COMBUSTION PHENOMENA IN AN EMULSION WORKSHOP

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Summary

- Context
- Investigation
- What happened ?
- How to prevent it ?
- Which key learning ?

Context

EPC France factory is located in the town of Saint Martin de Crau, in south of France.

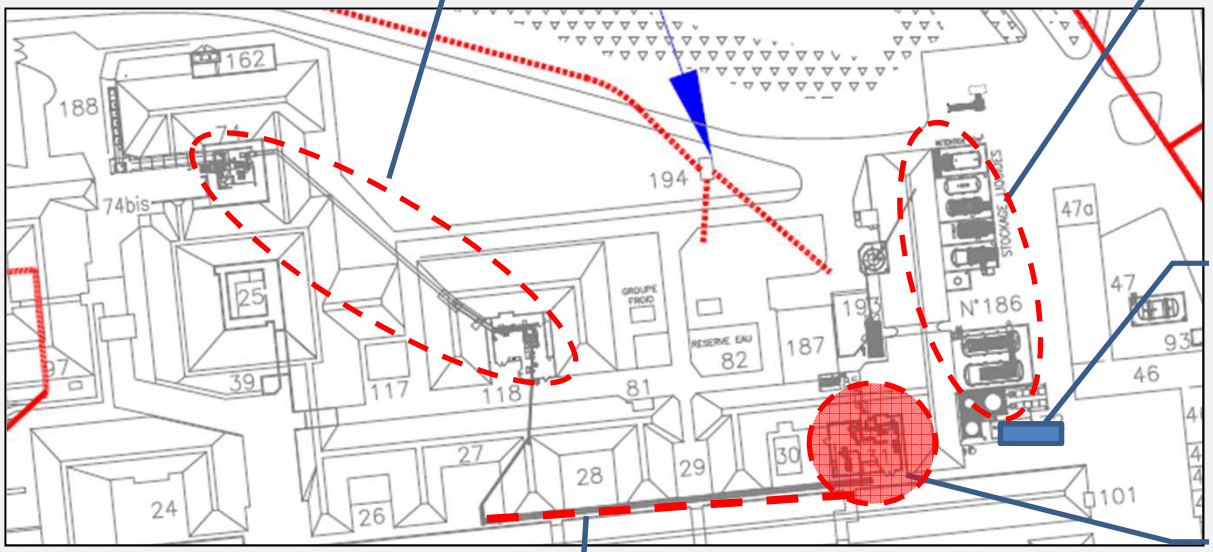
We manufacture 18 000 T/year of civil explosives :

- Bulk emulsion
- Emulsion cartridges
- Anfo

The accident occurred on cartridges emulsion line in the cartridging workshop.

Context

Unit design :



Packaging

Storage of raw material

Control room

Cartridging workshop

Cooling bath

Context

The cartriging workshop design :

Gazing reactor to sensitizing emulsion

pipe

Electrical Trace Heating (ETH)

The hopper

The Pump

Chub machine

Context

- On Friday, November 11th 2011 the operators stopped the production line at 4:00 am.
- It was the end of the week, they cleaned all the unit in compliance with the plant operating procedures.

- On Monday, operators returned to work and started the production line as usual.

- After 1 hour of production, they detected a smell of burn and a minor leak of emulsion on the pipe .

- They immediately stopped the production and tried to understand what happened.

- No previous event allowed them to be aware of what was happening.

Context

- Then, we decided to dismantle part of the thermal insulation of pipe that seemed to provide the burning smell and the leak.

- The Electrical Trace Heating was burned and glued around the pipe.
- The pipe appears to have strongly heated (blue/black color)

Context

- Then, we decided to open the gazing reactor

- The stator was burned inside.

