

Gasexplosion och brand i en anläggning för etylenoxidproduktion på ett raffinaderi.

890307 MARS 1800_006_004

En explosion utlöstes då etylenoxid sönderdelades i en reaktion med isoleringsmaterialet i en nivåindikator. Gasmatarledningen slets av och den frisläppta gasen fattade eld. Då trycket i tanken snabbt föll uppstod ett undertryck som drog in lågorna i tanken varvid en andra våldsamt explosion inträffade blott 26 sekunder efter den första. En gasåtervinningslina träffades av spillror varvid den frisläppta gasen fattade eld och brann med en jet-låga. Företagets interna brandkår lyckades begränsa brandens omfattning och fick den under kontroll inom en timme. Räddningstjänsten tillkallades men behövde inte ingripa.

Etylenoxiden kom i kontakt med isoleringsmaterialet pga ett läckage genom en spricka som uppstått på grund av materialutmattning i en svetsfog.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
Etylenoxid	75-21-8	10 ton
Etylen	74-85-1	
Naturgas	74-82-8	

Mängden etylenoxid i de båda explosionerna uppskattas till 10 ton, medan den totala mängden gas (etylenoxid, etylen och naturgas) som förbrändes i jet-lågan uppskattas till 2 ton. Inbördes halter kan inte uppges.

Skador:

Människor:	Fem anställda fick mindre (ospecificerade) skador.
Materiella:	Olyckan skadade etylenoxidanläggningen allvarligt. Den omgivande utrustningen skadades av kringflygande splinter.
Miljö/ekologi:	Inga skador rapporterade.
Infrastruktur:	Inga skador rapporterade.

Erfarenheter redovisade (Ja/Nej): Nej

Endast indirekt i form av åtgärder för förbättrade rutiner och konstruktioner.

Report Profile

Identification of Report:

country: FA ident key: 1800_006_04

reported under Seveso I directive as major accident reports: SHORT+FULL

Date of Major Occurrence: Time of Major Occurrence

start: 1989-03-07 start: 17:00:00

finish: 1989-03-07 finish:

Establishment:

name:

address:

industry: 2002 petrochemical, refining, processing

Petrochemical (Ethylene Oxide Production Plant)

Seveso II status: not applicable: Yes art. 6 (notification): No

art. 7 (MAPP): No

art. 9 (safety report): No

Date of Report:

short: full:

Authority Reporting:

name:

address:

Authority Contact:

rep_cont_name:

rep_cont_phone:

rep_cont_fax:

Additional Comments:

a) - not applicable -

b) - not applicable -

c) - not applicable -

d) - not applicable -

e) - not applicable -

Short Report

country: FA **ident key:** 1800_006_04

Accident Types:

release: Yes **explosion:** Yes

water contamination: No **other:** No

fire: Yes

description:

ACCIDENT CASE HISTORY DESCRIPTION:... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: Yes **explosive:** Yes

ecotoxic: No **other:** No

flammable: Yes

description:

- Ethylene oxide (C.A.S. CODE: 75-21-8); amount involved in the two explosions = 10,000 Kg.... see Appendix Short Report / description of substances involved

Immediate Sources of Accident:

storage: No **transfer:** No

process: Yes **other:** No

description:

The accident occurred in an ethylene oxide/glycol plant of a petrochemical industry. The components involved were the distillation column K-303 (aldehyde column) and the purification column K-302. The distillation column K-303, containing a... see Appendix Short Report / description of immediate sources

Suspected Causes:

plant or equipment: Yes **environmental:** No

human: No **other:** No

description:

CAUSES:... see Appendix Short Report / description of suspected causes

Immediate Effects:

material loss: Yes

human deaths: No

human injuries: Yes **community disruption:** No

other: No

ecological harm: No

national heritage loss: No

description:

EFFECTS ON PEOPLE:... see Appendix Short Report / description of immediate effects

Emergency Measures taken:

on-site systems: Yes **decontamination:** No

external services: Yes **restoration:** No

sheltering: No **other:** No

evacuation: No

description:

INTERNAL TO THE ESTABLISHMENT:... see Appendix Short Report / description of emergency measures taken

