Selection of Gloves & Respirators
for use with Ethyleneamines

Glove Selection

To assist Huntsman customers in selecting gloves for their applications, available data was reviewed on the effectiveness of various gloves for the following ethyleneamines:

EDA	Ethylenediamine
DETA	Diethylenetriamine
TETA	Triethylenetetramine
TEPA	Tetraethylenepentamine
E-100	Ethyleneamine E-100
AEP	Aminoethylpiperazine
AEEA	Aminoethylethanolamine

When interpreting glove effectiveness, it is important to understand why gloves are recommended for use with ethyleneamines. Some ethyleneamines may be absorbed through the skin in harmful amounts and may cause skin burns and irritation.

In some cases there may also be allergic reactions in susceptible individuals. The following information will help in the selection of effective gloves. Please refer to the corresponding material safety data sheet (MSDS) for detailed health effects and safe handling information for the specific product being used.

Permeation Testing

The relative effectiveness of glove materials as barriers to a given chemical may be established by "permeation testing". An American Society for Testing and Materials (ASTM) method has been established for permeation testing (F739-91).

Permeation testing involves exposing one side of a glove material sample to the chemical of interest and noting the time at which the chemical first be detected on the other side of the glove material sample. This time is designated as the breakthrough time. Once the chemical has broken through the glove material, the rate at which the chemical passes through the material is determined.

This number is called the permeation rate and is expressed in mass of permeated chemical per area of glove material per unit of time, usually $\mu g / cm^2 / min$. Permeation tests are usually conducted for a maximum of eight hours. If no breakthrough is observed in this time period, it is reported as a breakthrough time greater than (>) 480 minutes and no permeation rate is listed.

A summary of the glove permeation resistance data is presented in Table 1. This table summarizes the breakthrough times and permeation rates for the ethyleneamines and five different glove materials. Generally, the glove with the longest breakthrough time is the most effective. However, while permeation resistance data provides a convenient comparison of the relative effectiveness of various materials as barriers to chemicals, this information must be evaluated in the context of the specific use situation.

Other Factors Affecting Glove Selection

In selecting a glove which is effective for a particular operation, the following factors should be considered:

Glove Material: Gloves are made of different polymer materials, each of which will resist permeation by some chemicals better than others. The materials that have been listed in Table 1 represent a wide range of available glove materials.

Chemical Mixtures: The permeation behavior of mixtures can be very different than that of the individual components. Since the test data was obtained with individual ethyleneamines, this data may not apply to the various mixtures of ethyleneamines with other solvents.

Temperature: The test data was obtained at a room temperature of approximately 75°F (24°C). Gloves become less resistant to chemical permeation as the temperature increases. An increase in temperature of 18°F (10°C) causes approximately a two-fold decrease in the breakthrough time and a corresponding increase in the permeation rate.

Thickness: Permeation varies directly with thickness. The thicker the glove material, the longer the breakthrough time and the lower the permeation rate. This is important since the same glove material could have different thicknesses, even from the same manufacturer.

Glove Use: Independent from the permeation resistance of a glove, other factors are also very important in selecting a glove which is effective for a specific use. The physical characteristics of the glove such as the durability, dexterity, heat/cold resistance and mode of use (reusable or disposable) must also be considered in the selection process.

Depending on a particular job, the amount of contact of the ethyleneamine with the glove material will vary. The data presented in Table 1 represents a "worst case" situation where there is continuous liquid contact with the glove material. In some work situations, occasional splashes with small amounts of a chemical may be the only contact. In that type of use situation, even though a particular glove may have a relatively short breakthrough time in comparison to another glove material, it may be an adequately protective and cost-effective choice.

Proper care and maintenance of protective equipment is important. Gloves should be inspected before and after each use. Proper decontamination and storage of gloves is important as continuous contact with chemicals during storage may cause decreased permeation resistance. Gloves that are damaged during use may have decreased permeation resistance and gloves that are torn or punctured may not provide protection at all.

Glove Selection continued

Different Manufacturers

There are many different processes for making gloves.

A given glove material from different glove manufacturers may have different breakthrough times and permeation rates when challenged with the same chemical.

