

Octadecylamine

Processing

Chemical Name(s):

Octadecylamine

CAS Number:

124-30-1

Other Names:

1-Aminooctadecane, 1-Octadecanamine, adagenen 142, Alamine 7, Alamine 7D, Armeen 118D, Armeen 18D, Armofil, Kemamine P990, N-Octadecylamine, N-Stearylamine, Nissan Amine AB, Stearamine, Stearylamine, ODA

Other Codes:

NIOSH Registry Number: RG4150000

Summary of Advised Recommendation*

Synthetic / Non-Synthetic:	Allowed or Prohibited:	Suggested Annotation:
<i>Synthetic</i>	<i>Prohibited</i>	<i>None.</i>

Characterization

Composition:C₁₈H₃₉N**Properties:**

Opaque, off-white liquid with ammoniacal odor; insoluble in water but soluble in alcohol, ether, benzene; very soluble in chloroform; miscible in acetone; boiling point 346.8 deg C at 760 mm Hg; melting point 52.9 deg. C; molecular weight 269.51; specific gravity 0.8618 at 20 deg C/ 4 deg. C.

How Made:

ODA is produced by catalytic hydrogenation of stearyl nitrile, which itself is the product of stearic acid and nitride. Stearic acid is an 18-carbon saturated fatty acid found in tallow, coconut, soya, palm kernel and palm. The highest levels— over 19%— are found in tallow. Nitride is produced by passing ammonia over a heated metal.

Specific Uses:

Boiler water additive used to prevent the corrosion of boiler equipment and their distribution lines; used as a mold release agent in manufacture of battery cases; chemical intermediate for octadecyl isocyanate; chemical intermediate for other surface-active agents; anticaking agent; flotation agent; agents in various aspects of petroleum industry; antistripping agent in asphalt emulsions for highways.

Action:

Octadecylamine forms a molecularly thin film on the interior of steam lines. This boiler water additive prevents corrosion by preventing carbonic acid formed from carbon dioxide captured within the steam from coming into contact with the steam lines. ODA also has surfactant properties.

Combinations:

Used in combination with ammonium hydroxide and various volatile amines (cyclohexylamine, diethylaminoethanol, and morpholine).

* This Technical Advisory Panel (TAP) review is based on the information available as of the date of this review. This review addresses the requirements of the Organic Foods Production Act to the best of the investigator's ability, and has been reviewed and commented on by experts on the TAP. The substance is evaluated against the criteria found in section 2119(m) of the OFPA (7 USC 6517(m)). The information and advice presented to the NOSB is based on the technical evaluation against that criteria, and is not intended to incorporate commercial availability, socio-economic impact, or any other factor that the NOSB and the USDA may want to consider in making their decisions.

Status

OFPA

May be added to the National List as an equipment cleaner [7 USC 6517(c)(1)(B)(i)].

Regulatory

FDA— [21CFR Sec.173.310] Boiler water additives; not to exceed 3ppm in steam and excluding use of such steam in contact with milk and milk products.

EPA/NIEHS/Other Appropriate Sources

EPA - Does not appear on any of the EPA's lists of hazardous substances (EPA, 1998b).

NIEHS - National Toxicological Program (NTP, 2001)

Acute Toxicity:

dose	mode	specie	amount	unit
LD50	ipr	mus	250	mg/kg

Sax Toxicity Evaluation: Not available

Carcinogenicity: Not available

Mutagenicity: Not available

Teratogenicity: Not available

Standards, Regulations & Recommendations:

OSHA: None

ACGIH: None

NIOSH Criteria Document: None

NFPA Hazard Rating: Health (H): None

Flammability (F): None

Reactivity (R): None

Other Toxicity Data:

Skin and Eye Irritation Data:

skn-rbt 500 mg/24H MOD

Review: Toxicology Review

Status: Reported in EPA TSCA Inventory, 1980

Acute/Chronic Hazards:

Exposure to this compound may cause sensitization of the skin.

Minimum Protective Clothing:

If Tyvek-type disposable protective clothing is not worn during handling of this chemical, wear disposable Tyvek-type sleeves taped to your gloves.

Recommended Respirator:

Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas and SO₂) with a dust/mist filter. Splash proof safety goggles should be worn while handling this chemical. Alternatively, a full face respirator, equipped as above, may be used to provide simultaneous eye and respiratory protection.

Storage Precautions:

You should keep this material in a tightly-closed container under an inert atmosphere, and store it at refrigerated temperatures.

Spills and Leakage:

If you spill this chemical, **FIRST REMOVE ALL SOURCES OF IGNITION**, then dampen the solid spill material with toluene, then transfer the dampened material to a suitable container. Use absorbent paper dampened with toluene to pick up any remaining material. Your contaminated clothing and absorbent paper should be sealed in a vapor-tight plastic bag for eventual disposal.

Solvent-wash all contaminated surfaces with toluene followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

Skin Contact:

IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water.

IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop.

IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.

Inhalation:

IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Respirator Recommendation.

Eye Contact:

First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center.

Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician.

IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

Ingestion:

DO NOT INDUCE VOMITING. Corrosive chemicals will destroy the membranes of the mouth, throat, and esophagus and, in addition, have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems.

If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and **IMMEDIATELY** call a hospital or poison control center. **IMMEDIATELY** transport the victim to a hospital.

If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. **DO NOT INDUCE VOMITING.** Transport the victim **IMMEDIATELY** to a hospital.

Status Among U.S. Certifiers

Not allowed by any U.S. Certifier. See the discussion in the background paper Steam Generation in Organic Food Processing Systems (Steam Paper).

International

Canada - Not included in the list of permitted non-organic additives substances for organic food products (CGSB, 1999).

CODEX- Not in Annex 2, Table 4, 'Processing Aids' (FAO/WHO, 1999).

EU 2092/91 - Not in Annex VI, 'Processing Aids' (EU 2092/91).

IFOAM - Not on Appendix IV, approved processing aids and other products (IFOAM, 2000).

Japan - Not on the list of approved food additives (Woolsey, 2000).

OFPA 2119(m) Criteria

- (1) *The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.*
As this is a processing material, the substance is not used in organic farming systems. Chemical interactions within a processing environment are discussed in the Steam Paper.
- (2) *The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.*
See processor criteria (3) below.
- (3) *The probability of environmental contamination during manufacture, use, misuse or disposal of such substance.*
This is considered below under item (2).
- (4) *The effect of the substance on human health.*
This is considered in the context of the effect on nutrition (3) below as well as the consideration of GRAS and residues (5) below.
- (5) *The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock.*
As this is not released into the agroecosystem, there is no direct effect.
- (6) *The alternatives to using the substance in terms of practices or other available materials.*
See discussion of alternatives in the Steam Paper.
- (7) *Its compatibility with a system of sustainable agriculture.*
This is considered more specifically below in the context of organic handling in (6) below.

Criteria from the February 10, 1999 NOSB Meeting

A PROCESSING AID OR ADJUVANT may be used if;

1. *It cannot be produced from a natural source and has no organic ingredients as substitutes.*
When considering chemical means to condition steam lines in boiler systems, the additives to the steam lines must be volatile, so that they purposely travel along with the steam. There are no known non-synthetic boiler additives that can serve this purpose. However, steam can be produced from water without the addition of boiler water additives. A list of substances that are FDA approved for boiler water contact is attached. While these are not direct substitutes, these are available options. The NOSB has already recommended that several of these be listed. See the Steam Paper for more discussion.
2. *Its manufacture, use, and disposal do not have adverse effects on the environment and are done in a manner compatible with organic handling.*
Octadecylamine (ODA) is manufactured from stearic acid and ammonia. Stearic acid is a fatty acid derived from beef tallow and other natural sources. The impact of ammonia is covered in the TAP review on ammonium hydroxide. Catalytic hydrogenation entails a significant use of energy in addition to that expended for ammonia production.

The material is an irritant, and needs to be handled as such. There are no instructions or restrictions for disposal (EPA, 1998b). Properly handled, its environmental impacts appear to be negligible. However, both surfactant and amine properties may be harmful to aquatic life if discharged into water. Octadecylamine can be poisonous by intraperitoneal routes, and is a skin irritant (Lewis, 1989) and a severe eye irritant (Akzo Chemie, 1995). Fatty alkylamines are generally considered skin and eye irritants, but generally not a hazard by inhalation routes (Visek, 1992). When heated to decomposition, it produces toxic fumes of NO_x (Lewis, 1989).
3. *If the nutritional quality of the food is maintained and the material itself or its breakdown products do not have adverse effects on human health as defined by applicable Federal regulations.*
The effects of the addition of octadecylamine to the processing stream on the nutritional or other quality of food does not appear to have been studied. Octadecylamine is a moderately toxic compound that is considered poisonous

when ingested (Lewis, 1989). Rated as 3 on a scale of 1-5 or moderately toxic (Gosselin, Smith, and Hodge, 1984). One source states that primary amines with very long alkyl chains, such as octadecylamine, are regarded as practically non-toxic, and some lab animals have tolerated high doses for long periods (Greim, et al., 1998). However, researchers have noted histological changes in the lymph nodes, gastrointestinal mucosa and liver of test animals (Gosselin, Smith, and Hodge, 1984). One study noted that laboratory animals with long-term exposure to this material produced some intestinal tract cellular aberrations (Deichmann, et. al, 1958).

4. *Its primary purpose is not as a preservative or used only to recreate/improve flavors, colors, textures, or nutritive value lost during processing except in the latter case as required by law.*
The primary use is to prevent corrosion of boiler and steam line equipment. It is not intended to have any functional effect on the food, but will carry over into the steam that is in direct food contact. It does not serve as a preservative, or to recreate/improve flavors, colors, textures, or nutritive value lost during processing.
5. *Is Generally Recognized as Safe (GRAS) by FDA when used in accordance with Good Manufacturing Practices (GMP), and contains no residues of heavy metals or other contaminants in excess of FDA tolerances.*
Octadecylamine is not Generally Recognized as Safe (GRAS). The FDA sets a threshold for its use in steam that is in contact with food because of its toxicity. There is no Food Chemicals Codex monograph.
6. *Its use is compatible with the principles of organic handling.*
Organic standards are precautionary when evaluating synthetic substances used in food. Volatile amines in general do not appear to be compatible with the principles of organic handling. They are synthetic, toxic, and are not necessary to produce any food. Even though octadecylamine appears to be the least toxic of the compounds, it still has environmental impacts of the manufacturing process and the adverse health effects from exposure that do not fit within organic principles. Food processors generated and used steam for a long time without these chemicals. Many organic food processors have already adopted viable and practical ways to address corrosion. This is further discussed in the Steam Paper, as well as in the TAP Reviewers' comments.
7. *There is no other way to produce a similar product without its use and it is used in the minimum quantity required to achieve the process.*
Again, culinary steam can be produced without the use of this chemical. See the Steam Paper and the TAP Reviewers' comments for a further discussion.

