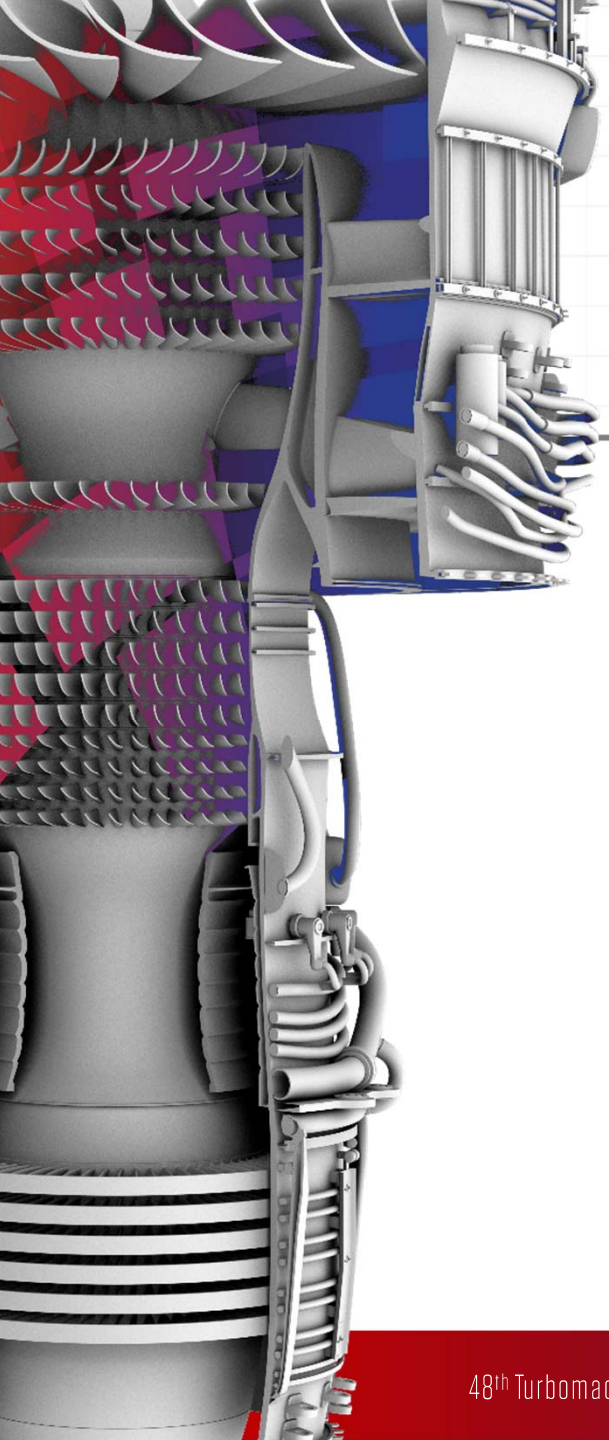


TURBOMACHINERY & PUMP SYMPOSIA

Shop Run Test Failure of an API 610 Vertical Sump Pump: what it exposed, and why it was critical to solve.

Mohamed Hazem Sadek

Enppi

Author Biography

Mohamed Hazem Sadek, a Senior Mechanical Engineer holding a Bachelor's Degree in Mechanical Engineering and a Masters of Global Business Administration Degree.

Working in the Mechanical Division of Engineering for Petroleum and Process Industries (ENPPI) based in Cairo, Egypt.

