Environmental Product Declaration

Ethylene amines

Description of the product and the company

The product
Ethylene amines are essential building blocks, so called intermediates, in the manufacture of a wide range of products. Examples are bleaching agents, paints, adhesives, lubricants and fuel additives, concrete, asphalt adhesives, fabric softeners and pharmaceuticals.

Ethylene amines are particularly reactive substances and have the ability to change the properties of chemical products. They can make them softer, firmer or more supple. They can make them adhere better or stop them from coagulating, help them to retain a thicker consistency, make them foam in a controlled fashion or keep them free-flowing.

Ethylene amines are manufactured in Stenungsund, Sweden, and are delivered to customers all over the world in drums, IBCs or tank containers.

Ethylene amines are classified as corrosive. The labelling differs among the products, as can be seen in the table below.

	Category of danger	Risk phrases
EDA	Corrosive/Flammable	R 10, 21/22, 34, 42/43
DETA	Corrosive	R 21/22, 34, 43
AEEA	Corrosive/Toxic	R 61, 62, 34, 43, 52/53
PIP - 68	Corrosive	R 34, 42/43, 62, 63
PIP Anh	Corrosive	R 34, 42/43, 62, 63
AEP	Corrosive	R 21/22, 34, 43, 52/53
BA-20	Corrosive/Toxic	R 61, 21, 34, 43, 52/53

The process
The reaction steps in the manufacturing process of ethylene amines are performed in reactors in a continuous process. Ethylene amines are produced when monoethanolamine and ammonia react under high pressure and at a high temperature in the presence of hydrogen gas and a catalyst. The process, which is ethylene oxide based, has been developed by Akzo Nobel and offers many advantages over older processes that involve ethylene chloride, ammonia and lye.

The company
Based in the Netherlands, Akzo Nobel is a multicultural organization serving customers throughout the world with human and animal healthcare products, coatings, and chemicals. Akzo Nobel employs around 61,500 people and conduct activities in four segments - human and animal health, coatings and chemicals - subdivided into 13 business units, with operating subsidiaries in more than 80 countries.

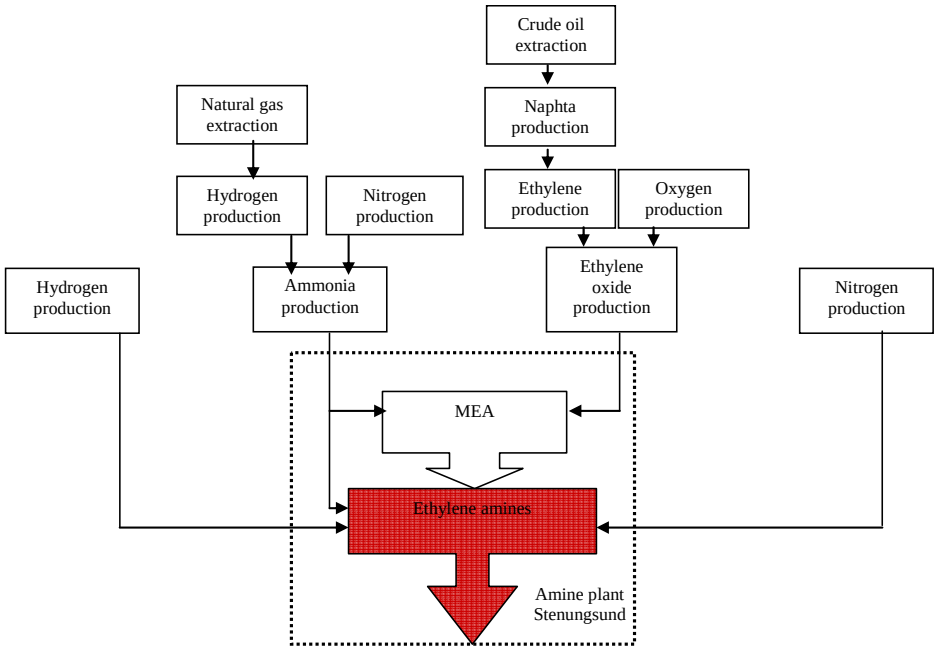
A world leader in the production of ethylene amines, the Stenungsund sub business unit of Akzo Nobel Functional Chemicals is responsible for the development, production and marketing of ethanolamines, ethylene amines and glycols.

Management systems are certificated in accordance with ISO 9001 (Quality Assurance) and ISO 14001 (Environmental Management).

Presentation of environmental performance

The functional unit is 1000 kg of ethylene amines. This means that the environmental load presented, is valid for 1000 kg of ethylene amines.

All major steps, from the extraction of natural resources until the product leaves the gates in Stenungsund, are included in the environmental performance of the manufacturing phase. A few of these steps are displayed in the simplified flowchart below.



The data used were collected for year 2004[1] and others are said to be valid for that time according to suppliers. Site-specific data have been retrieved as far as possible and when not possible average European data have been used. The environmental load from the production processes of the raw materials have been divided amongst the received products according to the economic value. For the products from the amine plant in Stenungsund mass allocation has been applied since the price of the products vary from time to time.

The manufacturing phase

The figures displayed below cover not only the environmental load derived from the production site of ethylene amines. All steps during the life cycle up until the product leaves the gates in Stenungsund are included like natural resource extraction, raw material production, energy production and transportation. All figures are given for 1000 kg of ethylene amines.

Non-renewable resources			
Without energy content	**kg**	**With energy content**	**MJ**
Nitrogen	29,0	Natural gas	43050
Copper ore	1,9	Crude oil	34910
Uranium ore	1,1	Nuclear energy	9720
Sodium Chloride	0,7	Coal	1060
Sand	0,5		

This table displays the total use of non-renewable resources, including feedstock, needed for 1000 kg ethylene amines.

