Environmental Product Declaration

Ethylene amines

Description of the product and the company

The product
Ethylene amines are essential building blocks in manufacturing of a wide range of products. They are particularly reactive substances and have the ability to add or increase properties of chemical products. They can make them softer, firmer or more supple. They can prevent products from coagulating, retain a creamy consistency or keep products anti-static. Examples of products that ethylene amines are used in are: detergents, paints, adhesives, fuel oils, make-up soaps, pharmaceuticals, concrete, asphalt, pulp and paper.

The reaction steps in the manufacturing process of ethylene amines are performed in reactors in a continuous process. First ethylene oxide is reacted with ammonia to obtain monoethanolamine which then reacts with anhydrous ammonia to form ethylene amines. The formed ethylene amines are separated by distillation and then filled in drums, IBC or tank containers and delivered to customers. The manufacturing of Ethylene amines takes place in Stenungsund, Sweden.

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

Ethylene amines are classified as corrosive (not irritant). The labelling differs among the different ethylene amines, see 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, Repr. Cat2, Repr Cat3
PIP-68	Corrosive	R 38, 41
PIP Anh	Corrosive	R 34, 42/43, 52/53
AEP	Corrosive	R 21/22, 34, 43, 52/53
BA-20	Corrosive/Toxic	R 61, 21, 34, 43, 52/53, Repr. Cat2

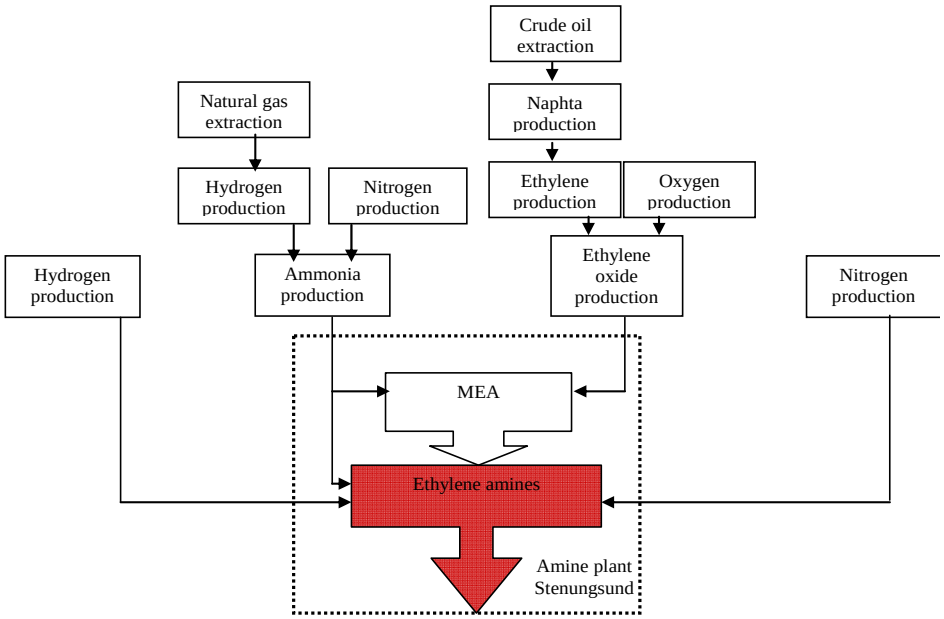
The company
The Ethylene Amines and Ethanolamines section located in Stenungsund, manufacturing ethylene amines, is part of the business unit AkzoNobel Functional Chemicals, a world leader in the production of ethylene amines.

The production process for ethylene amines that is used in Stenungsund, has been developed within the company and this process offers many advantages over older processes that involve ethylene dichloride, ammonia and lye.

Management systems are certified according to ISO 9002 and ISO 14001.

Presentation of environmental performance

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. In this environmental declaration economic allocation has been the base for calculations, meaning the environmental load from a production has been divided according to the economic value of the products produced. In the case of the production at the amine plant in Stenungsund the value of the major products are in the same range and do also vary from time to time therefore mass allocation has been applied for these.

The manufacturing phase

The figures displayed below cover not only the environmental load derived from the production site of Ethylene Amines. All other 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

The net electricity consumption is not a resource use since the resources used for, and emissions and waste derived from, electricity production are included in the other displayed figures. It simply displays how much electricity that has been consumed within the system studied.

[1] Data for Steam production is collected fro 2005 since changes were made in the steam production during 2004, why data from 2005 is more representative.

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 environmental flows presented below have indexes in the different environmental impact categories and are therefore influencing them. 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
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.	

The most important air and water emissions are expressed as influence on different environmental impact categories. The result is displayed below.

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 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, 100 km for the means of transport in question. This makes it possible for customers to assess the environmental load derived from transportation of ethylene amines. The actual means 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

Contact: Ulf Schröder
Akzo Nobel Functional Chemicals AB
S-444 85, Stenungsund, Sweden

Phone: +46-(0)303-85000
Fax: +46-(0)303-887 86
http://www.akzonobel.com/ea

References:

- LCA documentation for Ethylene Amines, 2005

Other information:

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.