Immediate Lessons Learned:

prevention: Yes **other:** No

mitigation: No

description:

MEASURES TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:... see Appendix Short Report / description of immediate lessons learned

A Occurrence Full Report

country: FA **ident key:** 1800_006_04

1 Type of Accident

remarks: An ethylene oxide decomposition occurred in the column K-303 which exploded (the confined vapour explosion began in the lower section of the column [code 1307]). The gas supply line to column K-302 was torn off and the escaping gas (code 11... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: The total establishment and the potential directly involved inventories of ethylene oxide refer to the amount involved in the two explosions. The total amount of ethylene oxide, ethylene and natural gas involved in the jet-fire that followe... see Appendix Full Report A / dangerous substances

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred in an ethylene oxide/glycol plant (code 3102) of a petrochemical industry (code 2002). The components involved were the distillation column K-303 (aldehyde column) and the purification column K-302 (codes 4007). The di... see Appendix Full Report A / source of accident - remarks

4 Meteorological Conditions

precipitation none: fog: rain: hail: snow:

No No No No No

wind speed (m/s):

direction (from):

stability (Pasquill):

ambient temperature (°C):

remarks: - not applicable -

5 Causes of Major Occurrence

main causes

technical / physical 5104 operation: corrosion/fatigue

5107 operation: unexpected reaction/phase-transition

- not applicable -

- not applicable -

- not applicable -

human / organizational 5303 organization: organized procedures (none, inadequate, inappropriate, unclear)

5307 organization: process analysis (inadequate, incorrect)

5308 organization: design of plant/equipment/system (inadequate, inappropriate)

- not applicable -

- not applicable -

remarks: Ethylene oxide leaked through a hair-crack (due to fatigue) in a weld on the distillation column K-303 (aldehyde column) and contaminated the rock-wool insulation of a level indicator (code 5104). The released ethylene oxide reacted with mo... see appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident country: FA **ident key:** 1800_006_04

event:

major occurrence - not applicable -

initiating event - not applicable -

associated event - not applicable -

event:

major occurrence 1101 release: gas/vapour/mist/etc release to air

initiating event 1307 explosion: VCE (vapour cloud explosion; supersonic

wave front)

associated event - not applicable -

Dangerous substances

country: FA **ident key:** 1800_006_04

a) total establishment inventory

CAS number: 74-82-8 **identity:** Natural Gas

name from Seveso I Directive: - not applicable -

name from Seveso II Directive: - not applicable -

category from Seveso II: - not applicable -

other hazards (1): - not applicable -

other hazards (2): - not applicable -

maximum quantity (tonnes): 2

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 2 **potential quantity:** 2

c) substance belongs to relevant inventory indirectly involved: No

actual quantity: -1 **indir_pot_quant:** -1

a) total establishment inventory

CAS number: 75-21-8 **identity:** Ethylene Oxide

name from Seveso I Directive: - not applicable -

name from Seveso II Directive: - not applicable -

category from Seveso II: - not applicable -

other hazards (1): - not applicable -

other hazards (2): - not applicable -

maximum quantity (tonnes): 12

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 12 **potential quantity:** 12

c) substance belongs to relevant inventory indirectly involved: No

actual quantity: -1 **indir_pot_quant:** -1

a) total establishment inventory

CAS number: 74-85-1 **identity:** Ethylene

name from Seveso I Directive: - not applicable -

name from Seveso II Directive: - not applicable -

category from Seveso II: - not applicable -

other hazards (1): - not applicable -

other hazards (2): - not applicable -

maximum quantity (tonnes): 2

use of substance as: STARTING MATERIAL

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 2 **potential quantity:** 2

c) substance belongs to relevant inventory indirectly involved: No

actual quantity: -1 **indir_pot_quant:** -1

Source of Accident - Situation country: FA **ident key:** 1800_006_04

situation

industry

initiating event 2002 petrochemical, refining, processing

associated event - not applicable -

activity/unit

major occurrence 3102 process: chemical continuous reaction

initiating event 3102 process: chemical continuous reaction

associated event - not applicable -

component

major occurrence 4007 machinery/equipment (pump, filter, column separator, mixer, etc.)