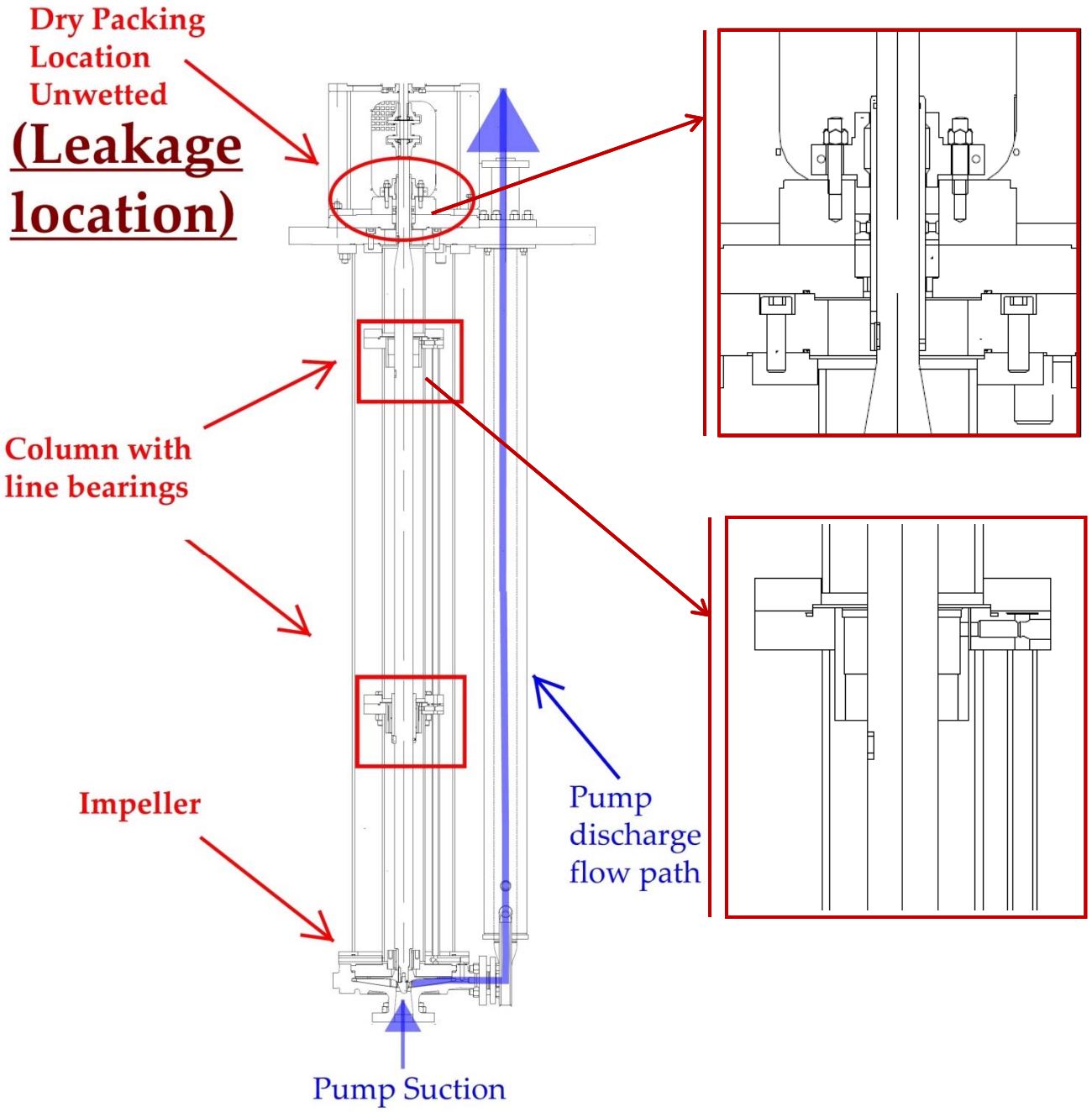
ENPPI is responsible for fully integrated engineering services and construction supervision for projects in the petroleum, petrochemicals and power generation industries.

Problem Statement

- Shop Run Testing was performed to a VS4 pump in Sulphur service for an SRU in a gas project.
- One acceptance criterion for run test is to have no leakage from pump sealing location.
- This specific service contained dry running packing due pump construction.
- The pump was found heavily leaking test liquid (Water) from the packing location which is considered a Non-Conformity.

Analysis

- The pump is a **Vertical Sump Pump** construction as per **API610 VS4** configuration
- The vertical Sump pump has the discharge through a separate column .
- The pump is supported by a column with line bearings , the line bearings are lubricated by the pumped fluid through a separate path.
- The packing for this pump is not in the fluid path, and accordingly is dry running, in our case.. Test Liquid (Water at ambient conditions) was leaking out of it!!



Analysis

Photos showing the test water leakage from the packing location

Analysis

- The pump is VS4 construction, where the seal chamber location is not wetted.

- The pump service is molten (liquid) Sulphur with flow of about 1.5 m3/hr. and 25 m head (about 1.5 bar-a suction pressure), where the pump is steam jacketed and runs at about 1500RPM, pumping temperature is about 130 to 140 °C

- It was critical to have zero leakage from the packing as:
  - The molten Sulphur path inside the pump shall cool down and solidify away from the steam jacketed locations.
  - Environmental hazards of having Sulphur leaking from the pump

Analysis

Three Attempts were made to uncover/resolve the issue:

- **First Attempt:** Elevate the pump to simulate lower sump liquid level and re-conduct the running test.
- **Second attempt:** Further tightening to the packing gland.
- **Third attempt:** Root Cause Analysis (RCA) and internal examination for the pump construction to uncover core issue.

Analysis (Cont.)

First Attempt :

- The supplier suggested that the liquid level in the test bed was higher than the actual operating liquid level the pump shall operate at.
- Doubtfully, it was agreed to re-conduct the test with the pump elevated to simulate the correct liquid level at the workshop sump
- Again the pump suffered leakage from the packing location!!!

Pump at grade Level →

← **Pump Elevated about one meter**

Analysis (Cont.)

