FLASH ARIA
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Seal boxes:
Not to be mistaken as a cure for ageing

Commonly used to plug leaks on pipelines, seal boxes serve to stop discharge flows without entirely shutting down production. Despite this advantage, several accidents have shown that this type of remedial action is not sustainable and moreover necessitates regular monitoring during operations while awaiting definitive repairs.

1st case, date: 19th Nov 2013 - Fatal accident at Antwerp refinery in Belgium (ARIA 44781):

An explosion occurred around 3 pm near a valve inside a refinery. **Two technicians were pronounced dead.** The facility was evacuated and all on-site production halted.

Both of these (subcontractor) victims had been re-injecting resin into a seal box on a flange when the fastening rods broke. The release of boiler water (pressure: 70 bar, temperature: 290°C) caused a steam explosion.

A metallurgical analysis **of the failed rods revealed that they had been subjected to stress corrosion cracking**.

The assessment of deep-rooted causes indicated that:
- the **valve displayed a design or manufacturing flaw:** the throat diameter of the joint inside the cap was too small. This flaw caused non-alignment in the vicinity of the flange, along with additional mechanical stresses;
- the seal box (installed in 2011) attached to the valve was turned off for 6 weeks in 2012, during which time it was **maintained under pressure although at low temperature**. In this condition, boiler water made its way to the flange-seal box connection and formed a corrosive medium;
- **the additional mechanical stresses, produced at the time of re-injection, were sufficient to cause the corroded rods to fail;**
- **the seal box had not been designed to withstand the additional axial force resulting from broken rods**.

Following this accident, the site operator evaluated the condition of the other seal boxes and detected no abnormalities (lack of widespread corrosion or stress corrosion cracking). The inspected equipment however had not been exposed to low temperature.

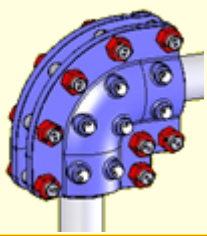
The refinery owner was able to draw several lessons, namely:
- **a visual inspection of rod condition does not offer an adequate level of certainty;**
- **if resin is to be re-injected into the seal box, the condition of the bolts would need to be determined;**
- **both an inventory and a log of operations performed** on the various seal boxes are valuable records.

Moreover, the seal boxes must be considered as **a temporary and non-definitive repair**.


Vanne après l'explosion - DR

What exactly is a seal box?

The seal box assembly consists of installing a paste retention system, referred to as a clogging device, around a leaky piece of equipment while it is still in operation. A plastic compound is then injected into the device cavities until the leak is completely plugged. Such installations initially made use of thermosetting pastes alone, but over time other types of materials were introduced, such as rubber pastes loaded with carbon or Kevlar© fibres.



2nd case, date: 14th Jan 2014 - Sealing paste blocks a valve in Martigues (ARIA 44848):

During a scheduled **maintenance procedure** within a chemical plant, **2 subcontractors** were installing traps on a steam pipe.
During the disassembly of a valve, one of the two assigned technicians sustained serious burns to the abdomen and legs by a steam jet at 25 bar. Surprised by the steam leak, the second technician fell from a 3-m high scaffolding. The leak was isolated and the premises secured. No impact on the environment or on any of the installations was reported.
According to the plant operator, no pressure equipment malfunction was to be blamed.
The company's internal investigation indicated that the valve where works were underway had been fitted with **an internal sealing paste injection model that was outdated and unreferenced**. Neither the staff technicians nor the subcontractors were able to detect this invisible injection that prevented shutting off steam circulation for the purpose of conducting works.

3rd case, 30th Dec 2006 - An unplugged leak after re-injection at the Petit-Couronne Refinery (ARIA 33472):

A **loss of confinement** was detected near a vacuum distillation column line. Since this line could not be isolated, the entire unit had to be shut down and stripped of its heat insulation. A 1-mm hole was identified at an elbow joint on the installation. Metallurgical analysis revealed that the carbon steel used to build the line was not suitable to the required operating conditions.
On 3rd January 2007, **a subcontracted firm was hired to install a seal box (2 half-shells), into which a resin was injected in order to create a seal against leaks.** Then, on 16th January 2007 around noon, a leak was found adjacent to the box. **Another resin injection was undertaken, yet the leak persisted.**
The refinery operator nonetheless decided to keep **the unit running until the next scheduled maintenance** at the end of January. A **spout connected to a pipeline was installed underneath the box** to route products flowing into a mobile container. An emergency vehicle and deployment of one of the refinery's staff firefighters were also part of this prevention measure.

Questions to raise in the interest of accident prevention

Before the repair work:

- Is the company hired to execute this sealing task competent in its field? Has its staff been properly trained and certified? Has it previously handled the same type of jobs?
- Has a design computation been performed? Has the risk of overly tight pins been assessed?
- Has the box life cycle been adequately established?
- Is the proposed solution well adapted to the process, to the equipment (pressure, operating temperature, compatibility of paste used with steel walls) and to the level of external stresses (earthquake resistance, pressurised tests, thermal shock)?
- In the event of re-injecting paste into an existing box, are the reinforcement rods and bolts in good condition? Have any traces of deposits or corrosion been identified?

During the repair work:

- Has the bolt clamping torque been verified?
- Is the quantity of injected paste known ahead of time?
- Has the solution proven to be effective? Has the leak been stopped? If not, have suitable prevention measures been taken: collection of hazardous or polluting products, presence and availability of fire-fighting resources adapted to the risk at hand?

After the repair work:

- Are all valves on the plugged network easy to access and open?
- Have all repaired devices been inspected, e.g. for an absence of shocks in the case of excessive bolt clamping?
- Has an inventory of the site's various seal boxes been generated?
- Have all instances of paste re-injection been recorded?
- Does the seal box undergo regular and appropriate monitoring until the completion of definitive repairs? Has this monitoring been logged?
- Are the boxes being replaced on schedule?

For all comments / suggestions or to notify an accident or incident:
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Accident summaries recorded in the ARIA database may be consulted on:
www.aria.developpement-durable.gouv.fr