TAP Reviewer Discussion*

Reviewer 1 [Food Science and Nutrition Professor with inspection and certification experience]

Octadecylamine is . . . a synthetic compound . . . intended to function similarly to a coating on the inside walls of the steam pipes. Fatty amines which contain alkyl chains of 10 to 14 carbons are considered more irritating than fatty amines containing 1 to 18 carbon atoms such as octadecylamine which is C₁₈H₃₉N from a health and safety issue. Overall oral and dermal toxicity has been reported to be moderate and is not considered an inhalation hazard at ambient conditions because of its low volatility. However, inhalation of its heated vapor such as in steam may result in irritation of the nose, throat and upper respiratory system.

[ODA] is not allowed by any US certifier [or] any international certification agency.

...

Octadecylamine is used with a combination of emulsifiers and in some cases neutralizing amines (Betz, 1980). The film is spread out giving more uniform [coverage] and increasing the protection afforded by the filming amine.

Even though the reactivity of ODA is generally less than the neutralizing amines, since it is blended with other volatile components or ingredients especially neutralizing amines, it clearly is not consistent with sound organic principles and sustainability. It is considered poisonous when ingested and is not generally recognized as safe. My conclusion is that it be

* OMRI's information is enclosed in square brackets in italics. Where a reviewer corrected a technical point (e.g., the word should be "intravenous" rather than "subcutaneous"), these corrections were made in this document and are not listed here in the Reviewer Comments. The rest of the TAP Reviewer's comments are edited for identifying comments, redundant statements, and typographical errors. Any text removed is identified by ellipses [. . .] Statements expressed by reviewers are their own, and do not reflect the opinions of any other individual or organization.

prohibited from all organic food processing operations where there is direct contact of the steam to the organic food being processed. As a prohibited boiler additive, I do not feel this will present an unsolvable issue with large scale organic food processors since there are a number of options used individually or collectively to insure boiler-steam line integrity and overall energy efficiency. These options include boiler feed water treatments and/or installation of stainless steel steam lines as noted previously.

Advised Recommendations to the NOSB

1. Synthetic
2. Prohibited
3. Suggested annotation: prohibited for processing operations where there is direct steam to food contact.

Reviewer 2 [Consultant to organic certifiers]

Octadecylamine is a synthetic material . . . use[d] as an additive to steam that comes into direct contact with organic foods during processing. . . It is interesting to note that the levels of octadecylamine permitted in contact with foods during processing is lower [more strict] than those set for morpholine, diethylaminoethanol, [and] cyclohexylamine. . .

Historically, NOSB recommendations have been against the contact of any synthetic boiler additives with organic foods. All organic production and processing standards are in agreement that toxic substances should not contaminate organic foods. Organic certifiers in the United States, if they take a position at all on this issue, are consistent in repeating the prohibition recommended by the NOSB. Of all volatile amines used in food processing systems, octadecylamine is perhaps the least toxic, but it is nonetheless synthetic, it does have some deleterious affects on health from exposure, and does not pose any benefits to the nutritional qualities of foods. Ammonium soaps have been prohibited [for handling] by the NOSB (OMRI, 2001).

Live steam can be and is produced in many processing systems without the use of any boiler additives that carry over onto the food products. Boiler water can be treated in advance of use in the system by a variety of methods to soften, deionize, filter, and otherwise purify it. These steps reduce the need for addition of synthetic materials not on the National List to the boiler system. In some applications, the steam or heating system for the food may be changed to one where live steam is not the active agent, but rather heating (of food contents directly, or of steam in contact with food) is done via a heat exchange system. The wide variety and individuality of processing systems which exist is indicative of the many ways in which the full range of processed food products can be made, without the need for toxic boiler additives to be used in contact with organic foods. This reviewer does not know of any food product type that absolutely requires octadecylamine in steam which contacts organic food.

Justification of use of octadecylamine by the petitioners is based on the constraints of their particular boiler and steam systems as they currently exist, and on the financial and/or logistical challenges involved with changing those systems so as to avoid contact of the organic food by the octadecylamine. However, economic considerations are clearly not one of the criteria (either in OFPA or the final NOP rule) for determining the suitability of materials used in organic production systems.

History shows that . . . an organic operator (producer or handler) has had to make substantial changes to their system in order to be compliant with organic standards. These changes often involved redesigning of systems, practices, and techniques. In many cases, such changes resulted in the need for financial investment, as well as an investment in time. Some creativity on the part of the operator was often needed, to devise a new system. This has indeed been the case for certain processors, who made adjustments to their boiler systems or manufacturing practices in order to comply with the prohibition of contact of organic foodstuffs by synthetic boiler chemicals. The inconvenience of having to retool or readjust systems should not be the determining factor in whether or not such materials are added to the National List.

For certain processors, where organic processing events are not frequent, the boiler may be operated without the octadecylamine for a limited time, without significant affect on the boiler or steam line system. For these operations, no retooling may be needed; instead, a procedure can be designed whereby it is verifiable that the volatile boiler chemical has been exhausted from the system prior to handling the organic goods.

For processors who intend to process frequently enough, or for long enough run times, redesigning of the system will be necessary, in one way or another. Prohibition on the use of volatile boiler chemicals can exist without consigning processors to premature deterioration of their equipment. It is often the case in industry that the creative process involved in redesigning systems has unpredicted benefits (short- and long-term) to the operator and the environment, in terms of long-term cost-effectiveness and sustainability; efforts in this direction should be encouraged, especially if not doing so results in a compromise of organic principles.

In fact, running boiler equipment designed for use with synthetic additives without the additives in place does lead to deterioration, and consequent lower efficiency of the system, which generally means greater energy consumption (Kohan, 1997). While greater efficiency of energy consumption seems undoubtedly to be desirable (both economically and ecologically), energy balance as a whole has not been considered as factor by the NOSB or certifiers when making determinations on the compatibility or allowability of materials or methods. To use such a factor as a criterion in the case for the volatile boiler additive is therefore inconsistent with the rest of the paradigm, and should not be a determining factor at this time.

Advised Recommendations to the NOSB

Octadecylamine should be deemed a synthetic, prohibited material, and not be added to the National List for any purpose.

Reviewer 3 [University staff in Food Science with inspection, consulting, and certification experience] Octadecylamine (ODA) is . . . a steam additive chemical to reduce corrosion in pipes. There could be direct food contact in many processing operations when steam is used to cook or heat food, such as in a blancher, cooker, canner, or other operations. ODA has no functionality toward the food. Much of the petition was such a poor copy as to be illegible. The sections were not numbered so those that are illegible could not be identified.

Comments Based on the Criteria

Octadecylamine is manufactured from stearic acid (derived from beef tallow) and ammonia. These potentially might be available from a natural source, but no indication is made in the petition to use natural sources, nor is there discussion of potentially acceptable manufacturing practices.

Octadecylamine is an irritant and must be handled properly. Octadecylamine is rated as poisonous when ingested and as moderately toxic. In spite of this lab animals have tolerated high doses for long periods. It would appear that it has no adverse effects on human health if used as intended.

The justification for use of ODA is no different than trying to justify the use of a synthetic herbicide like Round-Up for organic farming, just because it provides a cheaper alternative to weed control and does not leave any detectable residue. Organic handling isn't about economics or end product testing, it's the process that's critical when evaluating compatibility with organic principles. Food processors generated and used steam for a long time without these chemicals. Many organic food processors have already adopted viable and practical ways to address corrosion without the use of ODA.

There are other solutions that could be used to produce the desired result (no corrosion of piping). To summarize many of the citations reviewed, 'use of stainless steel piping completely solves the problem of corrosion.' The justification statement in the petition and the alternative control methods do not mention this as a possible solution. They do mention the costs of capital equipment and provide anecdotal evidence of the life expectancy and replacement needs should boiler water additives not be used, but provide no data to support this. There are numerous tests that can and should be performed periodically to determine the corrosion rates, (even with the use of inhibitors) to insure that equipment is being operated and maintained in a safe and efficient manner. Without confirming studies to show the differences in corrosion rates with and without the use of corrosion inhibitors, it appears that these petitioners are using anecdotal evidence to justify their continued use of cheap toxic chemicals instead of more expensive, but viable alternatives. There are several cited alternatives: stainless steel piping (suitable for all operations); discontinued use during organic processing (some operations); steam to steam heat exchanger (suitable for some operations); secondary boiler for food contact application only (suitable for all operations) that could be used. None of these are necessarily cheap, but all offer a viable alternative to the use of toxic chemicals.

Advised Recommendations to the NOSB

In spite of the low health and environmental impact of ODA, alternatives exist with even lower impacts. Octadecylamine should not be approved for use as a boiler chemical for organic production.

Conclusion

The reviewers unanimously consider octadecylamine to be synthetic, and unanimously advise the NOSB to not add octadecylamine to the National List. Use should remain prohibited in organic handling.

References

See the Steam Paper.

J. Rindtorff
aski.
71, 213-231

o Eastman
Stanin (to
Khim. 56,
Metzger (to
yclopedia of
k, 1971, pp.

s, Inc., New
-681 (1972).
ith ed., sect.

als, 2nd ed.,

V. Arbir (to
Ohsako (to
SF).
,G).
er (to CIBA

l).
Nalepa (to
Campbell (to
Campbell (to

0 (1986).

6 (1985).

88. U.S. Pat. 3,401,190 (Sept. 10, 1968), K. Schmitt, F. Gude, K. Rindtorff, and J. Disteldorf (to Schloven-Chemie).
89. U.S. Pat. 4,256,869 (Mar. 17, 1981), H. Schulze, and co-workers (to Akzo).
90. U.S. Pat. 4,892,920 (Jan. 16, 1990), J. R. Quay and J. P. Casey (to Air Products).
91. U.S. Pat. 3,309,192 (Mar. 14, 1967), (to E. I. du Pont de Nemours & Co., Inc.).
92. U.S. Pat. 3,902,887 (Sept. 2, 1975), K. Lin (to E. I. du Pont de Nemours & Co., Inc.).

General References

- R. L. Augustine, *Catalytic Hydrogenation*, Marcel Dekker, New York, 1965.
M. Freifelder, in *Practical Catalytic Hydrogenation: Techniques and Applications*, John Wiley & Sons, Inc., New York, 1971, Chapt. 16.
M. Freifelder, in *Catalytic Hydrogenation in Organic Synthesis: Procedures and Commentary*, John Wiley & Sons, Inc., New York, 1978, Chaps. 5, 7.
P. N. Rylander, Inc., *Catalytic Hydrogenation in Organic Syntheses*, Academic Press, New York, 1979.
P. N. Rylander, *Hydrogenation Methods*, Academic Press, London, 1985.

