



**anp**  
Agência Nacional  
do Petróleo,  
Gás Natural e Biocombustíveis

## Safety Alert 010 - ANP/SSM Cross-contamination in heat exchanger of offshore production plant

This Operational Safety and Environment Superintendence alerts the oil, gas industry and other stakeholders about the possibility of process current mixing due to a hole in the primary heat exchanger tube side in an offshore production plant.

### What happened?

The event occurred in production unit. Due to the high viscosity of the oil, it is necessary to heat the oil using heat exchangers that use steam as the heating utility. Steam is generated in an onboard boiler, and flows in a closed circuit.

It was detected a decrease in the thermal exchange efficiency in the C heat exchanger with suspected leakage between the oil and steam streams. After isolating the equipment, there were indications of the presence of oil in the steam purger, boiler water tank and at the steam side of the exchanger. Condensate samples were analyzed and after confirmation of the presence of crude oil in the boiler feed water it was decided to stop the process plant.

The performance of pressure tests in the three exchangers accused the occurrence of holes in all equipment. The following diagram and exchanger view illustrate the sequence of the incident and the photos reflect the results of the performed tests.

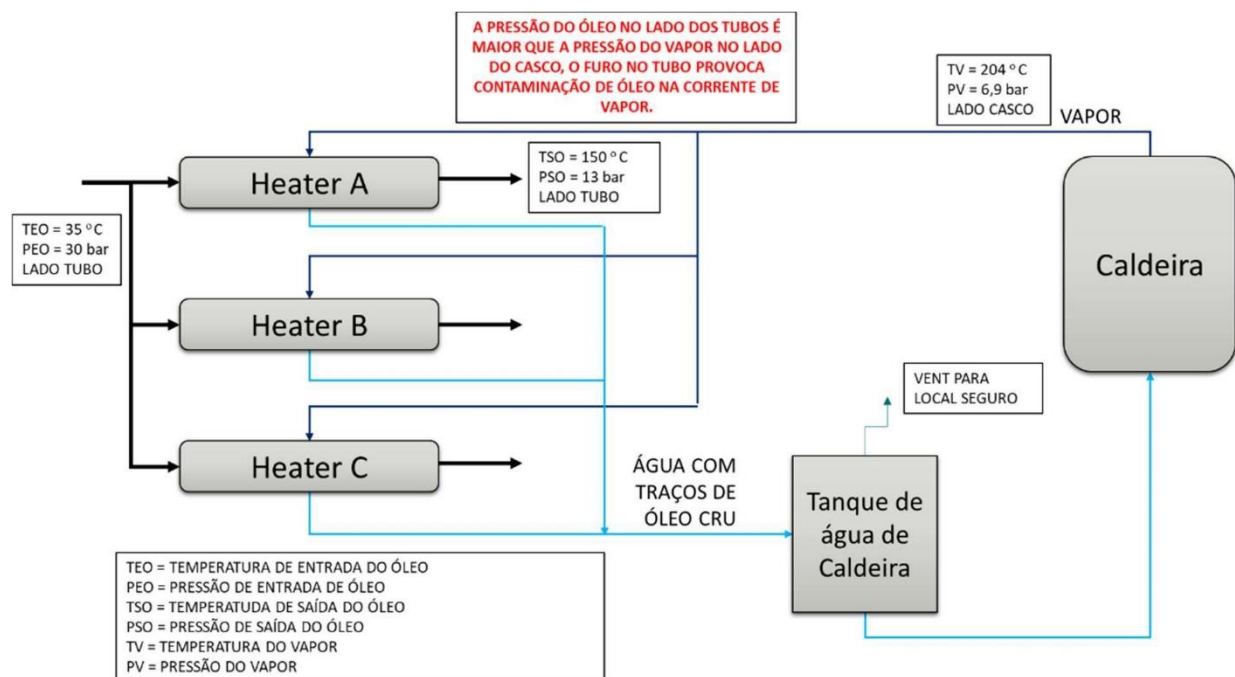


Figure 1 - Steam exchanger system and boiler system

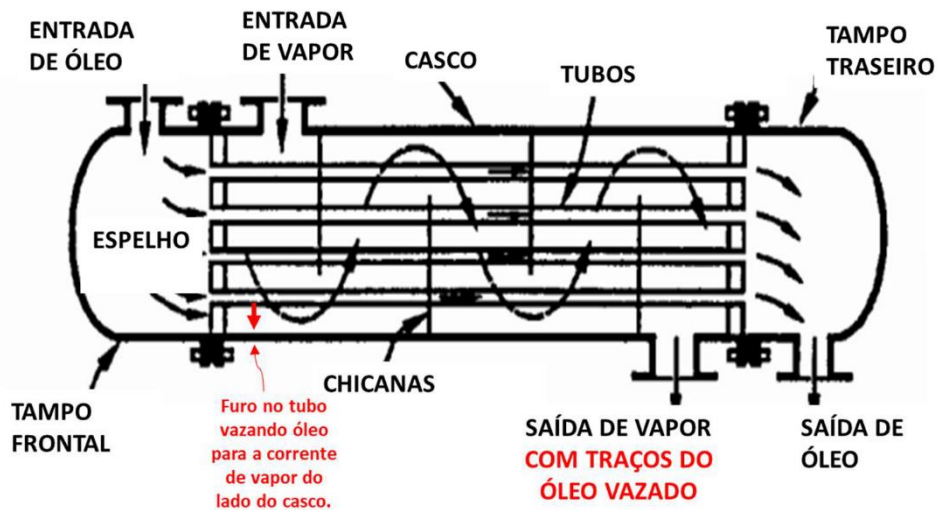


Figure 2 - Schematic design of the heat exchanger

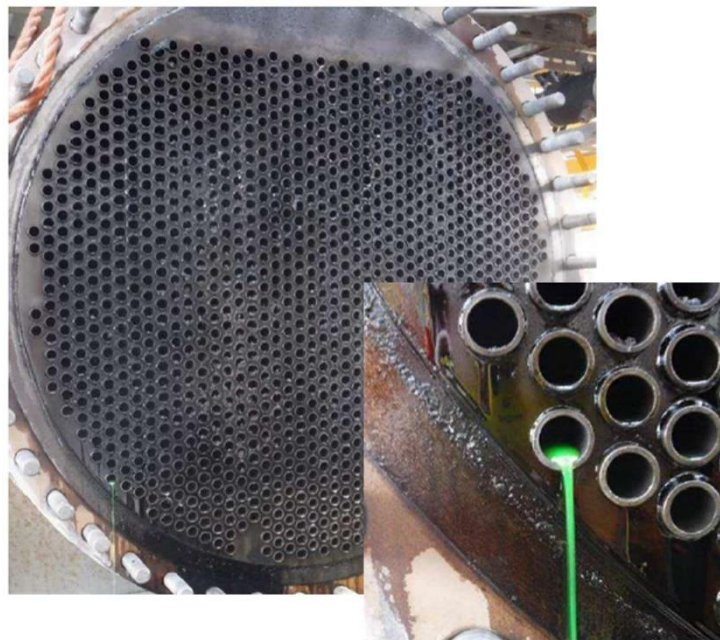


Figure 3 - Tubesheet with heat exchanger tubes and evidence of leakage during testing

### *Potential consequences*

The event resulted in the production plant being stopped for more than three months, with material losses.

The incident did not reach its full potential consequence. Under different conditions, a crack in the primary heat exchangers pipes could occur, and a larger amount of gas/oil could be released into the steam/condensate system, which could result in explosions while heating the contaminated condensate in the boiler and the total loss of steam heating to the process plant.

### *Identified causes*

The investigation carried out by the operator determined as an immediate cause of the holes in the exchangers the occurrence of corrosion in carbon steel pipes. Three corrosion mechanisms in this case were identified: CO<sub>2</sub> corrosion, microbiological influenced corrosion and fouling corrosion due to the