For this reason, we have listed the specific gloves that were tested:

Manufacturer Information

Ansell Occupational Healthcare
1300 Walnut Street
Coshocton, OH 43812
800 - 800 - 0444
888 - 426 - 3663 — technical

North Safety Products
2000 Plainfield Pike
Cranston, RI 02921
800 - 430 - 4110

Erista
Rex Gummitechnik GMBH
Ostendstrasse 5
64319 Pfungstadt, Germany
06157 / 2057

Table 1 — Ethyleneamines Glove Test Results

Material Construction	Manufacturer & Model	Thickness (mm)	Thickness (mil)	Breakthrough Time in Minutes (Permeation Rate in μg/cm^2/min.)[a]						
				EDA	DETA	TETA	TEPA	E-100	AEP	AEEA
Viton	North F-091	0.23	9	Degraded	>480 (NL)	>480 (NL)	>480 (NL)	Use	Not Tested	Use
Neoprene	Ansell 29-845	0.46	18	396 (14.7)	>480 (NL)	>480 (NL)	>480 (NL)	TEPA	Not Tested	TEPA
Butyl Rubber	North B-174	0.63	25	480 (NL)	>480 (NL)	>480 (NL)	>480 (NL)	as	240[b] (NL)	as
Polyvinyl Chloride (PVC)	Ansell 34-100	0.16	6	9 (50.8)	38 (1.7)	Degraded	Degraded	reference	Not Tested	reference
Nitrile	Ansell 37-155 / Erista	0.38	15	Degraded	Degraded	>480 (NL)	Not Tested		Degraded[c]	

mm - millimeters
mil - 1/1000 of an inch
μg / cm^2 / min. - micrograms per square centimeter per minute
NL - Not Listed
[a]Testing conducted at 21 - 25°C
[b]Glove tested was North Butyl Model B-161
[c]Glove tested was Erista Nitrile Special

Respirator Selection

To assist Huntsman customers in selecting respirators for use in various applications, available data from laboratory tests was reviewed on the effectiveness of various respirator cartridges at removing the following ethyleneamines:

EDA	Ethylenediamine
DETA	Diethylenetriamine
TETA	Triethylenetetramine
TEPA	Tetraethylenepentamine
E-100	Ethyleneamine E-100
AEP	Aminoethylpiperazine
AEEA	Aminoethylethanolamine

When interpreting respirator cartridge effectiveness, it is important to understand that respirators are recommended for use with ethyleneamines because excessive exposure may cause eye and upper respiratory irritation and other possible effects.

Some ethyleneamines are respiratory sensitizers (allergens). Please refer to the corresponding material safety data sheet (MSDS) for detailed health effects and safe handling information on the specific product being used.

Respirator cartridge breakthrough information specific to each ethyleneamine was not available. However, for materials within the same chemical family, data from similar materials can be helpful in determining the performance of a respirator cartridge.

Respirator Cartridge Breakthrough Testing

The relative effectiveness of a respirator cartridge to remove an air-contaminant may be estimated by respirator cartridge breakthrough testing. This testing is performed similarly to the permeation testing on glove materials.

A challenge atmosphere containing a known concentration of the test chemical is generated on one side of the respirator cartridge. The air is drawn through the cartridge and then the air exiting the cartridge is analyzed for the presence of the test chemical. The time at which the challenge chemical is first detected at a pre-determined level (breakthrough concentration) in the air exiting the cartridge is designated as the breakthrough time.

A summary of the respirator breakthrough data is presented in Table 2. Generally the cartridge with the longest breakthrough time is the most effective. However, while the breakthrough data provides a convenient comparison of the relative effectiveness of various cartridges at removing the chemical of interest, this information must be evaluated in the context of the specific use situation. The vapor pressure and molecular weight of the materials are helpful in determining an effective respirator cartridge in the event that test data is not available.

As the molecular weight of a material increases, its vapor pressure decreases proportionately. For chemicals within the same family, the adsorbent material within the respirator cartridge will tend to have a higher trapping capacity for a material that has a higher molecular weight and lower vapor pressure. For this reason, not all materials within a chemical family need to be specifically tested to determine the suitability of a respirator cartridge. More information on the physical properties of ethyleneamines is available on the MSDS for the specific product of interest.

Other Factors Affecting Respirator Selection

In selecting a respirator effective for a particular operation, the following factors should be considered:

Physical State & Concentration: The physical state and airborne concentration of the material should be estimated or determined to identify the appropriate respiratory protection. For example, in a situation where the material may be present both as a mist and as a vapor, a combination dust, mist and vapor cartridge should be used to provide protection against the material.

Additionally, where eye irritation is present or when the exposure concentration exceeds ten-times the occupational exposure guideline, a full-face respirator is recommended rather than a half-mask respirator as it provides eye protection as well as additional protection at higher concentration levels.