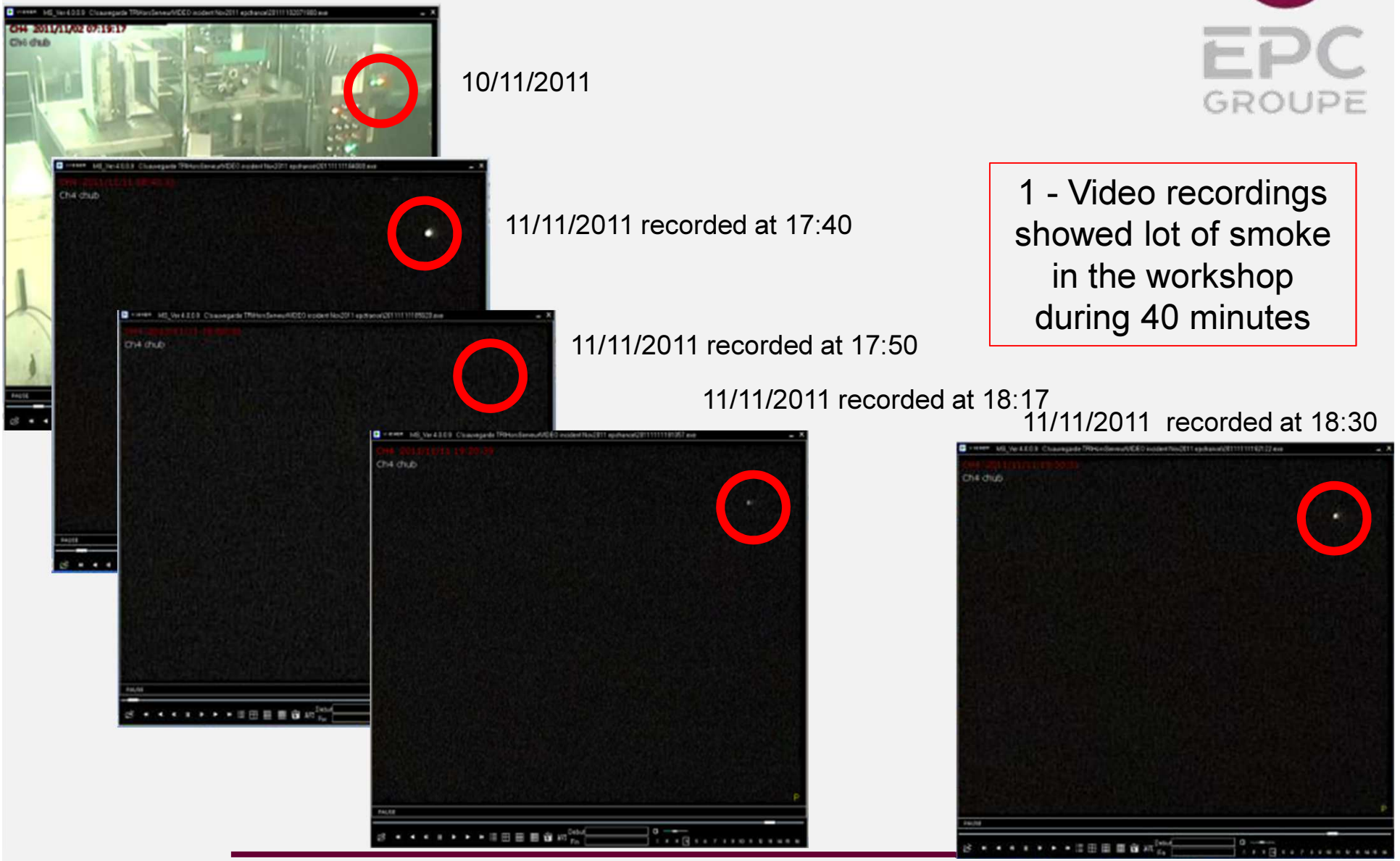
Context

- 11 hours were necessary to define clearly what happened.
- 3 months were necessary to confirm by simulations what happened.

We needed :

- Video recordings
- Humain Ressources
- Pilot for tests
- Time

Investigation



1 - Video recordings showed lot of smoke in the workshop during 40 minutes

Investigation

After each production, the pipe was clean by steam. But a thin emulsion layer resisted inside the wall of the pipe

2 – under the pipe thin emulsion layer

Investigation

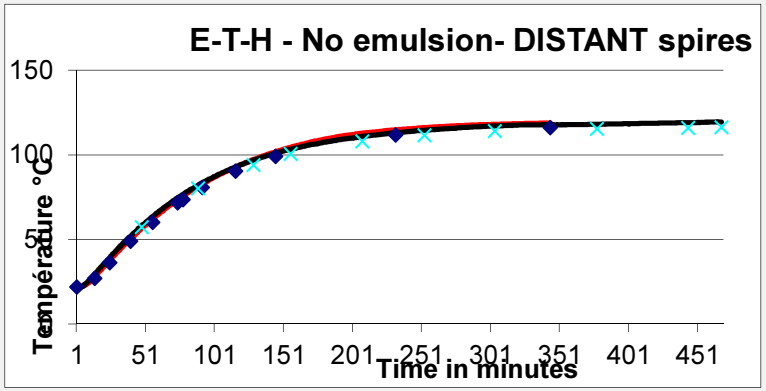
The Electrical Trace Heating was controlled by a temperature sensor. The sensor has been accidentally moved during the cleaning operation at the end of the last shift.

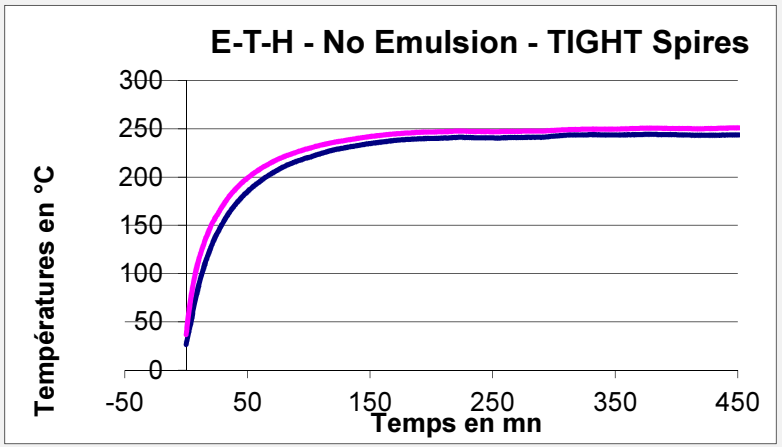
3 – ETH system heated without interruption.