Second Attempt:

- During the same trial for having elevated test, and after observing leakage, Supplier suggested to further tighten the packing glands to control the leakage.

- It was advised that this action is irrelevant to the core issue which is having leakage from this location in the first place, however, supplier progressed with the tightening attempt.

- The attempt failed (showed elevated packing temperature, and leakage still occurred) and the supplier was informed that a root cause analysis is mandatory to resolve this issue .

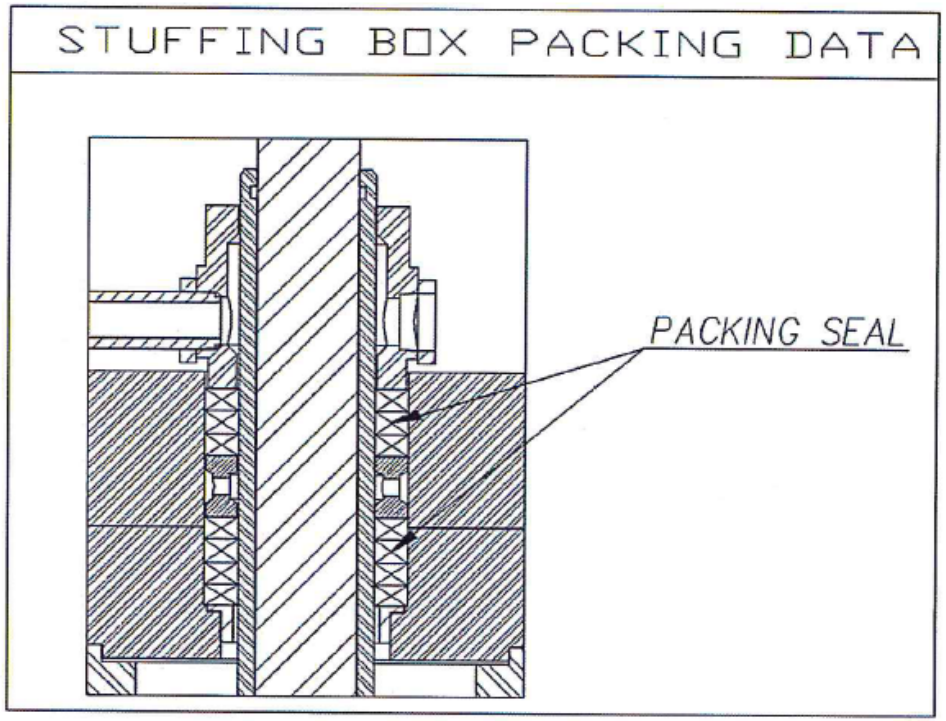
Analysis (Cont.)

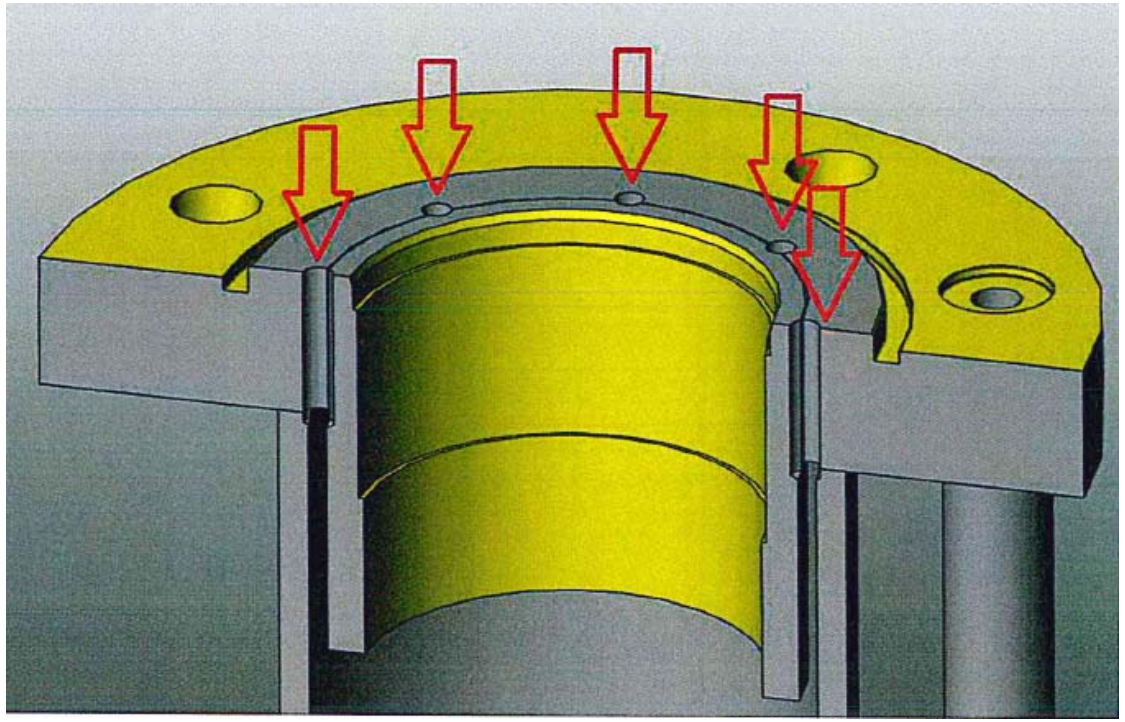
Third Attempt:

- One of the consequent suggestions raised to the supplier was to examine proper internal drainage of the pumped fluid to be sufficient.
- After conveying the concerns about drainage from the engineering team, Supplier performed a root cause analysis (RCA) to the issue.
- The RCA suggested also inadequacy of the drainage system inside the column (support pipes) that caused accumulation of the pumped liquid up to the packing location.
- Pump was disassembled and examined, which revealed that the drainage holes were totally missing from both casing and intermediate support pipes!!!

Conclusion

- The RCA and disassembly uncovered the missing drainage holes, immediately the supplier started with the remedy action needed: drilling 10 drainage holes in each location





Conclusion(Cont.)

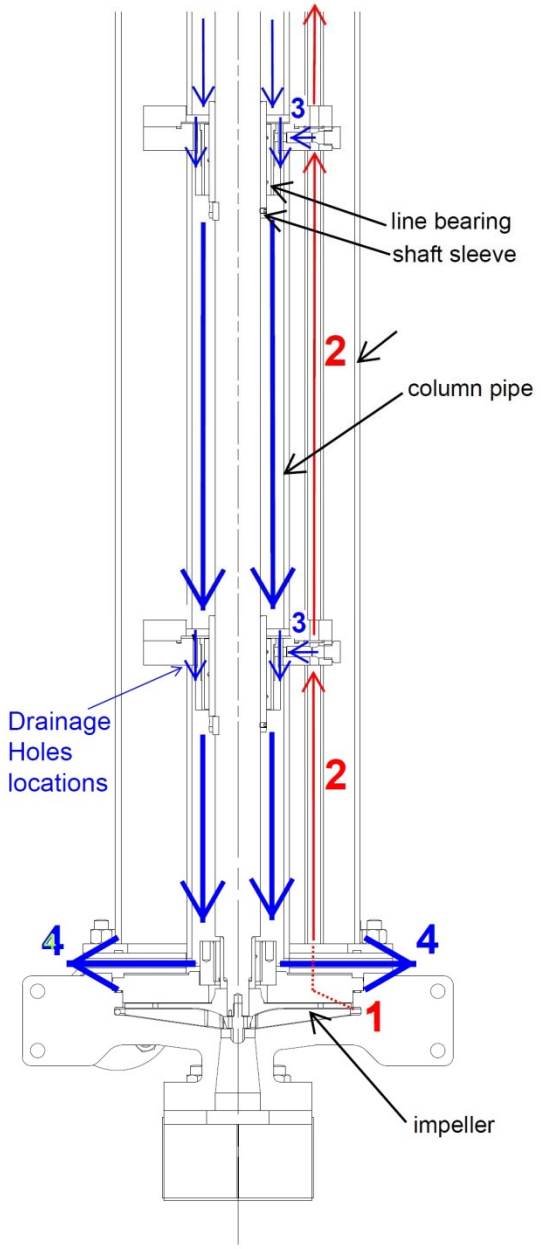
Legend and Explanation for Lubrication path inside the pump that caused leakage:

1) Source of liquid: Flow from impeller to guide bearings

2) Pipe route with flow from impeller to the bearings

3) Chamber where flow should take to fall back by gravity through the column

4) The path back to the vessel after passing through the drainage holes **(That were missing)**



Conclusion(Cont.)

- The below Photos show the drilling location for drainage holes that were actually executed on the pump

BEFORE

AFTER

Conclusion(Cont.)

- The pump was re-tested after implementation of the drainage holes as shown in the photos

- The test resulted no leakage from the packing location, concluding the **success** of the solution implemented.

Lessons Learned

- Proper design may be considered in documentation but not implemented, which reflects quality control issues.
- Even for small, straightforward pumps, testing is mandatory to ensure proper pump performance and running.
- Witnessing by customer representatives to the inspection (i.e. not only internal testing) is also important in many cases.
- The cost assumed for witnessing the tests is far less than the negative impact & costs of discovering such issues at site.
- Proper tracing and RCA for test issues are important, especially with supplier attempts in many occasions to convince clients that the issue is a “normal finding” or to propose unrealistic methods to resolve it.

Questions