JEREMIAH P. CASEY
Air Products and Chemicals

FATTY AMINES ^{oct}

Fatty amines are nitrogen derivatives of fatty acids, olefins, or alcohols prepared from natural sources, fats and oils, or petrochemical raw materials. Commercially available fatty amines consist of either a mixture of carbon chains or a specific chain length from C₈-C₂₂. The amines are classified as primary, secondary, or tertiary depending on the number of hydrogen atoms of an ammonia molecule replaced by fatty alkyl or methyl groups (Fig. 1). The amino nitrogen is most frequently found on a primary carbon atom, but secondary and tertiary carbon substitution derivatives have been made and are commercially available. Fatty amines are cationic surface-active compounds (see SURFACTANTS), which strongly adhere to surfaces by either physical or chemical bonding, thus modifying surface properties. Important commercial products are prepared using fatty amines as reactive intermediates.

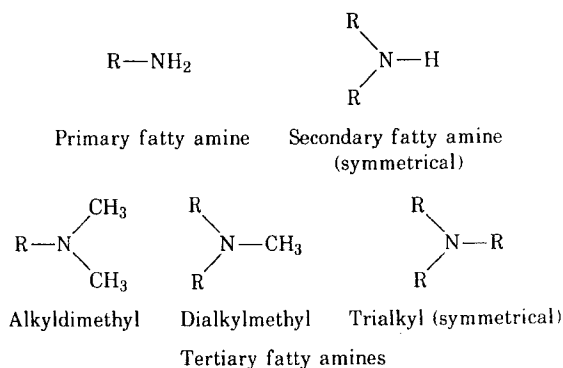


Fig. 1. Types of commercially available fatty amines. R = C₈-C₂₂.

Commercially available fatty amines are most frequently prepared from naturally occurring materials (see FATS AND FATTY OILS) by hydrogenation of a fatty nitrile intermediate using a variety of catalysts (1-3). Naturally occurring fats and oils (triglycerides) are continuously hydrolyzed at 200-280°C to yield saturated and unsaturated fatty acids and glycerol. Fatty nitriles are prepared from fatty acid mixtures by batch or continuous processes. The alkyl chain-length composition of the amines varies depending on the type of fat or oil. Other factors influencing alkyl chain composition include location of source, time of harvest, and, more recently, hybridization. Typical compositions for various fats and oils used to prepare commercially available fatty amines are given in Table 1 (4-8).

Table 1. Typical Fatty Acid Composition

Fatty acid ^a , %	Fat		Fatty oils		
	Tallow	Coconut	Soya	Palm kernel	Palm
caproic (C6:0)		1.2		<0.5	
caprylic (C8:0)		3.4-15.0		2.4-6.2	
capric (C10:0)		3.2-15.0		2.6-6.2	
lauric (C12:0)		41-56		41-55	
myristic (C14:0)	3.0	13-23	0.9	14-20	1
palmitic (C16:0)	29.2	4.2-12.0	7-12	6.5-11.0	43.5
stearic (C18:0)	19.1	1.0-4.7	2.0-5.5	1.3-3.5	4.5
oleic (C18:1)	43.6	3.4-12.0	20-50	10-23	40
linoleic (C18:2)	2.1	0.9-3.7	35-60	0.7-5.4	
linolenic (C18:3)	0.5		2-13		
other	2.5				11

^aThe number of carbon atoms and number of double bonds are designated in parentheses.

Fatty amines derived from fats and oils, containing several carbon-chain-length moieties, are designated as such by common names which describe these mixtures: tallowalkyl- [61790-33-8], cocoalkyl- [61788-46-3], and soyaalkylamines [61970-18-9], for example. High purity fatty amines are also commercially available. These amines are prepared by distillation of either the precursor fatty acid or amine product mixture. There are common names for single chain-length fatty amines in addition to IUPAC nomenclature, which uses the alkyl chain length in naming the amine. Secondary and tertiary amines have been named as primary amine derivatives, for example, *N*-hexadecyl-1-hexadecylamine instead of di-*n*-hexadecylamine (IUPAC). Examples include:

Common name	IUPAC name	Molecular formula	CAS Registry Number
laurylamine	1-dodecylamine	C ₁₂ H ₂₇ N	[124-22-1]
palmitylamine	1-hexadecylamine	C ₁₆ H ₃₅ N	[143-27-1]
stearylamine	1-octadecylamine	C ₁₈ H ₃₉ N	[124-30-1]
oleylamine	1-octadecen-9-ylamine	C ₁₈ H ₃₇ N (unsaturated)	[112-90-3]

Trade nam

In rec prepared v
In 1978 Ea
fatty acids
States, prc
acids was
synthetic f

Fatty
aldol or hy
or a prima
(10-12).

In ad
methods o
able tertia
have been
secondary
or an amm
atoms witl
in the pr
primary a
be prepar
100-250°C
carboxylic
pressure u
ide-alumi
high press
Groups 6
from an u
been usef
the Hofm:
odd-chain
pared. Th
strong ac
Haas Pri

Physical

Data on
summariz
(3,8,13,26
primary,
points w
with mol
point tha
a primar
symmetri
amine of

Trade names are commonly used for commercial products.

In recent years, especially in the USSR and Europe, synthetic fatty acids, prepared via hydrocarbon oxidation, have been used to prepare fatty amines (2,9). In 1978 Eastern Europeans produced an estimated 0.55 billion kg of synthetic fatty acids with odd and even numbers of carbon atoms, whereas in the United States, production of natural fatty acids with even carbon atom chain-length acids was 435 million kg. To date, there has been no significant production of synthetic fatty acids in the United States.

Fatty alcohols, prepared from fatty acids or via petrochemical processes, aldol or hydroformylation reactions, or the Ziegler process, react with ammonia or a primary or secondary amine in the presence of a catalyst to form amines (10-12).

In addition to the nitrile and alcohol routes just described, many other methods of preparation of fatty amines are available. Some commercially available tertiary fatty amines are prepared via a petrochemical route (13). The amines have been prepared by reaction of an olefin with ammonia or a primary or secondary amine in the presence of a catalyst prepared from a Group 8-10 metal or an ammonium halide (14-16). Nitration of paraffins having from 6 to 30 carbon atoms with nitrogen dioxide at elevated temperatures followed by hydrogenation in the presence of a nickel or palladium catalyst produces secondary alkyl primary amines (17-20). Long-chain, unbranched, aliphatic tertiary amines can be prepared by reaction of an alkyl chloride with an alkyl secondary amine at 100-250°C (21,22). Other methods of producing amines include reaction of a carboxylic acid ester with a secondary amine in the presence of hydrogen at high pressure using a metal oxide catalyst, zinc oxide-chromium oxide or zinc oxide-aluminum oxide (23), or by catalytic hydroammonolysis of carboxylic acids at high pressure and temperature in the presence of a mixture of sulfides of metals of Groups 6 and 8-10 (24). The Hofmann rearrangement, preparation of an amine from an unsubstituted amide using solutions of chlorine in sodium hydroxide, has been useful in preparing long-chain primary amines (25). Amines prepared using the Hofmann rearrangement contain one less carbon atom than the amide. Thus, odd-chain-length fatty amines, not available from natural sources, can be prepared. The Ritter reaction of olefins with hydrogen cyanide in the presence of a strong acid, after hydrolysis, produces tertiary-alkyl primary amines. Rohm and Haas Primene amines are prepared using the Ritter reaction.

Physical Properties

Data on physical properties of fatty amines have been well documented and summarized in many reference works on fatty acids and nitrogen derivatives (3,8,13,26-29). Table 2 lists melting point data of some commercially available primary, secondary, and tertiary fatty amines, and it is evident that: (1) melting points within a homologous series of single-chain-length fatty amines increase with molecular weight, (2) symmetrical secondary amines have a higher melting point than the primary amine of the same alkyl group, but are lower melting than a primary amine with the same number of carbon atoms (hydrogen bonding), (3) symmetrical tertiary amines are lower melting than a symmetrical secondary amine of the same alkyl group, (4) symmetrical tertiary amines are lower melting

1. 2

om
of a
ing
eld
red
gth
ors
est,
oils
-8).

alm

1
43.5
4.5
40

11

rain-
hese
ines
vail-
acid
fatty
th in
mary
di-n-AS
istry
nber22-1]
27-1]
30-1]
90-3]

than a primary or secondary amine containing the same number of carbon atoms, and (5) unsaturation lowers the melting point of the fatty amine, eg, oleylamine versus 1-octadecylamine and ditallowalkylamines versus dihydrogenated tallowalkylamines.

Table 2. Melting Points of Fatty Amines

Amine	Molecular formula	CAS Registry Number	Mp, °C
<i>Primary amines</i>			
cocoalkylamines		[61788-46-3]	16.0
1-dodecylamine	C ₁₂ H ₂₇ N	[124-22-1]	28.0
1-hexadecylamine	C ₁₆ H ₃₅ N	[143-27-1]	46.2
1-octadecylamine	C ₁₈ H ₃₉ N	[124-30-1]	53.0
oleylamine	C ₁₈ H ₃₇ N	[112-90-3]	21.0
soyaalkylamines		[61970-18-9]	29.0
tallowalkylamines		[61790-33-8]	40.0
hydrogenated tallowalkylamines		[61788-45-2]	55.0
<i>Secondary amines</i>			
dicocoalkylamines		[61789-76-2]	43.0
di- <i>n</i> -dodecylamine	C ₂₄ H ₅₁ N	[3007-31-6]	47.0
di- <i>n</i> -hexadecylamine	C ₃₂ H ₆₇ N	[16724-63-3]	67.0
di- <i>n</i> -octadecylamine	C ₃₆ H ₇₅ N	[112-99-2]	72.3
ditallowalkylamines		[68783-24-4]	55.0
dihydrogenated tallowalkylamines		[61789-79-5]	62
<i>Tertiary amines</i>			
<i>Alkyldimethyl</i>			
cocoalkyldimethylamines		[61788-93-0]	-22
dimethyl- <i>n</i> -octylamine	C ₁₀ H ₂₃ N	[7378-99-6]	-57
dimethyl- <i>n</i> -decylamine	C ₁₂ H ₂₇ N	[1120-24-7]	-35
dimethyl- <i>n</i> -dodecylamine	C ₁₄ H ₃₁ N	[112-18-5]	-15
dimethyl- <i>n</i> -tetradecylamine	C ₁₆ H ₃₅ N	[112-75-4]	-6
dimethyl- <i>n</i> -hexadecylamine	C ₁₈ H ₃₉ N	[112-69-6]	8
dimethyl- <i>n</i> -octadecylamine	C ₂₀ H ₄₃ N	[124-28-7]	21
dimethyl-oleylamine	C ₂₀ H ₄₁ N	[28061-69-0]	-10
<i>Dialkylmethyl</i>			
di- <i>n</i> -decylmethylamine	C ₂₁ H ₄₅ N	[7396-58-9]	-6.3
dicocoalkylmethylamines		[61788-62-3]	-2
dihydrogenated tallowalkylmethylamines		[61788-63-4]	38
<i>Trialkyl</i>			
tri- <i>n</i> -octylamine	C ₂₄ H ₅₁ N	[1116-76-3]	-34.6
tri- <i>n</i> -dodecylamine	C ₃₆ H ₇₅ N	[102-87-4]	-9
tri- <i>n</i> -hexadecylamines		[67701-00-2]	3

lating
primary
amine
point
critical
distill
cataly
durin

varyin
are fo
tempo
been
solub

chara

Water
form

Chem

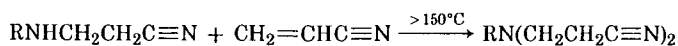
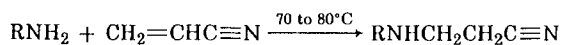
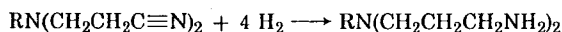
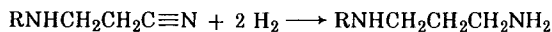
Gene
using
prod
follow

the I

Leuci

Redu

tion

Cyanoethylation (Michael addition)*Hydrogenation*

The addition of 1 mol of acrylonitrile (Michael addition) to the primary amine is an exothermic reaction, carried out at moderate temperature (70°C), either neat or using a polar solvent (water or low molecular weight alcohol). A fatty diamine, containing one primary and one secondary nitrogen, is formed when the nitrile adduct is catalytically hydrogenated. It is possible to add a second mole of acrylonitrile to the initial mononitrile adduct. However, the second addition does not occur as readily. Reduction of a dinitrile adduct forms a triamine, which contains one tertiary and two primary amino groups. Reduction of the nitrile can be problematic in that varying degrees of decyanoethylation occur depending on catalyst and temperature used during reduction.