initiating event 4007 machinery/equipment (pump, filter, column separator, mixer, etc.)

associated event - not applicable -

B Consequences Full Report

country: FA **ident key:** 1800_006_04

1 Area concerned

affected

extent of effects installation: Yes

establishment: Yes

off-site; local: No

off-site; regional: No

off-site; transboundary: No

illustration of effects - not applicable -

remarks In the Original Report there is no evidence of significant effects outside the e... see Appendix Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk -1 0 0

immediate fatalities 0 0 0

subsequent fatalities 0 0 0

hospitalizing injuries 0 0 0

other serious injuries 5 0 0

health monitoring 0 0 0

remarks 5 employees suffered only minor injuries.

3 Ecological Harm

pollution/contamination/damage of:

- residential area (covered by toxic cloud) Suspected
- common wild flora/fauna (death or elimination) Suspected
- rare or protected flora/fauna (death or elimination) Suspected
- water catchment areas and supplies for consumption or recreation Suspected
- land (with known potential for long term ecological harm or preventing human access or activities) Suspected

preventing human access or activities)

- marine or fresh water habitat Suspected
- areas of high conservation value or given special protection Suspected

remarks In the Original Report there is no evidence of significant ecological harms... see Appendix Full Report B / ecological harm

4 National Heritage Loss

effects on:

- historical sites not applicable - historic monuments not applicable
- historic buildings not applicable - art treasures not applicable

remarks No data available.

5 Material Loss

establishment losses off site losses

costs (direct costs to operator) (social costs)

in ECU BF ECU BF

material losses 4,9E+07 2E+09 0 0

response, clean up, restoration 0 0 0 0

remarks The accident damaged the distillation section and the surrounding equipment were... see Appendix Full Report B / material loss

6 Disruption of Community Life

establishment/plant evacuated disabled/unoccupiable destroyed

- nearby residences/hotels No No No
- nearby factories/offices/small shops No No No
- schools, hospitals, institutions No No No
- other places of public assembly No No No

interruption of utilities etc. no / yes duration

- gas No
- electricity No

- **water** No
- **sewage treatment works** No
- **telecommunications** No
- **main roads** No
- **railways** No
- **waterways** No
- **air transport** No

significant public concern none local level national level

- **off site populations** Yes No No
- **media interest** No No No
- **political interest** No No No

remarks In the Original report there is no evidence of significant effects outside the e... see Appendix

7 Discussion of Consequences

Ecological Components involved

country: FA **ident key:** 1800_006_04

type: - not applicable -

threatened: not applicable **affected:** not applicable

C Response Full Report

country: FA **ident key:** 1800_006_04

1 Emergency Measures

taken - on site - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

- **off site** - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

still - on site - not applicable - - not applicable -

required

- not applicable - - not applicable -

- not applicable - - not applicable -

- **off site** - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

continuing contamination or danger

-**on site** not applicable

-**off site** not applicable

remarks - not applicable -

2 Seveso II Duties

pre-accident evaluation

Article item not due yet not done done/submitted evaluated

6 notification No No No No

7 policy (MAPP) No No No No

9 safety report No No No No

9, 10, 11 update No No No No

11 internal plan No No No No

11 external plan No No No No

13 informing public No No No No

9, 12 siting policy No No No No

post-accident evaluation

Seveso II duty was actual were actual compared with actual

contingency consequences consequences, the

addressed? addressed? predicted extent was?

Article item

7 policy (MAPP) not applicable not applicable not applicable

9 current safety report not applicable not applicable not applicable

11 internal plan not applicable not applicable not applicable

11 external plan not applicable not applicable not applicable

13 informing public not applicable not applicable not applicable

9, 12 siting policy not applicable not applicable not applicable

evaluation of safety organisation

organisational element element existed did element relate to actual circumstances of

yes / no no / partly / yes adequate?

- written policy objectives No

- specified management No

structure

- specified responsibilities No

- specified working procedures No

- specified procedures for No

assessment/auditing of

management system

- specified procedures for No

review and update of

management policy

- specified general training No

procedures

- specified emergency No

training procedures

evaluation of ecological impact control

organisational element element existed did element relate to actual circumstances of

yes / no no / partly / yes adequate?

