

Blazing leak in a gasoline hydrotreatment unit of a refinery

November 17, 2002

Grandpuits Bailly Carrois [Seine et Marne] - France

- Torch fire
- Refinery
- Hydrotreatment unit
- Hydrocarbons
- Exchanger
- Internal Contingency Plan
- Works/ maintenance
- Equipment failure
- Checks
- Property damage

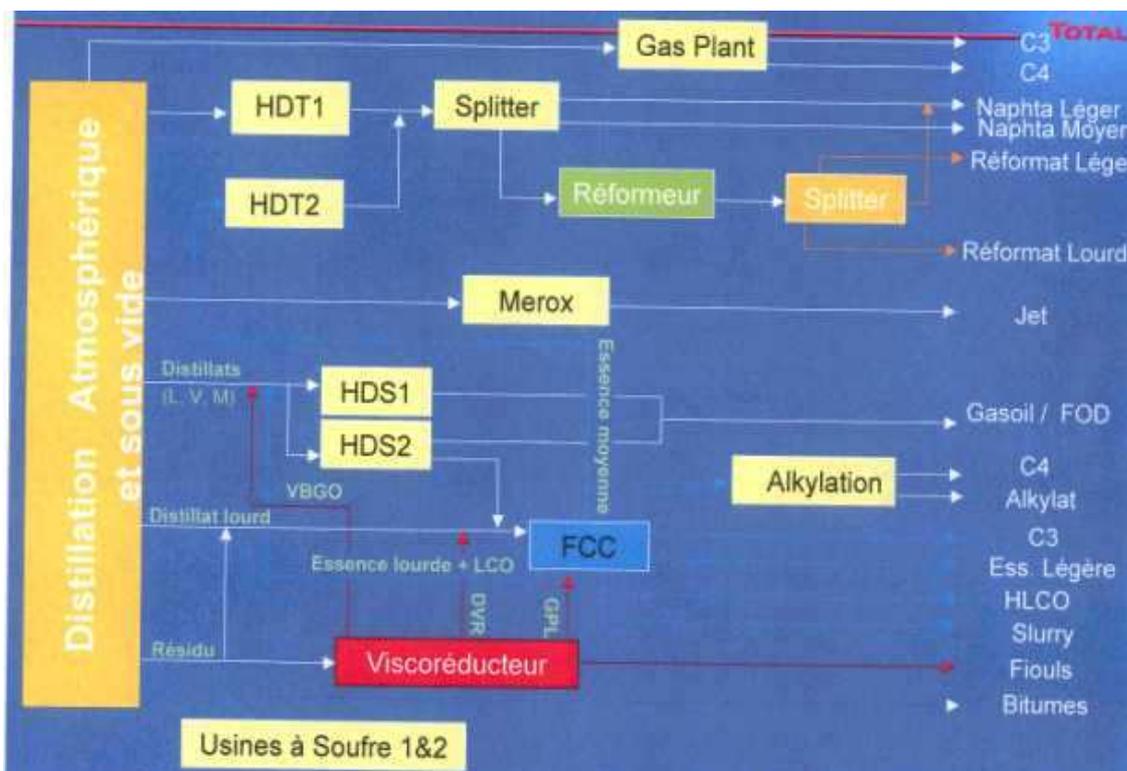
THE INSTALLATIONS IN QUESTION

The refinery is located 57 km from Paris and is spread over 153 ha. It produces the entire range of habitual petroleum products (LPG, kerosene, gasoline, diesel fuel, domestic fuel oil, bitumens, ...). The facility was commissioned in 1966. 355 people work at the site.

The fire occurred at the level of the hydrotreatment and catalytic reforming units located to the west of the refinery.

The hydrotreatment unit is designed to eliminate the sulphur, nitrogen and oxygen compounds in stabilised gasoline derived through atmospheric distillation. The purpose of this operation is to protect the reactor's catalyst from catalytic reforming, located downstream, for which these types of compounds are sources of poisoning.