Primary fatty amines also add (Michael addition) to esters of acrylic acid, $\text{H}_2\text{C}=\text{CHCOOH}$, methacrylic acid, $\text{H}_2\text{C}=\text{C}(\text{CH}_3)\text{COOH}$, or crotonic acid, $\text{CH}_3\text{CH}=\text{CHCOOH}$. Hydrolysis of the Michael ester forms an amphoteric surfactant. Crotonic acid can be used to form the amphoteric compound directly.

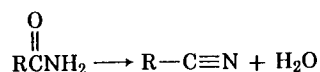
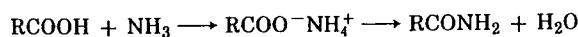
Manufacture

The principal industrial production route used to prepare fatty amines is the hydrogenation of nitriles, a route which has been used since the 1940s. Commercial preparation of fatty amines from fatty alcohols is a fairly new process, created around 1970, which utilizes petrochemical technology, Ziegler or Oxo processes, and feedstock.

In addition to the nitrile and alcohol routes for fatty amine preparation, processes have been described by Unocal and Pennwalt Corporation, using an olefin and secondary amine (14-16); by Texaco Inc., hydrogenation of nitroparaffins (17-20); by Onyx Corporation, reaction of an alkyl halide with secondary amines (21,22); by Henkel & Cie, GmbH, reduction of an ester in the presence of a secondary amine (23); by catalytic hydroammonolysis of carboxylic acids (24); and by the Hofmann rearrangement (25).

Nitrile Process. Fatty nitriles are readily prepared via batch, liquid-phase, or continuous gas-phase processes from fatty acids and ammonia. Nitrile formation is carried out at an elevated temperature (usually > 250°C) with catalyst. An ammonia soap which initially forms, readily dehydrates at temperatures above 150°C to form an amide. In the presence of catalyst, zinc (ZnO) for batch and

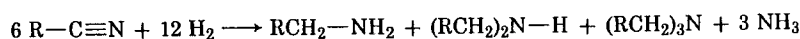
bauxite for continuous processes, and temperatures $>250^{\circ}\text{C}$, dehydration of the amide occurs to produce nitrile. Removal of water drives the reaction to completion.



Hydrogenation of fatty nitrile to amine can be either a batch or continuous process (39-42). For preparing primary amines, ammonia is used to suppress secondary amine formation, at a minimum partial pressure of ~ 1 MPa (150 psig). Batch hydrogenation of a nitrile produces primary amine at 96% purity with low secondary (1.5%) and tertiary ($<1\%$) amine levels (39). Reduction of the nitrile is carried out at elevated temperature (from 50 to 200°C), using hydrogen gas at high pressure, 3.5 MPa (500 psig) and higher total pressure of ammonia and hydrogen gases, in the presence of various catalysts. Catalysts useful for nitrile reduction include (1) aluminum-nickel Raney alloy (39), (2) Raney cobalt (40,43,44), (3) zinc-chromium or zinc-aluminum (41), (4) Raney nickel (42,45), (5) cobalt, copper, and chromium pellets (46), and (6) various nickel-supported catalysts (47-49).

A mixture of primary and secondary amines is formed when ammonia is not used during the nitrile reduction. It is possible to prepare high purity secondary amines by carrying the reduction out at low pressure and passing hydrogen through the reaction in a batch process (47,48), $2 \text{RNH}_2 \rightarrow \text{R}_2\text{NH} + \text{NH}_3$. A nickel-diatomaceous earth catalyst has been used at 220°C at low pressure and hydrogen purge to prepare secondary amines in high yield. Ammonia is removed continuously to drive the reaction to completion. The selectivity to secondary amine can be further enhanced by adding small amounts of an aliphatic carboxylic acid amide (48). Cobalt or copper chromite catalysts are also used to prepare secondary amines (1). Imines ($\text{RCH}=\text{NH}$ and $\text{RCH}=\text{NCH}_2\text{R}$) are suggested as intermediates in the process (3).

Symmetrical tertiary amines can be prepared in an analogous manner to secondary amines (1). Catalytic hydrogenation at elevated temperature and low pressure with a hydrogen purge produces a mixture of primary, secondary, and tertiary amines.



The rate of reaction slows down as the conversion to tertiary amine increases and primary amine concentrations drop below 1%. Conversion to 100% tertiary amine is difficult.

Alkyldimethyl and dialkylmethyl tertiary amines are commercially available. These amines are prepared by reductive methylation of primary and secondary amines using formaldehyde and nickel catalysts (1,3,47,48). The asymmetrical tertiary amines are used as reactive intermediates for preparing many commercial products.

Catalytic hydrogenation of raw materials prepared from natural fats and oils can be difficult because impurities are present which can affect the catalyst performance. Tallow fatty acid can contain the following catalyst poisons in

differ
poiso
lyst l

hydr
cis a
such

weig
be p
Proc
mat
metl
>20
chro
(hyc
(eth

(52-
elev
am

For
ing
pro
am
of
rea
by

or

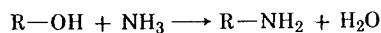
W
A
ca
an
an
re
h
tu
u
r

differing amounts: sulfur, phosphorus, chlorine, and nitrogen (49). These catalyst poisons are removed to varying degrees during the refining process. Thus, catalyst loading levels can change from batch to batch.

Homogeneous and heterogeneous catalysts which selectively or partially hydrogenate fatty amines have been developed (50). Selective hydrogenation of cis and trans isomers, and partial hydrogenation of polyunsaturated moieties, such as linoleic and linolenic to oleic, is possible.

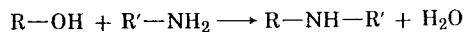
Alcohol Process. Fatty alcohols react with ammonia, or a low molecular weight primary or secondary amine, to form fatty amines. The fatty alcohols can be prepared from natural sources, fats and oils, or may be petroleum derived. Processes for manufacturing the fatty alcohol vary and depend on the raw material source, natural or petrochemical. Natural fatty acids, or preferably methyl esters of fatty acids, are catalytically reduced to alcohols by high pressure >20 MPa (3000 psig) and temperature (250–300°C) hydrogenation using copper chromite catalyst (11,51). Synthetic fatty alcohols are prepared using the Oxo (hydroformylation, reaction of carbon monoxide and hydrogen) or the Ziegler (ethylene and triethylaluminum) processes (10).

Primary amines can be prepared from alcohols and an excess of ammonia (52–55). Either a batch or continuous process can be used. The reaction is run at elevated temperature (50–340°C) and high pressure, 3.5 MPa (500 psig), with an ammonia-to-alcohol ratio of 5:1 to 30:1.



For example, a secondary alcohol of an average molecular weight of 202, containing 12–14 carbon atoms, is introduced into a reaction tube packed with a cobalt promoted zirconium catalyst on alumina at a rate of 60 mL/h along with liquid ammonia (90 mL/h) and hydrogen (5 L/h) to produce an amine mixture composed of 92.2% primary amine, 2.15% secondary and tertiary amines, and 5.7% unreacted alcohol (52). The reaction, at 180–190°C and 24 MPa (\approx 3500 psig), is run by withdrawing the liquid reaction product from the bottom of the reactor.

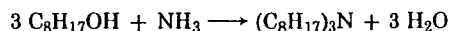
Secondary amines can be prepared from an alcohol and either ammonia (56) or primary amine (57).



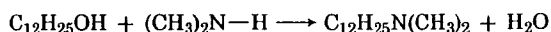
When a mixture of long-chain alcohols, Neodol 25 (Shell Chemical Company) and Alfol 1618 [Conoco Inc. (E. I. du Pont de Nemours & Co.)], containing a nickel catalyst (Girdler G49B) is heated at 190°C for six hours with a hydrogen and ammonia sparge, a mixture of amines is formed: 3.7% primary, 76.7% secondary, and 16.9% tertiary (56). This is similar to what is observed when fatty nitriles are reduced at low pressure and high temperature. High purity secondary amines have been prepared by reaction of an alcohol with a primary amine at elevated temperature (to 250°C) and low pressure (atmospheric) using a selective catalyst; use of copper, nickel, and a noble metal catalyst such as platinum, palladium, or ruthenium is recommended (57). For example, dilaurylamine was prepared at 92%

purity by reaction of lauryl alcohol with laurylamine in the presence of a ruthenium catalyst.

Batch or continuous processes can be used to prepare tertiary amines from alcohols and ammonia or a secondary amine, such as, dimethylamine.



Trioctylamine has been prepared, in a continuous process, using 5,200 kg of *n*-octanol, 100 kg of copper formate catalyst, 500 kg of *n*-octylamine, 10 kg of calcium hydroxide, and 240 kg of ammonia (58). Ammonia was added over a 10-h period while 10 m³ of hydrogen/h was passed through the reactor at a reaction temperature of 180–200°C. The final product was composed of 94% trioctylamine, 2% dioctylamine, 1% octylamine, and 0.5% *n*-octanol. A tertiary amine was prepared from dodecanol and dimethylamine using a nickel promoted-catalyst.



Thus, a 94% conversion to dimethyldodecylamine was obtained in five hours using nickel catalyst promoted with chromium and iron at 180°C and 1.1 MPa (160 psig) (59).

