Accident Profile

Title

Explosion in high pressure (3000 bar) production line for low density polyethylene during the start-up

Date/Time of Major Occurrence

Start Date 22-03-2002 **End Date** 22-03-2002

Accident Type

Major Accident

Reported under

EU Seveso II Directive

Seveso II Status

Upper tier

Industrial Activity

Plastic and rubber manufacture

Reasons for Reporting

Substances involved: greater than 5% of quantity in Column 3 of Annex I

Injury to persons: >= 1 fatalities, >= 6 hospitalizing injuries, evacuation, shelter-in-place, utility disruption and damage to real estate

Immediate damage to the environment (according to Annex VI)

Damage to property: on-site >2M €, off-site > 0.5M €

Cross-border damage: transboundary accidents

Interesting for lessons learned.

Accident Report

Accident description

An explosion occurred in a high pressure (3000 bar) production line for low density polyethylene during the start-up of the line. A recycle line from the high pressure separator ruptured and about 2 tonnes of ethylene and decomposition products were released. The released ethylene caught fire. The fire only burned for a couple of minutes until all ethylene was released through the 124 mm diameter ruptured pipe. Interlock systems had blocked connections to other equipment immediately after the explosion. The site intervention team started firefighting and cooling down of the equipment. When the fire brigade arrived (15-20 minutes later) the incident was completely under control and no further interventions were needed.

Accident involving

☐ Domino effects ☐ Natech events ☐ Transboundary effects ☐ Contractors

Release

Major Occurences

gas/vapour/mist/etc release to air

Fire

Major Occurences

jet flame (burning jet of fluid from orifice)

Explosion

Major Occurences

runaway reaction explosion (usually exothermic)

Initiating Events

explosive decomposition (of unstable material)

runaway reaction explosion (usually exothermic)

Site and installation

Site description

Installation/Unit description

Due to incomplete purging of the installation prior to start up, a pocket of air remained in the installation. During the pressurising of the installation this air was mixed with ethylene at 170 bar and 200°C. Under this conditions the oxygen in the air reacted with ethylene (acts as catalyst) and started the decomposition of ethylene. This decomposition is strongly exothermic and the system reached 270 bar and 700°C (calculated).
At first this caused a safety valve further in the installation to open with a visible soot emission. The safety valves on the ruptured pipe didn't open because they were set at a higher pressure. The pipe ruptured due to weakening by the high temperature. Calculations afterwards showed that the pipe's resistance was lowered to 150 bar at 700°C.
Due to the fact that the decomposition took place in the start up phase, only intermediate pressure, the temperature could rise considerably before the pressure reached the setpoint of the safety valves. During normal production, the working pressure is much closer to the setpoint of the safety valves, so they can act more adequately as a release and safety measure for this scenario.

Process

Major occurrences	Equipment Type
chemical continuous reaction	general pipework/flanges

Initiating Events	Equipment Type
chemical continuous reaction	general pipework/flanges

Substances

Substances Involved

ethene (ethylene, C.A.S. No: 74-85-1): 2 tonnes ethylene and decomposition products (soot, methane (C.A.S. No: 74-82-8)) released.

Ethylene is used in 6 parallel and independent production units for polyethylene. The total inventory of ethylene on site is limited to intermediate vessels in the reaction cycle. Ethylene is supplied by pipeline.

Substances Classification

08. EXTREMELY FLAMMABLE - note 3(c)

Substances detail

Substance	CAS Number	Quantities (t.)	
		Involved	Potential
ethylene	74-85-1	2.00000	6.00000

Causes

The decomposition reaction was caused by incomplete purging of the installation, leaving an air pocket in a line. The air pocket remained between 2 closed valves. One of these valves normally stays open after shut-down and allows the part to be purged. During the shut-down this valve was closed during an interlock test and left closed. The operator performing the purging operation assumed is was still as left at shut down.

The purging operation was done on the basis of operator knowledge, without an instruction. No checklists were used to guide the start-up process and to mark the completion of start up phases. Inadequate training of emergency procedures: There are different emergency buttons available, an emergency stop which stops the installation and isolates all major inventories of ethylene and a dump system to evacuate certain vessels to the (small) flair. The difference between the systems and when to use which was not understood properly by the operators. They used the emergency stop (isolating the decomposition reaction) instead of the dump. Dumping the high pressure separator to the flare could have prevented the rupture of the pipe.

Organizational

Causative Factor	Type
organized procedures	
training/instruction	
user-unfriendliness (apparatus, system, etc.)	

Plant/Equipment

Causative Factor	Type
vessel/container/containment-equipment failure	
unexpected reaction/phase-transition	

Human

Causative Factor	Type
operator error	

Consequences

Apart from the ruptured pipe the explosion caused structural damage to the nearby platform and damaged weaker construction elements (doors, plastic wall panels) in a wider radius (100-200 m) mostly on-site. Parts of the pipe had to be replaced due to the high temperature they experienced during the incident.

Human

On site	Quantity	Quantity/Effect
At risk		Establishment Population: 30

Cost

On site	Quantity	Quantity/Effect
material losses		Apart from the ruptured pipe the explosion caused structural damage to the nearb

Emergency Response

Official action taken: The company's accident evaluation was followed up by the inspection team. Causes and actions to take were discussed and proved adequate.

The installation was shut down and isolated by the emergency stop and interlock systems. This isolated the ruptured pipe and the connected high pressure separator from other equipment. After the explosion the site intervention team started the firefighting and cooling of the installation, but basically the fire burnt itself out because only the inventory of the high pressure separator was available and all other sources were

isolated. When the fire brigade arrived 15-20 minutes after the explosion the situation was completely under control and all isolated inventories in the installation were one-by-one directed to the flair.

Emergency Response	Quantity	Quantity/Effect
On-site systems		plant emergency shut-down procedures; alarms/sirens sounded; internal emergency teams (fire, ambulance, etc.); firewater runoff control
Off-site external services		external fire-fighting services
Sheltering		
Evacuation		
Other		

Remedial Measure	Quantity	Quantity/Effect
Decontamination		
Restoration		
Other		

Lessons Learned

Theme of the Lessons Learned

Causes - Plant/Equipment

Causes - Organisational

Lessons Learned

- better, more detailed start up procedures are needed
- a checklist to guide the start up
- better training of emergency operating procedures
- ergonomics of emergency panel is to be checked

Event Profile

Publication Date