The catalytic reforming unit is designed to produce a gasoline blending stock with a high octane index (the reformate) from a load with a mediocre octane rating. It also produces the hydrogen required for the hydrotreatment and hydrodesulfurization units. The diagram below shows the 2 units in the general operation, after atmospheric distillation.

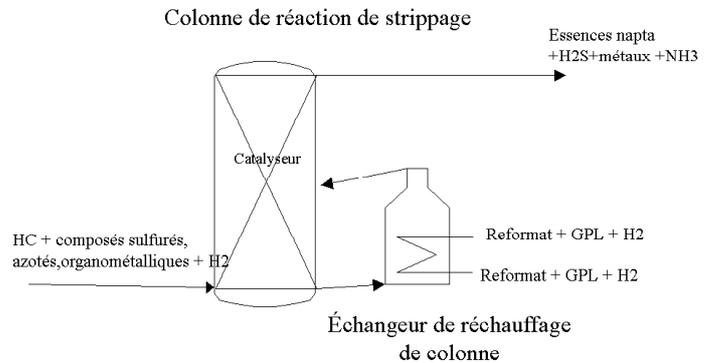


THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

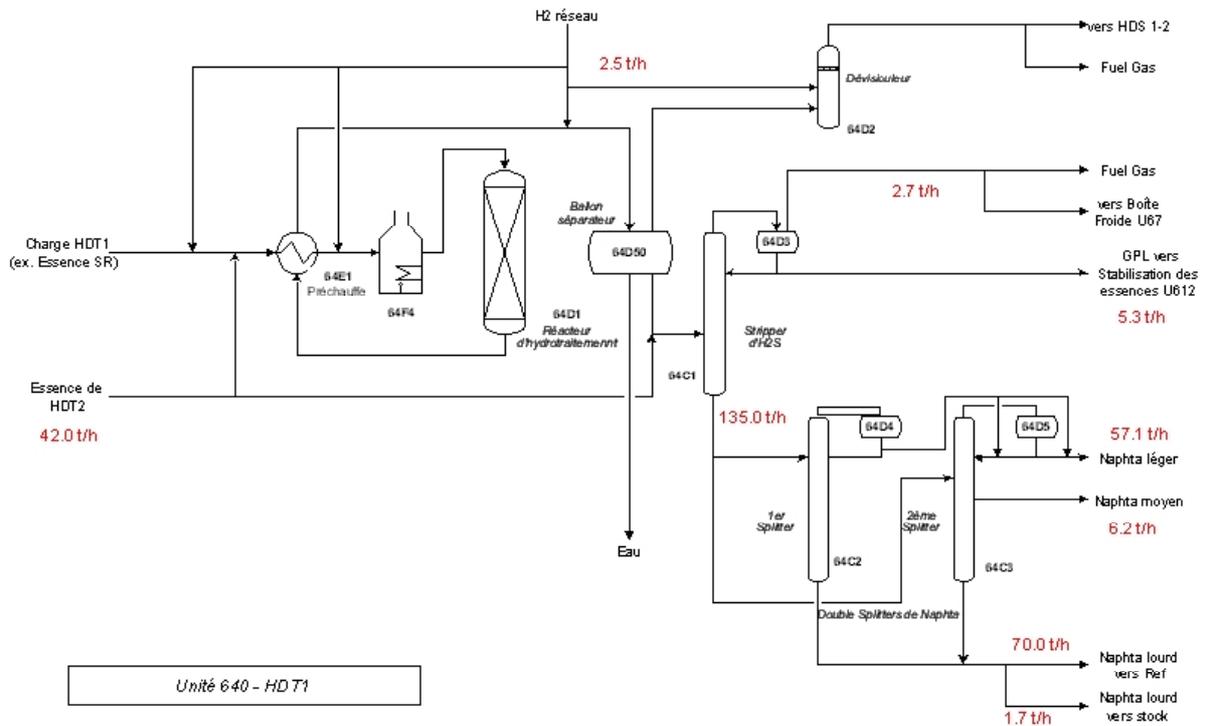
The accident:

The leak occurred on the gasket plane of the reboiler, on the hot fluid side, and immediately burst into flames producing a nearly vertical flame cone roughly ten meters in length.