Catalysts used for preparing amines from alcohols include: cobalt promoted with zirconium, lanthanum, cerium, or uranium (52); the metals and oxides of nickel, cobalt, and/or copper (53,54,56,60,61); metal oxides of antimony, tin, and manganese on alumina support (55); copper, nickel, and a metal belonging to the platinum group 8–10 (57); copper formate (58); nickel promoted with chromium and/or iron on alumina support (53,59); and cobalt, copper, and either iron, zinc, or zirconium (62).

Commercial Availability

United States consumption of fatty nitrogen derivatives amounted to 231,100 t in 1985 (63) and 200,000 t in 1984 (8). With an average annual growth rate anticipated at 3.7%, U.S. consumption was estimated to be 280,000 t in 1990. Fatty amine usage was 15,500 t (6.7% of the nitrogen derivative market) in 1985 and expected to increase to 20,500 t through 1990 (5.6%/yr). Fatty amines were used as intermediates (1985 data with percentage of total market) for the preparation of quaternaries [86,700 t (37.5%)], fatty diamine/polyamine condensates [20,000 t (8.6%)], amine oxides [13,500 t (5.8%)], betaines [4,300 t (1.9%)], and ethoxylated amines [2,500 t (1%)]. Fatty amine end use pattern for 1985 was as follows: ore flotation, 55%; biocide/corrosion inhibitor, 24%; metal working, 5%; and others, 16% of the market (64). It was estimated in 1986 that plant capacities of the major U.S. producers of fatty amines and derivatives were 207,000 t (64). Thus, plant expansion was needed to keep up with the increasing usage of fatty amines and nitrogen derivatives. Plant expansions have occurred at Akzo Chemicals Inc. (65), Ethyl Corporation (66,67), Humko Chemical (Witco Corporation) (68), Jetco Chemicals, Inc. (The Procter & Gamble Company) (69), Tomah Products, Inc. (Exxon Chemical Company) (70), and Sherex Chemical Co. (71,72).

f a ruthe-
nes from

200 kg of
10 kg of
ver a 10-h
reaction
ylamine,
nine was
catalyst.

ve hours
1.1 MPa

promoted
oxides of
, tin, and
ing to the
chromium
ron, zinc,

1,100 t in
iticipated
ity amine
expected
interme-
ration of
[20,000 t
hoxylated
llows: ore
and others,
the major
us, plant
ines and
s Inc. (65),
8), Jetco
ucts, Inc.

Table 3. Commercially Available Fatty Amines

Fatty amine (common name)	Molecular formula	CAS Registry Number	Trade name	Manufacturer	Appearance
2-ethylhexylamine cocoalkylamines	C ₈ H ₁₉ N	[104-75-6] [61788-46-3]	Armeen L8D	Akzo	liquid
			Armeen CD	Akzo	liquid
			Alamine 21D	Henkel	liquid
dodecylamine	C ₁₂ H ₂₇ N	[124-22-1]	Kemamine P-650	Humko	liquid
			Jet Amine PCD	Jetco	liquid
			Adogen 160-D	Sherex	liquid
			Armeen 12D	Akzo	semisolid
			Alamine 4D	Henkel	liquid
hexadecylamine	C ₁₆ H ₃₅ N	[143-27-1]	Adogen 163-D	Sherex	liquid
			Armeen 16D	Akzo	solid
			Kemamine P-880D	Humko	solid
octadecylamine	C ₁₈ H ₃₉ N	[124-30-1]	Armeen 18D	Akzo	solid
			Alamine 7D	Henkel	solid
			Kemamine P-990D	Humko	solid
oleylamine	C ₁₈ H ₃₇ N	[112-90-3]	Adogen 142-D	Sherex	solid
			Armeen OD	Akzo	solid
soyaalkylamines		[61970-18-9]	Alamine 11D	Henkel	semisolid
			Kemamine P-989D	Humko	liquid
			Jet Amine POD	Jetco	liquid
			Adogen 172-D	Sherex	liquid
			Armeen SD	Akzo	paste
Jet Amine PSD	Jetco	paste			
Adogen 115-D	Sherex	liquid			

Primary amines

Health and Safety Factors

Skin and Eye Irritation. Fatty alkylamines are generally considered to be irritating to both the skin and eyes (83). The severity or degree of irritation is usually dependent on the type of alkylamine, concentration of the chemical, time of exposure to the chemical, and sensitivity to the chemical. A small percentage of the population who come into contact with fatty amines may develop a skin hypersensitivity to certain amines and diamines.

Alkylamines and diamines are generally classified as corrosive to the skin based on results from laboratory animal (rabbit) studies performed in accordance with the Department of Transportation (DOT) test method (84); rabbits are considered to be especially sensitive to alkylamines which even at low concentrations can induce skin redness and swelling. Oleylamine has been shown to induce mild to moderate skin irritation in laboratory rats when applied at a concentration of 0.3% in mineral oil (Chemical Manufacturer's Association, 1985). Fatty amines which contain alkyl chains of 10–14 carbons are considered more irritating than related products which contain alkyl chains of 14–18 carbon atoms. Ethoxylation generally decreases the irritation potential of alkylamines.

Oral Toxicity. Depending on the chemical class, most fatty amines range from moderately toxic to practically nontoxic by acute oral ingestion. Laboratory animal testing has revealed that the amines and diamines can induce irritation and damage to the gastrointestinal tract. The acute oral LD₅₀ of cocoalkyldiamine in rats is less than 200 mg/kg body weight (Armak Test Data, 1981), whereas the corresponding value for dihydrogenated tallowalkylmethylamine (Akzo Chemie Data, 1984) is greater than 5,000 mg/kg. Products which have LD₅₀ values greater than 5000 mg/kg are considered practically nontoxic by accidental ingestion.

Dermal Toxicity. Fatty alkylamines are not considered especially toxic with regard to skin penetration and systemic absorption into the body; certain polyamines may be absorbed through the skin to a much greater degree. The acute dermal LD₅₀ of decylamine in rabbits has been reported to be 350 mg/kg [RTECS, 1982 (85)]; dialkyl(C₁₄–C₁₈)methylamine has been shown to have an acute dermal LD₅₀ value of greater than 2000 mg/kg in rabbits (Dynamac Corporation, 1988). Products with acute dermal LD₅₀ values greater than 2000 mg/kg are considered to exhibit a low degree of hazard by acute dermal exposure.

Inhalation. Long-chain amines are not considered an inhalation hazard at ambient conditions because of their relatively low volatility. Inhalation of aerosols or heated vapors may result in irritation of the nose, throat, and upper respiratory system. Lower molecular weight and branched-chain amines are more volatile and can cause irritation if inhaled. Volatile amines are easily recognized by their unpleasant, fishy odor.

Uses

Fatty amines and chemical products derived from the amines are used in many industries. Uses for the nitrogen derivatives may be broken down as follows as a percentage of total market: fabric softeners (46%), oil field chemicals (15%),

asphalt emulsifiers (10%), petroleum additives (10%), mining (4%), and others (15%) (8).

Amine salts, especially acetate salts prepared by neutralization of a fatty amine with acetic acid, are useful as flotation agents (collectors), corrosion inhibitors, and lubricants (3,8). Amine acetates are commercially available from a number of suppliers: Akzo Chemicals Inc. (Armac) (73); Henkel Corporation (formerly General Mills) (Alamac) (74); Jetco Chemicals Inc. (The Procter & Gamble Company) (Jet Amine) (75); Sherex (Adogen) (76); and Tomah Products (Exxon Chemical Company) (Tomah) (77).

The single largest market use for quaternary fatty amines is in fabric softeners. Monoalkyl quaternaries (chloride) have been used in liquid detergent softener antistat formulations (LDSA), dialkyldimethyl quaternaries (chloride) in the rinse cycle, and dialkyldimethyl quaternaries (sulfate) as dryer softeners.

Another significant use for dialkyldimethyl quaternary ammonium salts and alkylbenzyltrimethylammonium salts is in preparing organoclays for use as drilling muds, paint thickeners, and lubricants.

Betaines, or specialty quaternaries, are used in the personal care industry in shampoos, conditioners, foaming, and wetting agents.

Companies producing fatty amine quaternaries include: Akzo Chemicals Inc. (Arquad) (73); Henkel Corporation (formerly General Mills) (Aliquat) (74); Humko Chemical (Witco Corporation) (Kemamine Q) (31); Jetco Chemicals (The Procter & Gamble Company) (Jet Quat) (75); Jordan Chemical Company (PPG Industries) (Jordquat and specialty quaternaries) (78); Lonza (Barquat and specialty quaternaries) (79); Sherex (Adogen) (76); and Tomah Products (Exxon Chemical Company) (Tomah Q) (77).

A significant use of ethoxylated and propoxylated amines is as antistatic agents (qv) in the textile and plastics industry (86). Ethoxylates are also used in the agricultural area as adjuvants. Ethoxylated fatty amines and derivatives are available from: Akzo Chemicals Inc. (Ethomeen) (73); Henkel Corporation (Trymeen) (87); GAF Chemicals Corporation (Rhône Poulenc) (Katapol) (88); Jetco Chemicals Inc. (The Procter & Gamble Company) (Jet Amine) (75); Mazer Chemicals (PPG Industries) (Mazeen) (89); Sherex (Adogen) (76); and Tomah Products (Exxon Chemical Company) (Tomah E) (77).

Examples of uses for amine oxides include: detergent and personal care areas as a foam booster and stabilizer, as a dispersant for glass fibers, and as a foaming component in gas recovery systems. Commercial suppliers of fatty amine oxides include: Akzo Chemicals Inc. (Aromox) (73), Jordan Chemical Company (PPG Industries) (Jordamox) (78), and Lonza (Barlox) (79).

Important uses for the diamines include: corrosion inhibitors, gasoline and fuel oil additives, flotation agents, pigment wetting agents, epoxy curing agents, herbicides, and asphalt emulsifiers (3,75,77). Fatty diamines, *n*-alkyl-1,3-diaminopropanes, and triamines, *n*-alkyldipropylenetriamines, are available commercially from: Akzo Chemicals Inc. (Duomeen and Triameen) (73), Henkel Corporation (formerly General Mills) (Diam) (74), Humko Chemical (Witco Corporation) (Kemamine) (31), Jetco Chemicals (The Procter & Gamble Company) (Jet Amine) (75), Sherex (Adogen) (76), and Tomah Products (Exxon Chemical Company) (Diamines, Triamines, and Tetramines) (77).

Fatty amines and derivatives are widely used in the oil field, as corrosion

inhibitors, surfactants, emulsifying/deemulsifying and gelling agents (90). In the mining industry, amines and diamines are used in the recovery and purification of minerals, flotation, and beneficiation. A significant use of fatty diamines is as asphalt emulsifiers for preparing asphalt emulsions. Diamines have also been used as epoxy curing agents, corrosion inhibitors, gasoline and fuel oil additives, and pigment wetting agents. Oleylamine is a petroleum additive useful as a detergent in gasoline (8). In addition, derivatives of the amines, amphoterics, and long-chain alkylamines are used as anionic and cationic surfactants in the personal care industry (91).

