CASE DESCRIPTION

FIRE IN A TANK STORAGE FACILITY

CASE STUDY

EMERGING TECHNOLOGIES AGAINST FIRES AND EXPLOSIONS

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Training for the prevention of fires and explosions through the use of data analysis and simulation Project TSP2021\100311
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INTRODUCTION

In chemical processing plants, the storage of inputs to supply the processes is common. The storage of flammable liquid in atmospheric tanks is very common in the chemical industry. This type of storage always implies a risk of fire and explosion, even more so when storage occurs in tank farms, where the explosion or fire of a tank can generate a chain reaction or domino effect that begins in a tank and affects to others nearby, due to factors such as heat load (convection and radiation) and shock waves. These incidents can escalate and affect the entire processing plant and lead to large economic losses and fatalities. Liquid pool fires are the most frequent type of fire event that occurs in industries that use this type of storage. The reduction of risk of incidents in the storage of flammable liquids, focuses mainly on good practices in hot work, avoiding the formation of flammable atmospheres and installation of flame arrester systems. This document presents a case study of an explosion and fire in a xylol storage tank (mixture of xylene isomers) in an agrochemical and paint production plant.

GENERAL INFORMATION

An explosion and subsequent fire occurred in the storage tank farm of a plant dedicated to the production of paints and agrochemicals. The explosion was reported around 11:08 am and was generated on a xylol storage tank, input that is used as a diluent in the production of paints. The tank had an installed capacity of 80 tons, and on the day of the event it contained approximately 25 tons of stored xylol. On the day of the event, work was being carried out to install brackets on the upper part of the tank, carrying out hot work such as welding and polishing. Some of the sparks from this work caused the xylol tank to explode, which fell from its base and traveled through the air like a projectile, leaving a trail of fire and falling 50 m into a courtyard between two plants. production, Figure 1. At this location the tank caused minor damage and the fire did not spread, Figure 2.

However, in the place where the tank was installed, a large fire was caused by the spilled xylol in the dam area, generating large losses and subsequent fire in the tanks near the containment zone, as shown in Figure 3. There were three human casualties during the event.

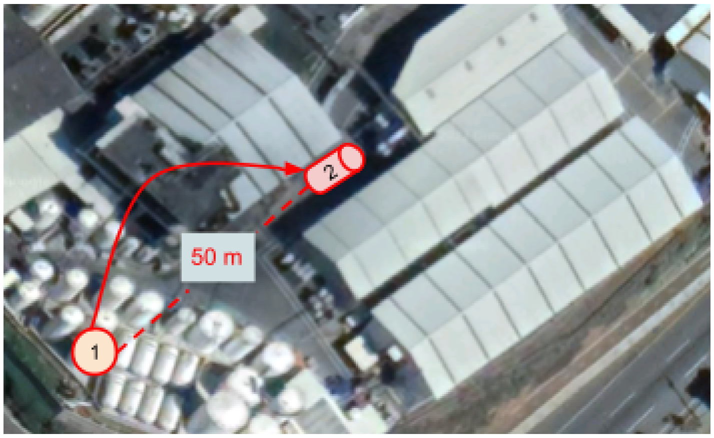

Figure 1. Location of the xylol tank (1). Place where it fell after the explosion (2)

Figure 2. Courtyard between the plants where the xylol tank fell.

Figure 3. Fire location on the containment dam.

INCIDENT DESCRIPTION

In the area of the plant's storage tanks, different inputs were stored, flammable liquids such as xylol, varsol (a mixture of aliphatic hydrocarbons derived from petroleum), styrene, butanol, vinyl acetate, acrylates, among others, as shown in Figure 4. These inputs are pumped as needed for the different production processes of agrochemicals and paints.

Figure 4. General plan of the storage tanks of the plant

In the area marked in red, a detail shown in Figure 5, there are two tanks that contained varsol, and the other tank with xylol that exploded. In Figure 6, the varsol and xylol tanks are shown before the explosion and fire. The size of these tanks vary between 3 - 4 m in diameter and 5 - 8 m in height, with capacities to contain between 70 - 80 m^3 of flammable liquids.