- ecological status review No

before incident

- potential ecological No

consequences assessment

- ecological impact review No

after incident

- ecological restoration No

procedures

- subsequent review of No

restoration success

remarks - not applicable -

3 Official Action Taken

legal action

- not applicable -

other official action

- not applicable -

4 Lessons Learned

measures to prevent recurrence

After the accident, the follow... see Appendix Full Report C / lesson learned - prevent

measures to mitigate consequences:

not given

useful references:

not given

5 Discussion about Response

- not applicable -

Appendices for the FA / 1800_006_04 report

Appendix Short Report / description of accident types:

ACCIDENT CASE HISTORY DESCRIPTION:

Ethylene oxide leaked through a hair-crack in a weld on the distillation column K-303 (aldehyde column) and contaminated the rock-wool insulation of a level indicator. The leak was caused by a hair-crack due to low cycle fatigue. The released

ethylene oxide reacted with moisture to form non-volatile polyethylene glycols (PEG) in the insulation material. PEG accumulated in the course of time. On the day of the accident, the metal covering of the insulation was removed in order to repair the level indicator. Air leaked into the insulation material already soaked with PEG, causing its decomposition and initiating auto-oxidation. The auto-oxidation of the PEG ignited the insulation and the resulting heat flux heated the metal wall of the piping of the level instrumentation system. The heating of the stagnant liquid of the level instrument stand pipe caused the ethylene oxide to decompose. The decomposition continued into the column K-303 which exploded (the confined vapour explosion began in the lower section of the column). The gas supply line to column K-302 (carrying gases from the head of column K-303) was torn off and the escaping gas caught fire. After the pressure decreased, the flames backed into the column K-302 and caused an internal explosion (approximately 26 seconds after the first explosion). The two explosions caused the impact of debris in other sections of the ethylene oxide/glycol installation and was followed by a huge fire. The recycle gas loop was hit by debris and the released gas burned as a jet-fire. The plant fire fighting team was able to confine the fire and to put it under control in less than one hour. The city fire brigade arrived on the scene but its intervention was not necessary.

Appendix Short Report / description of substances involved:

- Ethylene oxide (C.A.S. CODE: 75-21-8): amount involved in the two explosions = 10,000 Kg.

The total amount of ethylene oxide, ethylene and natural gas involved in the jet-fire that followed the explosions was approximately 2,000 Kg but no data are available about the single amounts of these substances.

- Ethylene oxide (C.A.S. CODE: 75-21-8).

- Ethylene (C.A.S. CODE: 74-85-1).

- Natural Gas (C.A.S. CODE: 74-82-8).

Appendix Short Report / description of immediate sources:

The accident occurred in an ethylene oxide/glycol plant of a petrochemical industry. The components involved were the distillation column K-303 (aldehyde column) and the purification column K-302. The distillation column K-303, containing approximately 89% wt of ethylene oxide and 10% wt of water, was operating at about 60°C and at a pressure of about 3 bar.

Appendix Short Report / description of suspected causes:

CAUSES:

Ethylene oxide leaked through a hair-crack in a weld on the distillation column K-303 (aldehyde column) and contaminated the rock-wool insulation of a level indicator. The leak was caused by a hair-crack due to low cycle fatigue. The released ethylene oxide reacted with moisture to form non-volatile polyethylene glycols (PEG) in the insulation material. PEG accumulated in the course of time. On the day of the accident, the metal covering of the insulation was removed in order to repair the level indicator. Air leaked into the insulation material already soaked with PEG, causing its decomposition and initiating auto-oxidation. The auto-oxidation of the PEG ignited the insulation and the resulting heat flux heated the metal wall of the piping of the level instrumentation system. The heating of the stagnant liquid of the level instrument stand pipe caused the ethylene oxide to decompose. It must be underlined that the use of a non-absorbing insulation material with a high specific surface area, the insufficient in-depth inspections for leaks and also for the possible existence of any accumulation of polyethylene glycols (PEG) and the lack of inertization of parts of the equipment where stagnant zones of ethylene oxide/water mixtures may be created (e.g. instrumentation stand pipes) by means of continuous nitrogen purging was caused by inadequate process analysis, design plant and inspection procedures.