BIBLIOGRAPHY

"Amines, Fatty" in *ECT* 2nd ed., Vol. 2, pp. 127-138, by H. J. Harwood, Durkee Famous Foods; in *ECT* 3rd ed., Vol. 2, pp. 283-295, by Harinath B. Bathina and Richard A. Reck, Armak Company.

1. S. Billenstein and G. Blaschke, *J. Am. Oil Chem. Soc.* **61**, 353 (1984).
2. N. O. V. Sonntag, *J. Am. Oil Chem. Soc.* **56**, 861A (1979).
3. R. A. Reck, in R. W. Johnson and E. Fritz, ed., *Fatty Acids in Industry*, Marcel Dekker, Inc., New York, 1989, pp. 177-199, 201-215.
4. R. A. Reck, *J. Am. Oil Chem. Soc.* **39**, 461 (1962).
5. D. R. Erickson, *J. Am. Oil Chem. Soc.* **60**, 351 (1983).
6. F. V. K. Young, *J. Am. Oil Chem. Soc.* **60**, 374 (1983).
7. R. A. Reck, *J. Am. Oil Chem. Soc.* **62**, 355 (1985).
8. *Oleochemicals: Fatty Acids, Fatty Alcohols, Fatty Amines*, Course sponsored by the Education Committee of the American Oil Chemists' Society, Kings Island, Ohio, Sept. 13-16, 1987.
9. H. Fineberg, *J. Am. Oil Chem. Soc.* **56**, 805A (1979).
10. J. A. Monick, *J. Am. Oil Chem. Soc.* **56**, 853A (1979).
11. T. Voeste and H. Buchold, *J. Am. Oil Chem. Soc.* **61**, 350 (1984).
12. R. Puchta, *J. Am. Oil Chem. Soc.* **61**, 367 (1984).
13. *Fatty Tertiary Amines, Product Bulletin*, CG-180R(288), Ethyl Corporation, Baton Rouge, La., Feb. 1988.
14. U.S. Pat. 3,513,200 (May 19, 1970), G. Biale (to Union Oil Company of California).
15. U.S. Pat. 4,483,757 (Nov. 20, 1984), D. M. Gardner and P. J. McElligott (to Pennwalt Corporation).
16. U.S. Pat. 4,827,031 (May 2, 1989), D. M. Gardner, P. J. McElligott and R. T. Clark (to Pennwalt Corporation).
17. U.S. Pat. 3,739,027 (June 12, 1973), W. C. Gates (to Texaco Inc.).
18. U.S. Pat. 3,917,705 (Nov. 4, 1975), R. W. Swanson and H. K. Zang (to Texaco Inc.).
19. U.S. Pat. 3,917,706 (Nov. 4, 1975), R. B. Hudson and W. C. Gates (to Texaco Inc.).
20. U.S. Pat. 3,920,744 (Nov. 18, 1975), R. M. Suggitt and W. C. Gates (to Texaco Inc.).
21. U.S. Pat. 3,385,893 (May 28, 1968), R. L. Wakeman (to Millmaster Onyx Corporation).
22. U.S. Pat. 3,548,001 (Dec. 15, 1970), Z. J. Dudzinski (to Millmaster Onyx Corporation).
23. U.S. Pat. 3,579,584 (May 18, 1971), H. Rutzen and R. Brockmann (to Henkel & Cie, GmbH).
24. Brit. Pat. 1,135,915 (Dec. 11, 1968), D. Zalmanovich Zavelsky and co-workers, (to Gosudarstvenny Ordena Trudovogo Krasnogo Znameni Institut Prikladnoi Khimii).
25. U.S. Pat. 4,198,348 (Apr. 15, 1980), F. Bertini and C. A. Pauri (to SNIA VISCOSA Societa Nazionale Industria Applicazioni Viscosa SpA).
26. *Armeen, Duomeen and Triamine Aliphatic Amines, Product Bulletin*, Bulletin 89-134, Akzo Chemicals Inc., Chicago, Ill., 1989.

27. N. O. V. Sonntag, "Nitrogen Derivatives," in K. S. Markley, ed., *Fatty Acids*, Part 3, John Wiley & Sons, Inc., New York, 1964, pp. 1551-1715.
28. S. H. Shapiro, "Commercial Nitrogen Derivatives of Fatty Acids," in E. Pattison, ed., *Fatty Acids and Their Industrial Applications*, Marcel Dekker, Inc., New York, 1968, pp. 77-154.
29. W. M. Linfield, "Straight-Chain Alkylammonium Compounds," in E. Jungermann, ed., *Cationic Surfactants*, Vol. 4, Marcel Dekker, Inc., New York, 1970, pp. 9-70.
30. S. H. Pine and B. L. Sanchez, *J. Org. Chem.* **56**, 829 (1971).
31. *Kemamine Fatty Amines*, *Product Bulletin AMN:901/MI*, Humko Sheffield Chemical, Memphis, Tenn., 1978.
32. C. W. Glankler, *J. Am. Oil Chem. Soc.* **56**, 802A (1979).
33. H. Maag, *J. Am. Oil Chem. Soc.* **61**, 259 (1984).
34. R. A. Reck, *J. Am. Oil Chem. Soc.* **56**, 796A (1979).
35. R. A. Reck, "Polyoxyethylene Alkylamines," in M. Schick, ed., *Nonionic Surfactants, Surfactant Science Series*, Vol. 1, Marcel Dekker, Inc., New York, 1967, pp. 187-207.
36. B. H. Babu, P. K. S. Amma, and S. V. Rao, *Indian J. Technol.* **5**, p. 262 (Aug. 1967).
37. U.S. Pat. 3,222,402 (Dec. 7, 1965), M. C. Cooperman (to Armour and Company).
38. R. W. Fulmer, *J. Org. Chem.* **27**, 4115 (1962).
39. Brit. Pat. 1,321,981 (July 4, 1973), N. Waddleton.
40. Brit. Pat. 1,388,053 (Mar. 19, 1975) (W. R. Grace & Co.).
41. Brit. Pat. 1,153,919 (June 4, 1969) (Henkel & Cie, GmbH).
42. U.S. Pat. 3,574,754 (Apr. 13, 1971), G. A. Specken.
43. U.S. Pat. 4,375,003 (Feb. 22, 1983), R. J. Allain and G. D. Smith (to Nalco Chemical Company).
44. U.S. Pat. 4,140,720 (Feb. 20, 1979), C. A. Drake (to Phillips Petroleum Company).
45. U.S. Pat. 4,359,585 (Nov. 16, 1982), C. R. Campbell and C. E. Cutchens (to Monsanto Company).
46. U.S. Pat. 4,552,862 (Nov. 12, 1985), J. M. Larkin (to Texaco Inc.).
47. U.S. Pat. 4,248,801 (Feb. 3, 1981), S. Tomidokoro, M. Sato, and D. Saika (to The Lion Fat & Oil Co., Ltd.).
48. U.S. Pat. 4,845,298 (July 4, 1989), T. Inagaki, A. Fukasawa, and H. Yamagishi (to Lion Akzo Company Limited).
49. H. Klimmek, *J. Am. Oil Chem. Soc.* **61**, 200 (1984).
50. E. Draguez De Hault and A. Demoulin, *J. Am. Oil Chem. Soc.* **61**, 195 (1984).
51. U. R. Kreuzer, *J. Am. Oil Chem. Soc.* **61**, 343 (1984).
52. Brit. Pat. 1,361,363 (July 24, 1974), H. Koike, T. Sawano, N. Kurata, and Y. Okuda (to Nippon Shokubai Kagaku Kogyo Co., Ltd.).
53. Brit. Pat. 1,074,603 (July 5, 1967) (to Jefferson Chemical Company, Inc.).
54. U.S. Pat. 4,418,214 (Nov. 29, 1983), M. G. Turcotte (to Air Products and Chemicals, Inc.).
55. U.S. Pat. 4,654,440 (Mar. 31, 1987), R. J. Card and J. L. Schmitt (to American Cyanamid Company).
56. U.S. Pat. 3,803,137 (Apr. 9, 1974), R. R. Egan, G. K. Hughs, and J. W. Sigan (to Ashland Oil, Inc.).
57. U.S. Pat. 4,792,622 (Dec. 20, 1988), Y. Yokota and co-workers (to Kao Corporation).
58. U.S. Pat. 4,827,035 (May 2, 1989), H. Mueller and H. Axel (to BASF Aktiengesellschaft).
59. Brit. Pat. 1,553,285 (Sept. 26, 1979), F. Wattimena and C. Borstlap (to Shell Internationale Research Maatschappij B.V.).
60. U.S. Pat. 4,851,580 (July 25, 1989), H. Mueller, R. Fischer, G. Jeschek, and W. Schoenleben (to BASF Aktiengesellschaft).
61. U.S. Pat. 4,014,933 (Mar. 29, 1977), G. Boettger and co-workers (to BASF Aktiengesellschaft).

Fatty Acids, Part 3,

in E. Pattison, ed.,
c., New York, 1968,

E. Jungermann, ed.,
, pp. 9-70.

Sheffield Chemical,

Anionic Surfactants,
, 1967, pp. 187-207.
p. 262 (Aug. 1967).
nd Company).

(to Nalco Chemical

leum Company).

chens (to Monsanto

aika (to The Lion Fat

i. Yamagishi (to Lion

1, 195 (1984).

ta, and Y. Okuda (to

ny, Inc.).

ucts and Chemicals,

o American Cyanamid

W. Sigan (to Ashland

o Kao Corporation).