Under some circumstances, self contained breathing apparatus (SCUBA) might be the preferred equipment. Refer to the Occupational Safety and Health Administration Respiratory Protection Standard (29CFR1910.134) and the American National Standards Institute Respiratory Protection Standard (ANSI Z88.2) for further information on respirator selection.

Flow Rate: Cartridges are typically tested at flow rates of 50 to 64 liters per minute. This represents a breathing rate of a person performing at a very heavy workload. Generally, the breakthrough time varies linearly with the breathing rate. For example, a person breathing at half of the tested flow rate could expect a breakthrough time twice as long as indicated by the testing data (assuming all other conditions were the same as those tested).

Temperature: The test data were obtained at a room temperature of approximately 75°F (24°C). As temperature increases, the airborne concentration of contaminant may increase due to additional vapor pressure which may reduce the time a cartridge can be used in a given situation before breakthrough occurs. Higher temperatures may also reduce the capacity of the absorbent material which may decrease breakthrough time.

Humidity: The test data were obtained at specific humidity conditions. As humidity increases, the increased water vapor will compete for sites on the adsorbent filter beds with the chemical of interest which may reduce the time a cartridge can be used in a given situation before breakthrough occurs.

Other Contaminants: The test data were obtained using the pure chemical as the only challenge agent. If other contaminants are present in significant amounts, they will compete for sites on the filter beds with the chemical of interest which will reduce the time a cartridge can be used in a given situation before breakthrough occurs.

Warning Properties: In general, respirators should only be used for materials with adequate warning properties. Ethyleneamines can be detected as an ammonia-like odor. If odors are detected within the respirator, this may indicate that there is contaminant breakthrough of the cartridge or that the respirator is damaged or not fitted properly.

Should this occur, the user should leave the area and investigate the cause of the problem by changing the cartridges, inspecting and repairing the respirator, or obtaining a correct-fitting respirator, as the conditions warrant.

Respirator Selection continued

Manufacturer Information

Aearo Corporation
Safety Products Division
90 Mechanic Street
Southbridge, MA 01550
800 - 225 - 9038
800 - 444 - 4774 — technical

3M Company
3M Center
Building 0235-02-E-91
St. Paul, MN 55144
800 - 243 - 4630

Scott Health & Safety
309 West Crowell Street
Monroe, NC 28112
800 - 247 - 7257

Table 2 — Ethyleneamines Respirator Test Results

Chemical	Molecular Weight	Vapor Pressure (mmHg, @20°C)	Concentration (ppm) Challenge	Concentration (ppm) Breakthrough	Relative Humidity (%)	Breakthrough Time in Minutes at 24°Celsius — Cartridge (Manufacturer[a], Model, Type[b]) AO R51A (OV-CART)	AO R54A (AM-CART)	S 805050-02 (OVAG-CAN)	3M 5201 (OV-CART)	3M 5204 (AM-CART)
Disopropylamine	101	18	1000.0	10.0	50	77	Not Tested	Not Tested	Not Tested	Not Tested
			1000.0	100.0	50	87	Not Tested	Not Tested	Not Tested	Not Tested
			1000.0	990.0	50	185	Not Tested	Not Tested	Not Tested	Not Tested
Ethanolamine	61.4	0.4	87.0	3.0	20	>2400	>2400	>2400	>2400	>2400
(MEA)			50.0	3.0	61	>2400	>2400	>2400	>2400	>2400
EDA	60.1	10.0	Use Disopropylamine as reference							
DETA	103.2	0.1	19.0	0.8	47	>2520	>2520	Not Tested	Not Tested	Not Tested
TETA	146.2	<0.01	Use DETA as reference							
TEPA	189.3	<0.01	Use DETA as reference							
E-100	275.0	<0.01	Use DETA as reference							
AEP	129.2	<0.1	Use DETA as reference							
AEEA	104.1	<0.01	Use MEA as reference							

[a]Manufacturer Codes

AO - Aearo Corporation
S - Scott Health & Safety
3M - Minnesota Mining and Manufacturing

[b]Type Codes

AM - Ammonia
OV - Organic Vapor
OVAG - Organic Vapor and Acid Gas
CART - Cartridge
CAN - Canister

In situations where air-purifying respirators are currently recommended, a dust/mist/fume (DMF) or high-efficiency particulate (HEPA) pre-filter should be used in combination with either an organic vapor or ammonia/amines approved cartridges when aerosols may be present.

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