

Implosion of a styrene storage tank during truck unloading operations

January 7th, 2005

Tertre - Belgium

Chemistry
Styrene
Unloading
Polyol
Barometric seal
Vacuum breaker

THE INSTALLATIONS CONCERNED

The site:

The plant, located in Tertre, specialises in the fabrication and storage of:

polyether-polyols: polymerisation of propylene oxide and ethylene oxide on an alcohol, in the presence of catalysts

polymer-polyols: polymerisation of styrene and acrylonitrile on a polyether-polyol.

With this fabrication process, the company supplies one of the two main raw materials required to produce polyurethane (insulating foam, etc.).

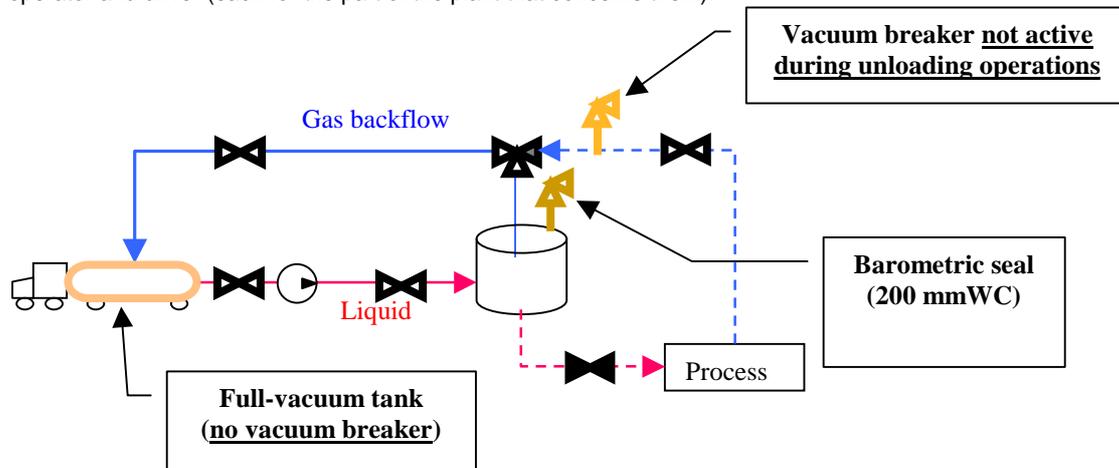
Created in 1928, the company has been producing polyols since 1964. The site currently employs 673 people, including 53 for the production of polyols.

The site is classified as "High Threshold" - Seveso.

The unit concerned:

The storage tank involved in the accident is used to store styrene (C_8H_8). It has a total capacity of 44 m³, of which 35 m³ is considered its "usable capacity". This represents 29 tons of product. The storage tank is equipped with a cooling system that conveys a glycol solution through a coil. It is protected against overpressure by a barometric seal calibrated at 200 mmWC. It is equipped with a pressure alarm: high level set at 150 mmWC and very high level set at 220 mmWC which shuts down the unloading pump. It also features vacuum breaker protection in case of significant draw by the process. Owing to the presence of the 3-way valve, this vacuum breaker is inactive when a truck is being unloaded. The storage tank is located in a 80 m³ retaining pit.

A truck comes to unload the styrene two times per week. Using a checklist, the alignment is ensured visually by the operator and driver (each for the part of the plant that concerns them).



The protective equipments installed on the storage tank and tanker efficiently protect the unit against the following two accident scenarios:

- Incorrect alignment of the gas return during the truck unloading operation generating a vacuum in the tanker truck (vacuum breaker or "full-vacuum" tank resisting a partial vacuum) and an increase in pressure of the storage tank (valve)
- Significant intake by production causing a vacuum inside the storage tank (vacuum breaker protection)

THE ACCIDENT, THE SEQUENCE OF EVENTS AND THE CONSEQUENCES

The accident:



A truck arrived to unload 24 tons of styrene in the morning of January 7.

After connecting the lines, the unloading operation began rather quickly although the pump experienced cavitation difficulties. The pressure alarm (high level) was triggered although is not handled in the control room. When unloading operation was finished, the driver noticed that he had left a gas return valve nearly completely closed. Of his own initiative, he climbed onto the truck and opened this valve completely without first informing the operator. After the unloading operation, the truck left.

Shortly thereafter, a low level alarm on the tank's refrigeration unit (glycol solution) sounded in the control room. A slight increase in the styrene tank's level was also observed at the same time. Following an inspection on site, a styrene and glycol water leak was reported, as well as significant deformation of the storage tank.

The contingency plan was initiated (including contacting the fire department and evacuation of personnel). Without waiting for the leak run out, the operator decided to transfer the content of the storage tank to another available tank.

The consequences:

Initiation of the contingency plan (fire department notified; evacuation of the personnel),

Destruction of the storage tank (and the internal coil),

Loss of approximately 3 tons of a styrene/glycol/water mixture. This mixture was confirmed and eliminated as dangerous waste,

Production shutdown for 2.5 days.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

Dangerous materials released			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Human and social consequences		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental consequences		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Economic consequences				<input type="checkbox"/>				

The parameters comprising these indices can be found at the following address: <http://www.aria.ecologie.gouv.fr>

The index relative to the quantities of dangerous materials released is equal to 1 as the quantity of styrene lost was less than 3 t. The operator stipulated that the index relative to the economic consequences reached level 2 owing to the property damage (parameter €15), without indicating the amount.

THE ORIGIN, THE CAUSES AND THE CONSEQUENCES OF THE ACCIDENT

The accident is due to the incorrect alignment of the gas return line: the butterfly valve on the truck remained nearly completely closed throughout the entire unloading operation (forgotten by the driver).

The tanker began depressurising and, as it was "full vacuum" type, a partial vacuum was created. Upon completion of the unloading operation, the partial vacuum was estimated to be 0.6 bar. This would not have happened if the tank had been protected by a vacuum breaker, as stipulated in the operator's specifications.

At the same time, the storage tank developed a slight overpressure. The high level alarm was not managed correctly in the control room when it had sounded. As far as the very high level is concerned (causing the unloading pump to stop), it was never reached due to bubbles that were trapped in the barometric seal, which limits pressure increase inside the tank.

At the end of the unloading operation, when the driver opened the butterfly valve completely, the pressures in both the tanker truck and the storage tank were balanced out. The intake of air that followed was enough to cause the implosion and subsequent destruction of the storage tank.

THE MEASURES TAKEN

The operator replaced the storage tank and undertook the action indicated in the following paragraph.

THE LESSONS LEARNED

The operator undertook the following measures to prevent an accident of this type from reoccurring:

- Installation of a system to prevent the depressurisation of the storage tanks at all time (even during truck unloading operations).
- Slaving of the unloading pump to the correct connection of the lines (pressure measurement).
- Ensure proper communication between the driver and the operator (the driver must not initiate actions without informing the operator). Furthermore, the two individuals must be able to communicate in a common language. In this case, one spoke French and the other Dutch.
- Ensure the correct configuration (set point) and management of the alarms (classification by priority).
- This accident scenario must be considered in the safety studies (HAZOP analysis) and applied to other the unloading stations, where applicable.

The modifications proposed by the operator must ensure that operation take place in improved security conditions.