The reboiler is designed to supply the energy required for column operation, which includes the pre-treatment stripper, on which the hydrotreatment unit depends. This is a preparation phase for the reformer's load. The reboiling energy is furnished by the reformer's effluent. The complete diagram of the unit, including the loop shown opposite, is represented on the following page.



UNITE HDT1



Chronology:

Analysis of the parameters (pressure and associated flow rates) on both systems, conducted after the accident, show that the leak occurred on the hot fluid side (thus containing effluent from the reformer). The chronological description is as follows:

- 8.23 pm: Outbreak of fire,
- 8.25 pm: Call of western units for fire. The site's siren is triggered.
- 8.30 pm: Departure of the intervention crews.

Emergency shut-down of the reformer – closure of damaged shut-off valves – Start of decompression in the assembly – gas directed to the flare stack

- 8.32 pm: Standby management called and in-home triggered (1st step)
- 8.34 pm: Standby management called and in-home call triggered (2nd step)
- 8.50 pm: Arrival of the security department manager.
- 8.55 pm: Arrival of the firemen from Nangis (1 truck +5 men) → mission: installation of a second nozzle on the west side.

Reboiler
flange



Photo DR

- 8.56 pm: Call received from the SDIS (Service Départementale d'Incendie et de Secours", fire and emergency services) signalling the dispatching of reinforcements.
- 9.00 pm: Arrival of the firemen from Mormant (5 men) → mission: preparation of two 1,000 l/min nozzles.
- 9.10 pm: Application of a foam blanket.
- 9.11 pm: Water curtain with nozzle on the west side of the fire zone.
- 9.35 pm: The gendarmerie set up a detour on the RN19 national highway.
- 9.45 pm: Prepositioning of a 4th nozzle, which would not be used.
- 11.21 pm: Fire is out and 3 nozzles stopped – 2 nozzles would be maintained for a certain amount of time on each side of the equipment.
- 11.25 pm: Detour called off on the RN 19.
- 11.30: Withdrawal of the emergency services – Inerting of the installations with nitrogen.
- 1.00 am: End of alert.

As far as the external rescue services are concerned, they were called by people driving by the site. Subsequently, 20 fire trucks were parked in front of the refinery as the establishment allowed only 2 trucks to enter the site due to safety reasons. The 18 trucks remained parked outside the site until the end of the alert.

Consequences:

The accident resulted in a slight injury: the back of one of the rescue team was injured while installing the water cannons.

There was significant property damage: Property damage was estimated at 4.3 MEuros. Furthermore, the main units damaged (hydrotreatment and reforming) were shut down for several weeks. Finally, considering the extent of the damage, the equipment requalification programs and zone rehabilitation operations were extensive. Operating losses totalled 1.7 MEuros.

Owing to the extent of property damage, the accident has to be reported in accordance with the criteria of appendix VI of the Seveso directive.

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.



The parameters which comprise these indices and the corresponding rating method are available at the following address: www.aria.ecologie.gouv.fr.

Owing to the lack of quantified data, the level 1 rating of the "dangerous materials released" index reflects the leak of easily flammable liquids per the table in part II of Appendix 1 of the Seveso Directive (parameter Q1).

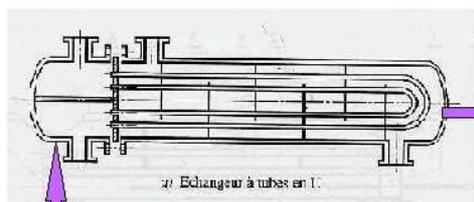
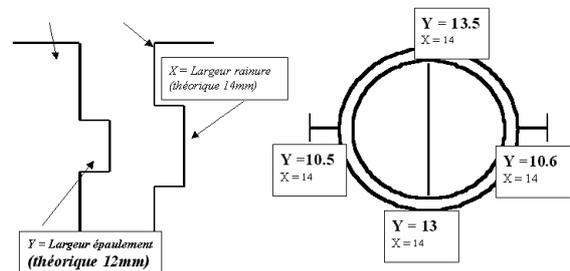
The human consequences rating bears a level 1 rating because an employee was slightly injured during the intervention (parameter H4).