F Aktiengesellschaft).

lap (to Shell Interna-

G. Jeschek, and W.

o-workers (to BASF

62. U.S. Pat. 4,153,581 (May 8, 1979), C. E. Habermann (to The Dow Chemical Company)
63. *Speciality Fatty Nitrogen Products*, Market Survey, Chem Systems Inc., Tarrytown New York, Sept. 1986.
64. *The World's Fatty Acids Industry—Their Derivatives & End-Products*, Market Survey Hewin International Inc., Amsterdam, The Netherlands, 1986.
65. *Chem. Week* 137, 5 (July 31, 1985).
66. *Soap Cosmet. Chem. Spec.* 61, 81 (June 1985).
67. *Soap Cosmet. Chem. Spec.* 63, 82 (July 1987).
68. *Chem. Mark. Rep.* 212, 4 (Nov. 28, 1977).
69. *Soap Cosmet. Chem. Spec.* 59, 87 (Nov. 1983).
70. *Chem. Mark. Rep.* 215, 7 (Mar. 12, 1979).
71. *Chem. Mark. Rep.* 227, 3 (Jan. 21, 1985).
72. *Chem. Mark. Rep.* 234, 31 (July 4, 1988).
73. *Fine and Functional Chemicals, Nitrogen Derivatives, General Catalog Bulletin 89*: Akzo Chemicals, Inc., Chicago, Ill., 1989.
74. *Industrial Chemicals/Fine Chemicals/Industrial Gums, Product Catalog, G-30*, General Mills Chemicals, Inc., Minneapolis, Minn., 1976.
75. *Jetco Chemicals, Product Guide to Jet Amines—Jet Quats*, Jetco Chemicals Inc., Corsicana, Tex., 1989.
76. *Adogen Fatty Amines, Diamines & Amides, Product Bulletin*, Sherex Chemical Company, Inc., Dublin, Ohio, 1989.
77. *Tomah Products, Product Bulletin, 1989 Formulary*, Exxon Chemical Company, Milton, Wis., Aug. 1, 1989.
78. *Innovative Specialty Surfactants Product Bulletin*, Jordan Chemical Company, Folcroft, Pa.
79. *Specialty Chemical Products, Product Bulletin, 5M 682 TGT*, Lonza Inc., Fair Lawn, N.J., 1987.
80. *Ethyl Chemicals Group, Product Bulletin, CG-220R (3/89), Industrial Chemicals Division Products*, Ethyl Corporation, Baton Rouge, La., Mar. 1989.
81. L. D. Metcalfe, *J. Am. Oil Chem. Soc.* 61, 363 (1984).
82. D. Firestone, ed., *Official Methods and Recommended Practices of the American Oil Chemists' Society*, 3rd ed., The American Oil Chemists' Society, Champaign, Ill., 1979.
83. N. Irving Sax, ed., *Dangerous Properties of Industrial Materials*, 5th ed., Van Nostrand Reinhold Company, New York, 1979, pp. 357, 683.
84. A. McRae and L. Whelchel, eds., *Toxic Substances Control Sourcebook*, Aspen Systems Corporation, 1978, p. 124.
85. R. L. Tatken and R. J. Lewis, eds., *Registry of Toxic Effects of Chemical Substances* 1981-1982 ed., Vol. 2, U.S. Department of Health and Human Services, 1983, p. 8.
86. R. A. Reck, *J. Am. Oil Chem. Soc.* 61, 187 (1984).
87. *Quantum Surfactants, Technical Bulletin 119*, Henkel Corporation, Cincinnati, Ohio, May 1989.
88. *Amine Ethoxylates, Technical Bulletin, 7.5M-189*, GAF Chemicals Corporation, Wayne, N.J., 1989.
89. *Mazeen Ethoxylated Amines Technical Bulletin*, Mazer Chemicals (PPG), Gurnee, Ill., Rev. Aug. 6, 1985.
90. C. D. LaSusa, *J. Am. Oil Chem. Soc.* 61, 184 (1984).
91. "Cosmetics & Toiletries," *Surfactant Encyclopedia* 104, 67 (1989).

K. VISEK
Akzo Chemicals Inc.

CAS: 1400-61-9

mw: 938.30

o light-tan powder; odor sug-
s. Mp: decomp > 160°. Spar-
hanol and ethanol; very sltly
l in chloroform, ether and ben-

◇ CANDEX ◇ CANDIO-HERMAL
RONAL ◇ MYCOSTATIN ◇ MYCOSTA-
NYSTAN ◇ NYSTATINE ◇ NYSTAVES-

il drug, animal feed drug.

imal feed, eggs, pork, poultry.
A - 21CFR 556.470. Limitation
wine, poultry. 21CFR 558.430.

xicology Program.

FILE: Poison by intraperitoneal
s routes. Moderately toxic by
ute. Mildly toxic by ingestion.
al teratogen. Experimental re-
ects. Mutagenic data. When
mposition it emits toxic fumes

TA and CODEN

mg/kg EXPEAM 33,306.77
100 mg/kg (9D preg): TER

75
:8000 mg/kg PMDCAY 14,105.77

Lewis, 1989, Foot Adheres to the back

O

OAV000 CAS: 31566-31-1
OCTADECANOIC ACID, MONOESTER
with 1,2,3-PROPANETRIOL
mf: C₂₁H₄₂O₄ mw: 358.63

PROP: Pure white- or cream-colored, wax-like
solid; faint odor. Mp: 58-59°, d: 0.97. Sol in
(hot) alc, oils, and hydrocarbons.

SYNS: ABRACOL S.L.G ◇ ADMUL ◇ ADVAWAX 140
◇ ALDO HMS ◇ ALDO-28 ◇ ARLACEL 161 ◇ ARMOSTAT
801 ◇ ATMOS 150 ◇ ATMUL 67 ◇ CEFATIN ◇ CELINHOL
A ◇ CERASYNT 1000-D ◇ CERASYNT S ◇ CITOMULGAN
M ◇ CYCLOCHEM GMS ◇ DERMAGINE ◇ DISTEARIN
◇ DREWMULSE TP ◇ DRUMULSE AA ◇ EMCOL CA
◇ EMEREST 2400 ◇ EMCOL MSK ◇ EMUL P.7 ◇ ESTOL
603 ◇ GLYCERIN MONOSTEARATE ◇ GLYCEROL MONO-
STEARATE ◇ GLYCERYL MONOSTEARATE ◇ GROCOR
5500 ◇ HODAG GMS ◇ IMWITOR 191 ◇ KESSCO 40
◇ LIPO GMS 410 ◇ MONELGIN ◇ MONOSTEARIN
◇ OGEEN 515 ◇ ORBON ◇ PROTACHEM GMS ◇ SEDE-
TINE ◇ STARFOL GMS 450 ◇ STEARIC ACID, MONOESTER
WITH GLYCEROL ◇ STEARIC MONOGLYCERIDE
◇ TEGIN ◇ UNIMATE GMS ◇ USAF KE-7
◇ WITCONOL MS

USE IN FOOD:

Purpose: Coating agent, emulsifier, lubricant,
solvent, texture modifying agent.

Where Used: Baked goods, cake shortening,
desserts, fruits, ice cream, nuts, peanut butter,
puddings, shortening, whipped toppings.

Regulations: FDA - 21CFR 184.1324. GRAS
when used in accordance with good manufactur-
ing practice.

SAFETY PROFILE: Poison by intraperitoneal
route. When heated to decomposition it emits
acrid smoke and irritating fumes.

TOXICITY DATA and CODEN

ipr-mus LD50:200 mg/kg NTIS** AD277-689

OAX000 CAS: 112-92-5
1-OCTADECANOL
mf: C₁₈H₃₈O mw: 270.56

PROP: Colorless solid or flakes. Mp: 58°, bp:
202° @ 10 mm, d: 0.8124 @ 59°/4°.

SYNS: ADOL ◇ ADOL 68 ◇ ATALCO S ◇ CO-1895
◇ CO-1897 ◇ CRODACOL-S ◇ DECYL OCTYL ALCOHOL

◇ DYTOL E-46 ◇ LOROL 28 ◇ OCTADECANOL ◇ n-OCTADEC-
CANOL ◇ OCTADECYL ALCOHOL ◇ n-OCTADECYL ALCO-
HOL ◇ POLAAX ◇ SIPOL S ◇ SIPONOL S ◇ STEAROL
◇ STEARYL ALCOHOL ◇ STERAFFINE ◇ USP XIII STEARYL
ALCOHOL

USE IN FOOD:

Purpose: Intermediate.

Where Used: Various.

Regulations: FDA - 21CFR 172.864. Use at a
level not in excess of the amount reasonably
required to accomplish the intended effect.

SAFETY PROFILE: Mildly toxic by ingestion.
An experimental neoplastigen. Flammable when
exposed to heat or flame; can react with oxidiz-
ing materials. To fight fire, use foam, CO₂,
dry chemical. When heated to decomposition
it emits acrid smoke and irritating fumes.

TOXICITY DATA and CODEN

imp-mus TDLo:1000 mg/kg:NEO CNREA8
26,105,66

orl-rat LD50:20 g/kg 37ASAA 1,722,28

OBC000 CAS: 124-30-1
OCTADECYLAMINE
mf: C₁₈H₃₉N mw: 269.58

SYNS: N-OCTADECYLAMINE ◇ OKTADECYLAMIN
(CZECH) ◇ STEARYLAMINE

USE IN FOOD:

Purpose: Boiler water additive.

Where Used: Various.

Regulations: FDA - 21CFR 173.310. Limitation
of 3 ppm in steam and excluding use of such
steam in contact with milk and milk products.

SAFETY PROFILE: Poison by intraperitoneal
route. A skin irritant. When heated to decompo-
sition it emits toxic fumes of NO_x.

TOXICITY DATA and CODEN

skn-rbt 500 mg/24H MOD 28ZPAK -,63,72
ipr-mus LD50:250 mg/kg NTIS** AD691-490

OCE000 CAS: 104-50-7
γ-OCTALACTONE
mf: C₈H₁₄O₂ mw: 142.22

acetyl groups prevent association of the outer branches of amylopectin and so stabilise the starch in solution.

Production:

- starch + acetic anhydride (acetylation)

Uses:

surface sizing (paper); thickening agent (prepared foods); warp sizing (polyester-cotton blends)

starch-acrylamide graft copolymers

starch-acrylonitrile graft copolymers; SPAN



R = starch-

Production:

- starch + acrylonitrile (cyanoethylation/nitrile hydration)

Uses: adhesives (gummed tapes)

starch hydrolysate

dextrose hydrosylate

Glucose syrup containing principally D-glucose. Different grades are characterised by their reduced sugar content expressed in terms of dextrose equivalents (DE). Starch hydrosylates have DE > 80.

Production:

- glucose syrup + glucoamylase (enzymatic hydrolysis)

Derivatives:

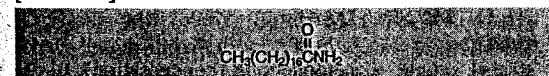
ethanol; D-glucose; D-glucuronolactone; high-fructose syrup; α -methylglucoside; pentaacetylglucose; sodium glucoheptonate; sodium gluconate; sorbitol

stearalkonium chloride

See: dimethylstearylbenzylammonium chloride

stearamide

[124-26-5]



$\text{C}_{18}\text{H}_{37}\text{N}_1\text{O}_1$. M: 283.50. White solid. Drop point: 100–104°C. Insoluble in water.

Production:

- stearic acid + ammonia (amide formation)

Derivatives: stearamidomethylpyridinium chloride

Uses: lubricant (textile spinning); plastics processing lubricant; slip improvement additive (printing ink); softening agent (textile finishes); solubiliser (oil-soluble dyestuffs); shampoo thickening agent/foam booster

stearamidomethylpyridinium chloride

octadecanamidomethylpyridinium chloride



$\text{C}_{24}\text{H}_{43}\text{Cl}_1\text{N}_2\text{O}_1$. M: 411.06.

Production:

- stearamide + formaldehyde + pyridine + hydrochloric acid (Mannich reaction/salt formation)

Uses: textile waterproofing agent

stearamidopropyldimethylamine

[7651-02-7]



$\text{C}_{23}\text{H}_{48}\text{N}_2\text{O}_1$. M: 368.64.