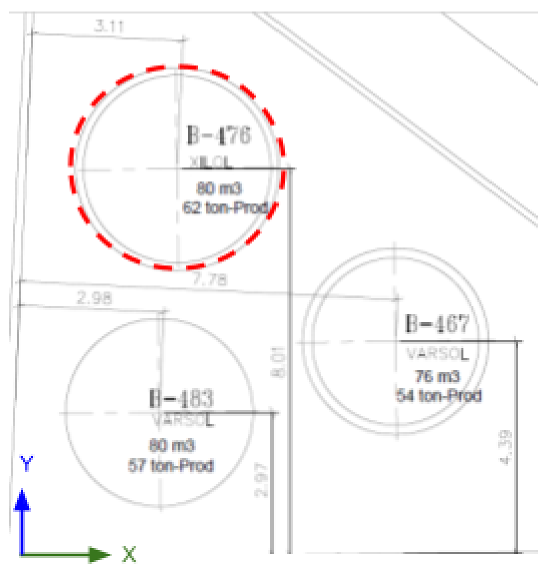

Figure 5. Detail of the storage tanks where the explosion occurred.

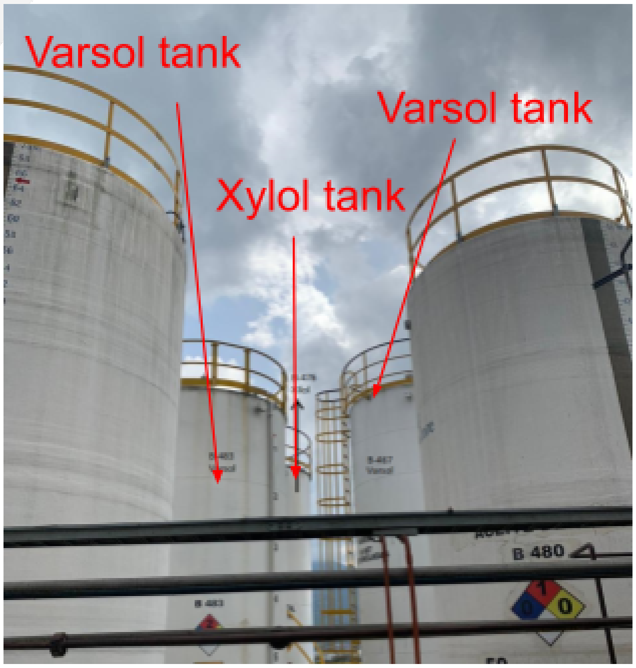

Figure 6. Xylol tank, located between the varsol tanks

After the explosion and detachment of the tank, the fire was generated and was located mainly in the area of the storage tanks. During the fire, a large amount of smoke and high flames were evident as shown in the photo taken by local authorities, Figure 7.

Figure 7. Fire in storage tanks. Taken from Twitter Corantioquia (June 2021)

INCIDENT INVESTIGATION

The video records inside the plant revealed the metal welding and polishing work carried out by two contractors on the top of the tank for the installation of the brackets, which would serve as support for the installation of a platform. At the time of the explosion, projection of sparks was observed, without being able to identify whether they were from surface polishing work or from the welding of the brackets. Figure 8 shows spark marks that show the polishing work that was carried out on the tank. These zones account for possible hot spots that could have started the explosion.

Figure 8 . Polish spark marks on xylol tank

In the film evidence it was not clear to determine how the explosion started, and how the flame entered to the interior of the tank. It is important to highlight that the tanks in this plant had flame arrester systems, however one of the hypotheses that were handled during the investigation is that there were leaks in the tank, which allowed flammable gases to escape to the outside. It was recognized that the xylol tank had access to a wire through a 1.27 cm hole to measure the liquid level. This hole did not have flame arrestor systems and possibly xylol vapor came out of that hole. In Figure 9. The orifice and the steel wire that was used in the level meter are evident.

Figure 9. Level meter orifice location.