Renewable resources			
Without energy content	**kg**	**With energy content**	**MJ**
–	–	Hydro energy	3650
		Biomass	280
		Wind energy	8

[1] Data for Steam production is collected for 2005 since data from 2005 is more representative due to changes made in the steam production during 2004.

The electricity net consumption, displays how much electricity that has been consumed within the system studied. The environmental load of this electricity is included in the other displayed figures.

Electricity net consumption	
Electricity production source	**kWh**
Unspecified	754
Hydro power	754
Nuclear power	875
Natural gas	3,8
Coal	16,4
Bio fuel	21,6
Wind power	2,1
Oil	1,3
Unspecified means that the electricity grid is not known and is represented by a mix of electricity production sources.	

Note that energy is not the same as electricity. For example nuclear energy is a measure of the total energy content in the uranium fuel in the same way as crude oil is a measure of energy content. Hence nuclear energy is not the same as nuclear electricity (here named Nuclear power), like crude oil is not the same as electricity produced from oil.

Some of the air and water emissions are expressed both as emissions and as influence on different environmental impact categories. The result is displayed below. The environmental flows displayed are the ones considered to be significant for the production of ethylene amines.

Emissions to air	g
CO_2	3126 000
CH_4	8300
NO_X	4600
SO_2	2450
Particles	2600
HC	3120
Ethene	220
CO	1140
Major and most significant air emissions.	

Emissions to water	g
COD	360
Cl^-	360
N total	130
P total	5,3
Amines	5,5
Major and most significant water emissions.	

Waste generation	kg
Non hazardous waste	96
Hazardous waste	0,05
Different types of waste are divided into the two groups displayed above.	

Emissions, expressed in terms of environmental impact		
Category of impact	**Equivalent unit**	**Impact**
Global warming potential (GWP)	g CO_2	3301 000
Ozone depletion potential (ODP)	g CFC-11	0
Acidification potential (AP)	mole H^+	190
Photochemical ozone creation potential (POCP)	g ethene	1480
Eutrophication potential (EP)	g O_2	38800
An explanation to these impact categories is found at the end of this EPD.		

The use phase

Ethylene amines are sold to industrial customers all over the world and end up in a wide range of products, from pharmaceuticals to concrete. Due to the wide spread of applications it is not possible to calculate the environmental load from the ethylene amines during the use phase.

The environmental impact from the transport to customer is given for the transport of 1000 kg of ethylene amines. The stated impact for the means of transport in question is based on a travel distance of 100 km. This makes it possible for customers to assess the environmental load derived from transport of ethylene amines. The actual means of transport used depend on where the customer is situated.

Environmental impact from transport to customer				
Impact	**Unit**	**Train[1]**	**Truck[2]**	**Ship[3]**
Crude oil	MJ	–	73	22
Hydro energy	MJ	23	–	–
CO_2	g	0,4	5200	1500
CO	g	0,01	5	0,9
HC	g	0,001	4	2
NOx	g	0,001	50	43
SO_2	g	0,0006	2,8	26
Particles	g	0,0001	0,9	2
All above means of transportation are used for transportation of ethylene amines to customers. Sometimes all three are used.				

The means of transport are approximated with a train transport, a truck transport and a ship transport.
1. The train is a Swedish electric train.
2. The truck has a maximum weight of 40 ton, a Euro II engine and is using EC3-diesel. The loading factor is 70%.
3. The ship has a maximum weight of more than 8000 ton and a loading factor of 50-60%.

Information from the company

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Other information

This Environmental Product Declaration and the underlying LCA has been prepared according to the guidelines of the Swedish system for Environmental Product Declarations (EPD®). The information is however not certified by a third party. Accordingly, this declaration is not a certified Environmental Product Declaration, an EPD®.

References:

- LCA documentation for ethylene amines, 2005
- Product-Specific Requirements Chemical Products, (PSR 2000:5)
- Requirements for Environmental Product Declarations, EPD (MSR 1999:2) – an application of ISO TR 14025.

Glossary

Acidification potential, AP. Chemical alternation of the environment, resulting in hydrogen ions being produced more rapidly than they are dispersed or neutralised. Occurs mainly through fallout of sulphur and nitrogen compounds from combustion processes. Acidification can be harmful to terrestrial and aquatic life.

Eutrophication potential, EP. Enrichment of bodies of water by nitrates and phosphates from organic material or the surface runoff. This increases the growth of aquatic plants and can produce alga blooms that deoxygenate water and smother other aquatic life.

Global warming potential, GWP. The index used to translate the level of emissions of various gases into a common measure to compare their contributions to the absorption by the atmosphere of infrared radiation. GWPs are calculated as the absorption that would result from the emission of 1 kg of a gas to that from emission of 1 kg of carbon dioxide over 100 years.

Life Cycle Assessment, LCA. A management tool for appraising and quantifying the total environment impact of products or activities over their entire life cycle of particular materials, processes, products, technologies, services or activities.

Ozone depletion potential, ODP. The index used to translate the level of emissions of various substances into a common measure to compare their contributes to the breakdown of the ozone layer. ODPs are calculated as the change that would result from the emission of 1 kg of a substance to that from emission of 1 kg of CFC-11 (a freon)

Photochemical ozone creation potential, POCP. The index used to translate the level of emissions of various gases into a common measure to compare their contributions to the change of ground-level ozone concentration. POCPs are calculated as the change that would result from the emission of 1 kg of a gas to that from emission of 1 kg of ethene.