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

5 employees suffered only minor injuries.

MATERIAL LOSS:

The accident damaged the distillation section and the surrounding equipment were damaged by the impact with debris. The cost of these material damages was estimated in about 2,000,000,000 Belgium Francs (about 0,05 MECU).

Appendix Short Report / description of emergency measures taken:

INTERNAL TO THE ESTABLISHMENT:

Columns K-302 and K-303 were automatically isolated. Energy to the installation was manually cut-off. All the personnel was warned and the fire fighting team was activated. It confined the fire that followed the explosions and put it under control in less than one hour. The city fire brigade arrived on the scene but its intervention was not necessary.

EXTERNAL TO THE ESTABLISHMENT:

No off-site emergency measures were required.

Appendix Short Report / description of immediate lessons learned:

MEASURES TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:

After the accident, the following measures were established:

- 1- use of a non-absorbing insulation material with a small specific surface area;
- 2- in-depth inspection for leaks and also for the possible existence of any accumulation of polyethylene glycols (PEG);
- 3- inertization of parts of the equipment where stagnant zones of ethylene oxide/water mixtures may be created (e.g. instrumentation stand pipes) by means of continuous nitrogen purging.

Appendix Full Report A / type of accident:

An ethylene oxide decomposition occurred in the column K-303 which exploded (the confined vapour explosion began in the lower section of the column [code 1307]). The gas supply line to column K-302 was torn off and the escaping gas (code 1101) caught fire (code 1203). After the pressure decreased, the flames backed into the column K-302 and caused a second explosion (code 1307). The recycle gas loop was hit by debris and the released gas (code 1101) burned as a jet-fire (code 1203).

Appendix Full Report A / dangerous substances:

The total establishment and the potential directly involved inventories of ethylene oxide refer to the amount involved in the two explosions. The total amount of ethylene oxide, ethylene and natural gas involved in the jet-fire that followed the explosions was approximately 2,000 Kg but no data are available about the single amounts of these substances.

Appendix Full Report A / source of accident - remarks:

The accident occurred in an ethylene oxide/glycol plant (code 3102) of a petrochemical industry (code 2002). The components involved were the distillation column K-303 (aldehyde column) and the purification column K-302 (codes 4007). The distillation column K-303, containing approximately 89% wt of ethylene oxide and 10% wt of water, was operating at about 60°C and at a pressure of about 3 bar.

Appendix Full Report A / causes of major occurrence:

Ethylene oxide leaked through a hair-crack (due to fatigue) in a weld on the distillation column K-303 (aldehyde column) and contaminated the rock-wool insulation of a level indicator (code 5104). The released ethylene oxide reacted with moisture to form non-volatile polyethylene glycols (PEG) in the insulation material that auto-oxidized (code 5107). These causes, together with inadequate process analysis, design plant and inspection procedures (codes 5303, 5307 and 5308), led to the accident.

Appendix Full Report B / area concerned - remarks:

In the Original Report there is no evidence of significant effects outside the establishment.

Appendix Full Report B / ecological harm:

In the Original Report there is no evidence of significant ecological harms.

Appendix Full Report B / material loss:

The accident damaged the distillation section and the surrounding equipment were damaged by the impact with debris. The cost of these material damages was estimated in about 2,000,000,000 Belgium Francs (about 0,05 MECU).

Appendix Full Report B / disruption of community life:

In the Original report there is no evidence of significant effects outside the establishment.

Appendix Full Report C / lesson learned - prevent:

After the accident, the following measures were established:

- 1- use of a non-absorbing insulation material with a small specific surface area;
- 2- in-depth inspection for leaks and also for the possible existence of any accumulation of polyethylene glycols (PEG);
- 3- inertization of parts of the equipment where stagnant zones of ethylene oxide/water mixtures may be created (e.g. instrumentation stand pipes) by means of continuous nitrogen purging.