

HPEO Explosion on June 18, 2022

GEOTEM 2023
Navigating Change

Reported Events*

- Leaked EO led to a fire
- This was followed by the explosion of the HPEO column
- Debris from the explosion caused fires to break out in four other locations
- An EOG operator was injured during evacuation
- A truck driver died due to a falling 3" N₂ pipe



*Based on report: <https://www.shanghai.gov.cn/nw12344/20230331/f56b07f01e214f6ab7ac48e048c6c99.html>

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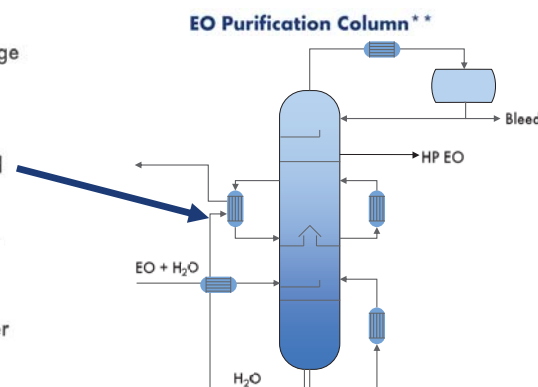
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What Happened?*

- Field operator hear a loud bang and saw a large steam plume
- Panel operator noticed low flow and low level
- Leak point was in the bottom line after the feed preheater
- Field operator tried to turn on a water cannon, but he felt dizzy and evacuated to the control room
- A flash fire started, followed a few minutes later by the explosion



*Non-Shell information, based on investigation report

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**Simplified scheme based on information from investigation report

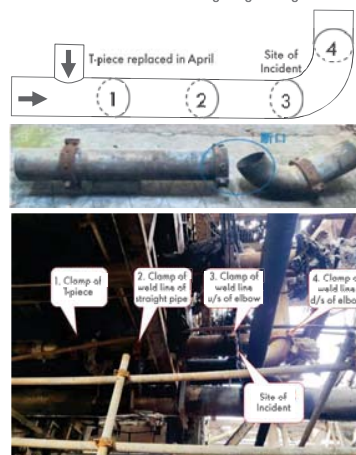
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From the Investigation Report

- The leak was in a SS 304 line (7 barg, ~110°C)
 - For several months, the line had 4 clamps because of leaks
 - Clamp 3 violently failed
- Via the ruptured pipe, first water, then EO escaped
- EO in air has a very low ignition energy; a fire started
- The external fire caused a self-decomposition reaction of EO inside the column, leading to the explosion
- The leaks in the line were caused by chloride stress cracking (Cl-SCC)
 - The leaks were close to / at welded connections
 - [Chloride concentrations are not mentioned in the report]



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What Can Be Learned from This Incident? (1)

- The clamps used at this plant to seal leaks were iron bands; they were unable to add strength to the pipe or hold it in the event of a pipe failure
 - Having 4 clamps over such a short piping length is exceptional and a warning that cannot be ignored
- Welds and bends are locations with higher stress and are more susceptible to Cl-SCC
 - Welding sensitisation may occur in SS 304; these zones are susceptible to intergranular stress cracking corrosion mechanisms
- The MOC for allowing the clamps may have only considered water leakage and not the potential for line failure and massive EO leakage



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What Can Be Learned from This Incident? (2)

- CI-SCC can happen at very low concentrations and high temperatures in water
 - Other contributing parameters are pH and aeration (O_2 content)
 - CI-SCC is often first seen at areas of higher stress, near welds or bends
 - CI-SCC is unpredictable, and cracks will propagate in a branched shape
- It is mentioned in the report that the CI-SCC started from the inside
 - Stainless steel lines need to be inspected for and protected against external CI-SCC as well