presence of free water in the crude oil stream. Thus, the root causes identified for the event were linked to the design of the equipment or unit, i.e.:

- Failure to identify design premises for the best selection of equipment material;
- Failure to assess the possibility of increasing BSW over the life of wells.

### *Lessons learned*

- Evaluate in the design phase all current process variables and possible changes during the installation lifespan.
- Install and maintain appropriate barriers to the scenario of hydrocarbons in boiler water, such as hydrocarbon detectors in boiler water tank vents, instrumentation and relief systems that prevent the escalation of the scenario if the leak increases. In the event of any cracking of the leaking pipes to the steam side, escalation for an incident with greater severity would be avoided due to the following installed barriers, as indicated in API RP 14C section A10 including:
  - High- and low-pressure sensors on the shell and tubes side;
  - Relief valves on the shell and tubes side;
  - High and low temperature sensors on the shell and tubes side.
- Need to update risk analyses whenever process conditions change.
- Need to verify the scope of the scenario for all similar equipment and implement the necessary measures to control the risk.

### *Regulatory Framework*

In accordance with item 10.3 of the Technical Regulation of the Operational Safety Management System (RT-SGSO), annexed to ANP Resolution No. 43/2007, Operator shall establish a system in such a way that: a) All aspects that may introduce risks to Operational Safety are properly considered in the installation design and in its subsequent revisions in the design, construction, installation and deactivation phases.

Furthermore, RT-SGSO item 10.2.1 recommends that the Operator must comply with the design criteria and consider industry standards and good engineering practices in the project planning, construction, installation and decommissioning of the facility. It is emphasized that heat exchangers are equipment that must follow the requirements of NR-13 (Boilers, pressure vessels, pipes and metal storage tanks) and the best practices provided by API – American Petroleum Institute and TEMA – Tubular Exchanger Manufacturers Association.

### *Contact*

For additional information regarding this safety alert, please contact ANP's Operational Safety and Environment Superintendence at [incidentes@anp.gov.br](mailto:incidentes@anp.gov.br).