It should be noted that the tank was only 30% full, and there was a xylol liquid-vapor mixture inside in the remaining volume. For the environmental conditions in the geographical area where the plant is located, and at the time of the event, the atmospheric pressure is around 651.1mmHg and the average ambient temperature is around 22°C. The pressure vapor of xylol is around 9 mmHg. For the above conditions, it can be determined that the concentrations of xylol in the vapor are 1.38 % v/v, a concentration that is within the range of the flammability limits of xylol (LFL1.1% - UFL 6.6%). With a spark close to the gas outlet area, the explosion could possibly start.

At the location where the tank fell, the photo in Figure 10 shows that the fire in this area did not spread to the surrounding production plants. Soot marks are evident in these areas Figure 10 a. Most of the units in the caged plastic tanks failed to melt. Figure 10 b, only the cage of one unit is observed next to the tank that possibly melted. Figure 10 c. Marks that show the melting of plastics are shown in Figure 10 d. in greater detail in Figure 11.

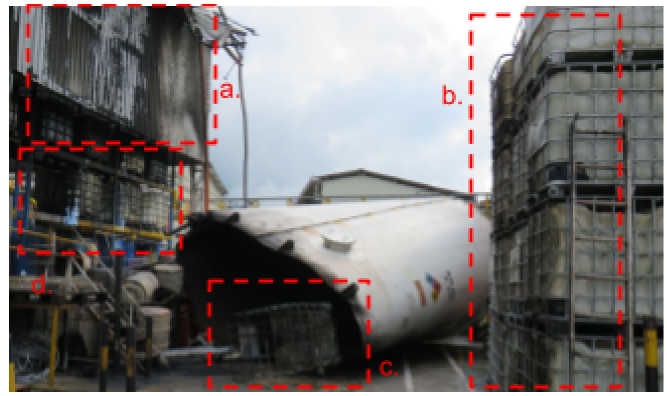

Figure 10. Damage to the place where the xylol tank fell.

Figure 11. Detail of evidence of plastic melting. Possibly from a caged tank

In the area of the storage tanks, it was the place that was most affected by the fire. In the photos of Figure 12 and Figure 13, the total loss of several tank units is evidenced, others partially. In Figure 12, it can be seen that the varsol tanks remained standing. However the later tanks were completely consumed.

Figure 12. Effects of the fire in the area of the storage tanks.

Figure 13. Bottom of the xylol tank and horizontal tanks area.

In Figure 13, it can be seen that only one horizontal storage tank remained standing (blue arrow), the other 7 were completely lost. In Figure 13, the red arrows show the oxidation in the metal tanks, which shows the high temperatures that occurred in the fire and the direct contact of the flames with the surface. Figure 14 shows the general plan of the storage tank area, where the tanks that had a total loss are demarcated in red. In blue, tanks that show evidence of a partial leak or only traces of flame on the surfaces.

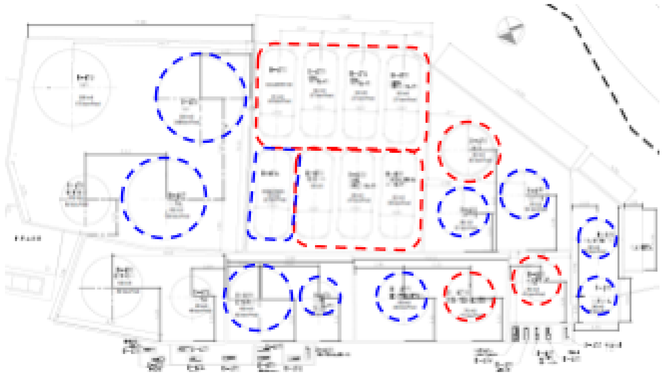

Figure 14. Tanks with major damages, in red.

SUMMARY

1. An explosion and fire occurred in the storage tank area of an agrochemical and paint processing plant.
2. On the day of the event, hot work (welding and metal polishing) was being carried out on top of a xylol storage tank.
3. Several sparks and flashes were observed before the explosion.
4. One of the hypotheses is that there was a leak of xylol vapor and a spark reached the area where the vapor came out, and started the explosion.
5. During the event, 3 fatalities were recorded.
6. The fire mainly occurred in the areas of the tanks, in the liquid containment dikes, where the greatest damage occurred.
7. During the explosion, the xylol tank dislodged from its base and went 50 m through the air. The fire was quickly contained in the area and the damage was minor.