario L5M 2J4
(416) 821-5570

LATIN AMERICA
Du Pont Company
Chemicals and Pigments
Latin America Sales Office
Brandywine Building
Wilmington, DE 19898
(302) 774-3403

EUROPE
Du Pont de Nemours International S.A.
P.O. Box CH-1211
Geneva 24, Switzerland
022-378111

ASIA-PACIFIC
Du Pont Far East, Inc.
Kowa Building No. 2
11-39 Akasaka 1-chome
Minato-ku
Tokyo 107, Japan
585-5511

Du Pont Far East, Inc.
Maxwell Road
P.O. Box 3140
Singapore 9051
273-2244

H-10901

Printed in U.S.A.

9/88 (2M)
103,313B