Production:

- stearic acid + 3-dimethylaminopropylamine (amide formation)

Derivatives:

stearamidopropyldimethylamine lactate

Uses: conditioning agent/emulsifier (cosmetics, toiletries); softening agent (textile finishes)

stearamidopropyldimethylamine lactate

[55819-53-9]



$\text{C}_{26}\text{H}_{54}\text{N}_2\text{O}_4$. M: 458.73.

Production:

- stearamidopropyldimethylamine + DL-lactic acid (salt formation)

Uses:

conditioning agent (cosmetics, toiletries)

stearamine *See:* stearylamine

stearic acid

palmitic/stearic acids; stearic/palmitic acids; stearine; stearin



$\text{C}_{18}\text{H}_{36}\text{O}_2$. M: 284.48. Colourless, waxy solid. d: 0.84 kg/l (80°C). Several grades of stearic acid are available commercially which vary in composition depending on the source and processing. A typical chain-length distribution of hydrogenated tallow is: 2% C_{14} , 38% C_{16} , 58% C_{18} , with MP: 54–59°C. Stearin, separated from the olein fraction of tallow by physical means, has a chain-length distribution like: 2.5% C_{14} , 50% C_{16} , 44% $\text{C}_{18.1}$, 3% $\text{C}_{18.2}$ for the 'triple-pressed' grade. 'Single-pressed' and 'double-pressed' grades have higher $\text{C}_{18.2}$ acid contents. Pure stearic acid, produced by fractional distillation, has a typical chain-length distribution of: 5% C_{16} , 93% C_{18} , 2% C_{20} with MP: 64–67°C.

Production:

- tallow acid (selective crystallisation or solvent separation; coproduced with oleic acid)
- tallow, hydrogenated (hydrolysis)

Derivatives: aluminium tristearate; ammonium stearate; barium stearate; barium-zinc heat stabilisers; *n*-butyl

precursor of oda

stearate; cadmium-zinc heat stabilisers; calcium stearate; calcium stearoyl-2-lactylate; cetyl stearate; cetyl-stearyl stearate; diethylene glycol monostearate; ethylene bis(stearamide); ethylene glycol distearate; ethylene glycol monostearate; 2-ethylhexyl stearate; ethyl stearate; glycerol monostearate; guanidine stearate; hexamethylenebis(stearamide); isobutyl stearate; isooctyl stearate; isopropyl stearate; isotridecyl stearate; lead stearate, dibasic; lead stearate, normal; lithium stearate; magnesium stearate; methyl stearate; pentaerythritol tetrastearate; polyethylene glycol distearate; polyethylene glycol monostearate; polyglycerol fatty esters; potassium stearate; propylene glycol monostearate; sodium stearate; sodium stearoyl-2-lactylate; sorbitan monostearate; sorbitan tristearate; stearamide; stearamidopropylidimethylamine; stearic acid diethanolamide; stearic acid fish amide; stearic acid monoethanolamide; stearic anhydride; *N*-stearoyl-*p*-aminophenol; stearoyl chloride; stearyl alcohol; stearylamine; stearyl stearate; tristearin; zinc stearate

Uses:

candles; organophilic/antistatic coatings (calcium carbonate fillers/polystyrene beads); emollient/superfating agent (cosmetics); lubricity additive (lubricants); paper sizing ingredient (speciality papers); plastics processing lubricant; polyvinyl chloride heat costabilisers; textile auxiliary; vulcanisation activator

stearic acid diethanolamide
stearic acid polydiethanolamide

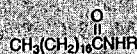


$\text{C}_{27}\text{H}_{45}\text{N}_1\text{O}_3$, M: 371.61. Mixed Kritchevsky reaction product containing 60% fatty diethanolamide and 25% diethanolamine.

Production:

• stearic acid + diethanolamine (Kritchevsky reaction)
Uses: petrol antiicing additive; emulsifier/corrosion inhibitor (soluble cutting oils)

stearic acid fish amide



R = fish-

Production:

• stearic acid + fish amine (amide formation)
Uses: internal plastics processing lubricant

stearic acid monoethanolamide
stearamide MEA (CTFA); [111-57-9]



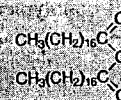
$\text{C}_{20}\text{H}_{41}\text{N}_1\text{O}_2$, M: 327.56. White or yellow flakes.

Production:

• stearic acid + monoethanolamine (amide formation)
Uses: emulsifier/pearlising/thickening agent (soaps, toiletries, cosmetics); foam stabiliser (laundry detergents)

stearic acid polydiethanolamide
See: stearic acid diethanolamide

stearic anhydride



$\text{C}_{36}\text{H}_{70}\text{O}_3$, M: 550.96. Solid. MP: 71°C. d: 0.84 kg/l. Insoluble in water and alcohol.

Production:

• stearyl ketene + stearic acid (addition)
Uses: paper sizing ingredient

stearin *See:* stearic acid

stearoamphoglycinate *See:* stearylimidazoline betaine

***N*-stearoyl-*p*-aminophenol**
4-hydroxystearanilide; Suconox-18 (Hexcel); [103-99-1]

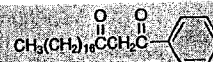


$\text{C}_{24}\text{H}_{41}\text{N}_1\text{O}_2$, M: 375.60.

Production:

• stearic acid + *p*-aminophenol (amide formation)
Uses: antioxidant (plastics)

stearoylbenzoylmethane

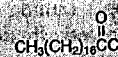


$\text{C}_{26}\text{H}_{42}\text{O}_2$, M: 386.63.

Production:

• stearyl ketene + acetophenone (condensation)
Uses: polyvinyl chloride heat costabilisers

stearoyl chloride



$\text{C}_{18}\text{H}_{35}\text{Cl}_1\text{O}_1$, M: 302.93. Liquid or solid. MP: 23°C. Soluble in hot water.

Production:

• stearic acid (acid chloride formation)
Derivatives: stearyl ketene

stearyl alcohol

1-octadecanol; octadecanol; *n*-octadecanol; octadecyl alcohol; [112-92-5]

$\text{C}_{18}\text{H}_{38}\text{O}_1$, M: 270.50.

de formation)
nt (soaps, toil-
ry detergents)

d: 0.84 kg/l.

zoline betaine

el); [103-99-1]

formation)

isation)
rs

id. MP: 23°C.

nol; octadecyl



Production:

- ethylene (Alfol/Epal processes; coproduced with *n*-hexanol/*n*-octanol/*n*-decanol/*n*-alkanol(C₈-C₁₀)/ lauryl alcohol, narrow-cut/myristyl alcohol/*n*-alkanol(C₁₂-C₁₄)/cetyl alcohol/cetylstearyl alcohol/*n*-alkanol(C₁₂-C₁₈)/*n*-alkanol(C₂₀))
- stearic acid/methyl stearate (hydrogenation)
- cetylstearyl alcohol (fractionation; coproduced with cetyl alcohol)

Derivatives:

dimethylstearylamine; distearyl pentaerythrityl diphosphate; distearyl thiodipropionate; octadecyl vinyl ether; stearyl alcohol ethoxylates; stearylamine; stearyl 3-(3',5'-di-*t*-butyl-4'-hydroxyphenyl)propionate; stearyl mercaptan; stearyl methacrylate; stearyl phosphoric acid; stearyl stearate

Uses:

plastics processing lubricant

stearyl alcohol ethoxylates

POE stearyl ether; steareth (CTFA)



n = 2-100. White solids. HLB: 4.0-15.3 (2-20 moles EO). Soluble in alcohol. Higher ethoxylated grades are dispersible in water.

Production:

- stearyl alcohol + ethylene oxide (epoxidation)

Uses: emollient/lubricant, emulsifier (cosmetics, pharmaceuticals)

stearylamine

hydrogenated tallowamine; stearamine; [124-30-1]; [61788-45-2]



C₁₈H₃₉N. M: 269.52. Solid. MP: 45-47°C. Typical chain-length distribution: 5% C₁₄, 30% C₁₆, 65% C₁₈.

Production:

- stearic acid + ammonia (nitrile formation/hydrogenation)
- stearyl alcohol + ammonia (reductive ammoniation)

Derivatives:

dimethylstearylamine; distearylamine; erucic acid stearylamine; fish acid stearylamine; stearylamine acetate; stearylamine ethoxylates; stearyl-1,3-propanediamine; tetrasodium *N*-(1,2-dicarboxyethyl)-*N*-octadecylsulphosuccinamate

Uses: cationic flotation agent (potash ores); filler dispersant (paper production); motor fuel distribution improvement additive; pigment grinding/dispersing agent; bitumen adhesion promotion agents; anticaking agent (fertilisers); antistatic agent (plastics); plastics mould release agent; organophilic surface treatment agent (china clay)

Octadecylamine

stearylamine acetate

hydrogenated tallowamine acetate; stearamine acetate; stearylammionium acetate



C₂₀H₄₃N₁O₂. M: 329.57. Solid. MP: 60°C. HLB: 10.7. A typical chain-length distribution is: 5% C₁₄, 30% C₁₆, 65% C₁₈.

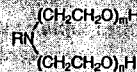
Production:

- stearylamine + acetic acid (salt formation)

Uses: dispersant/drainage aid/pitch emulsifier (paper production); anticaking agent (fertilisers); organophilic surface treatment agent (china clay)

stearylamine ethoxylates

hydrogenated tallowamine ethoxylates; PEG stearamine



R = stearyl-, *m*+*n* = 2-15. Stearylamine ethoxylates are liquids containing 5-30 moles EO. HLB: 15.0-19.0 (5-30 moles EO).

Production:

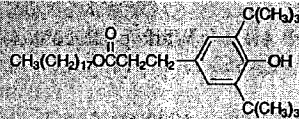
- stearylamine + ethylene oxide (epoxidation)

Uses:

corrosion inhibitor; emulsifier (wax, soluble oils, pesticides, cleaners, bitumen, silicone oils); antistatic agent (textile spin finishes, paper processing, plastics); wetting/dispersing agent (electrostatic paints, inks, dyes, pigments)

stearyl 3-(3',5'-di-*t*-butyl-4'-hydroxyphenyl)propionate

octadecyl 3,5-di-*t*-butyl-4-hydroxyhydrocinnamate; Ethnox 376 (Ethyl); Irganox 1076 (Ciba-Geigy); Naugard 76 (Uniroyal Chemical); Oxi-Chek 116 (Ferro); Ultra-nox 276 (Borg-Warner Chemicals); [2082-79-3]



C₃₅H₆₂O₃. M: 530.88.

Production:

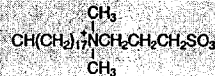
- stearyl alcohol + methyl 3,5-di-*t*-butyl-4-hydroxyphenylpropionate (transesterification)

Uses: antioxidant (plastics, rubber)

stearyldimethylamine See: dimethylstearylamine

stearyldimethylammonium-3-sulphopropylbetaine

Ralufon DS (Raschig)



C₂₃H₄₉N₁O₃S₁. M: 419.71.