On august, the Electrical Trace Heating was changed during a maintenance operation. There was no operating mode.

4 – ETH delivered more energy / meter

Laboratory test



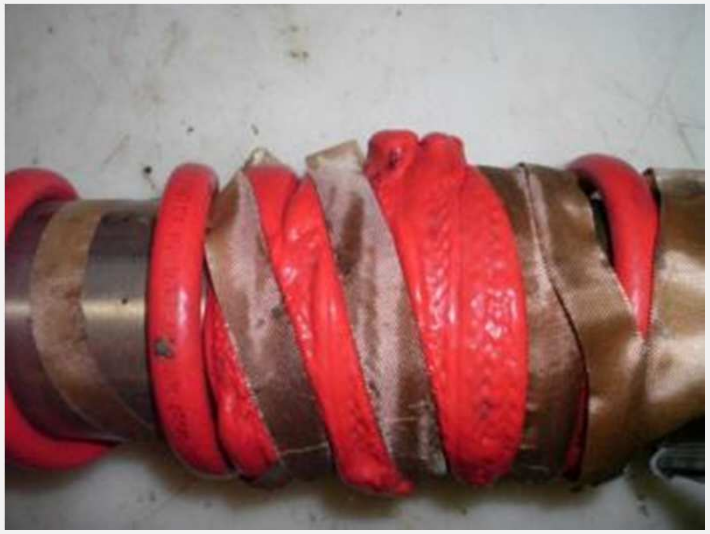


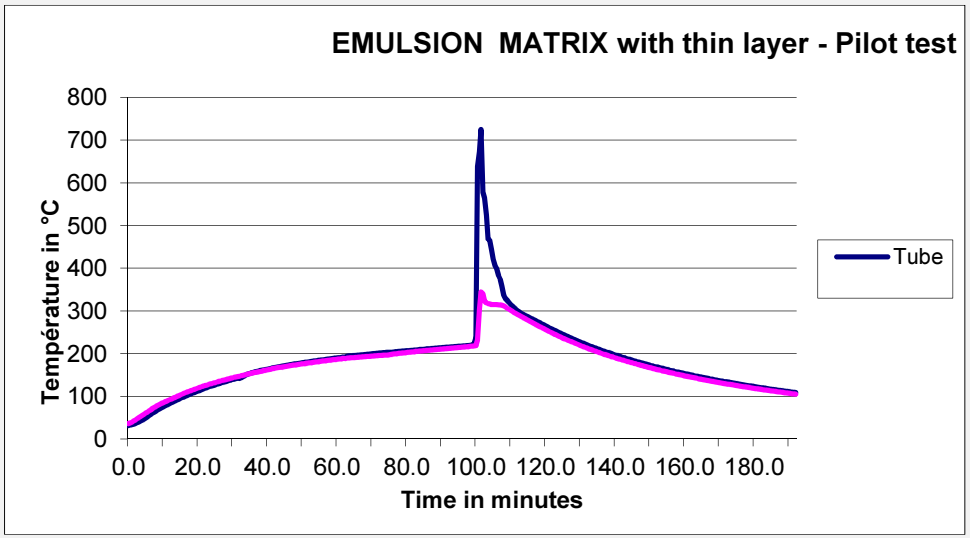
6 hours later for tight Spires test, the temperature was 250°C, then for the normal case, the Temperature was 120°C.

E-T-H : ELECTRICAL TRACE HEATING

Laboratory test

In the tight spires case with emulsion, the temperature suddenly increased more than 700°C. Emulsion decomposed.





What happened ?

1. The electrical trace heating was changed and the spires were tight.
2. Temperature sensor was accidently moved from it's dedicated location.
3. Then, the electrical trace system heated without any interruption.
4. The thin emulsion layer inside the pipe decomposed.
5. Smoke has been produced
6. The high temperature caused damage in pipe and reactor.

How to prevent it ?

- To remove Electrical Trace Heating on this part of the unit and change working instruction for start and stop chub machine.
- To use a bottle-brush with water under pressure to cleaning the pipe. Thin emulsion layer disappeare.
- To define specification and operating mode for E.T.H.

Which key learning ?

- Video is always extremely helpful for understanding,
- Pilot tests is good to confirm hypothesis (or not),
- Full understanding requires the support of various experts (mechanical, chemical,…),
- Change operating mode without study is forbidden in a pyrotechnical unit.

Thank you