The level 3 rating for the economic consequences rating is justified by the 4.3 million euros in property damage (parameter €15).

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

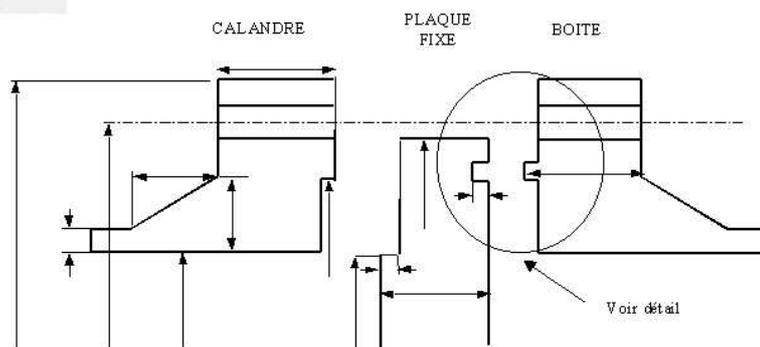
According to the findings and expert assessments, a construction defect on the exchanger is responsible for the leak. This circularity dimensional defect in the throat of the seal housing (see diagraph opposite) complicated its reassembly following the shutdown for maintenance prior to the accident.

The loss of seal coincided with the increase in the product's temperature and pressure.



Calandre : Essence
 Ps = 19 bars
 T = 210 °C

Faisceau : réformat
 Ps = 25 bars
 T = 440 °C



ACTION TAKEN

In addition to the repair stipulated by a specialized organization, the operator has finally implemented a rehabilitation program for the zone in question by following the recommendations of American standard "API RP 570 – section 11 – Assessment of fire damage".

The following actions were undertaken, in particular:

- ✓ Cartography of the sectors effected,
- ✓ A rehabilitation protocol including a visual inspection, ultra-sonic thickness checks, hardness tests, and replicas taken for metallographic inspections,
- ✓ Replacement of valves in the zone,
- ✓ Overhaul of valves in the zone.

LESSONS LEARNED

The notable points are as follows:

- ✓ The product's ignition at the leak prevented a flammable layer of gas from forming and a possible unconfined vapour cloud explosion (UVCE) phenomenon.
- ✓ The damage was able to be limited due to the resistance of the lines and heat-lagged reactors, and this, despite the rapid absence of a load circulating inside the tanks and piping, an element that contributes to cooling the equipment in which it circulates.
- ✓ The accident did not spread owing to the position of the water curtains.
- ✓ The positioning of the curtains was adequate and very important: owing to the location of the nozzles and the direction of the flame cone (vertical), the accident did not result in a domino effect although the scenario was perfectly possible owing to the configuration of the site (units separated by spans of roughly fifteen meters).

Technically speaking, the improvements aimed at limiting the consequences of a similar leak are as follows:

- ✓ An increase in the decompression speed of the reaction section of the reformer by changing a gas discharge valve toward the fuel-gas network.
- ✓ Modification of a valve that is currently slaved to a pressure threshold and that will be controlled from the control room console.

From the organisational standpoint, the operator has set up procedures for checking the dimensions of exchanger seal bear surfaces.

- ✓ Specific certification is now required for the personnel conducting this type of operation, together with appropriate training,
- ✓ For the external companies performing these operations, systematic dimensional inspection reports are to be compiled for the gasket bearing surfaces and shut-down points are foreseen after the upgrading, prior to installing assemblies, when reassembly operations are performed.