Characterization and assessment of laminations

CONCAWE - OPMG

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Characterization and assessment of laminations

1. About CLH
2. Laminations
3. CLH’s ILI campaign and results
4. Research by the Polytechnic University of Madrid (UPM)
5. Conclusions

CLH possesses modern logistics resources and infrastructures to offer its clients best-in-class services

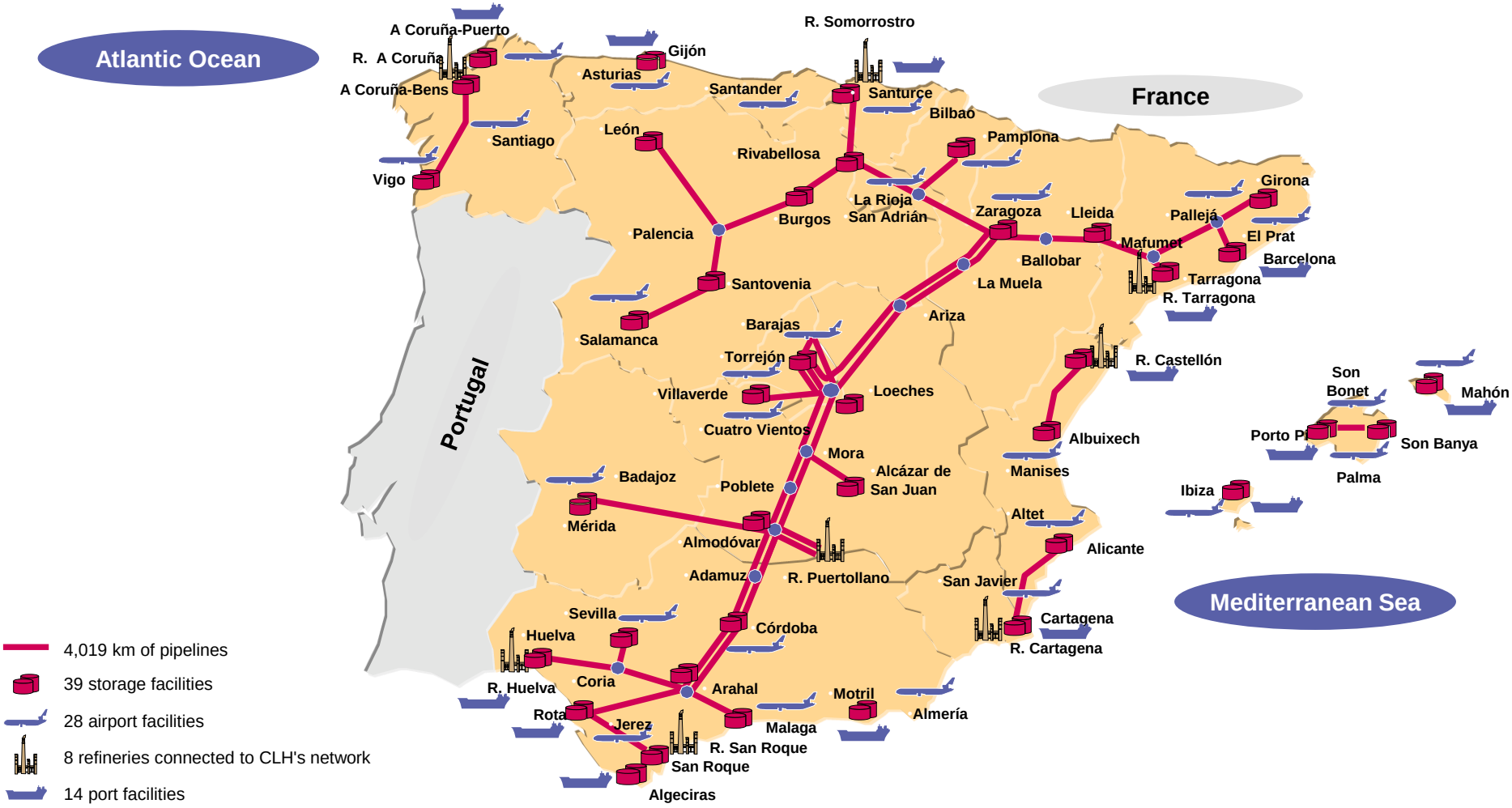
Infrastructures

Storage facilities	39 storage facilities
Storage capacity	8 million m^3 storage capacity
Pipelines	4,019 km of pipelines
Airport facilities	28 airport facilities
Hydrants	5 hydrant networks at major airports

Logistics resources

Tanker ships	2 chartered tanker ships
Dispensers	49 aviation fuel dispensers
Refuelers	123 refueling units
Human resources	1,348 people with extensive experience and know-how

CLH's logistics system guarantees product supply in the Spanish peninsula and the Balearic Islands

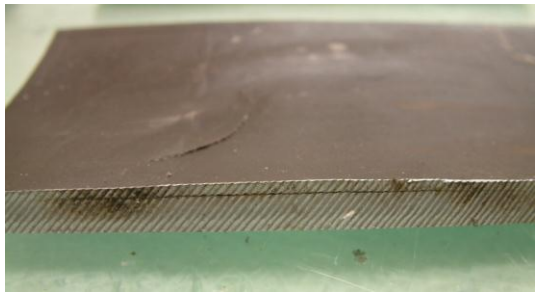


- 4,019 km of pipelines
- 39 storage facilities
- 28 airport facilities
- 8 refineries connected to CLH's network
- 14 port facilities

2- Laminations

- A lamination is a discontinuity in the pipe material caused by:
  - Concentration of non-metallic caused by rolling-out of inclusions
  - Blow holes
  - Ingot cracks in parent material

- Characterization:
  - Parallel
  - Inclined
    - Closed
    - Open to internal wall
    - Open to external wall



2- Laminations

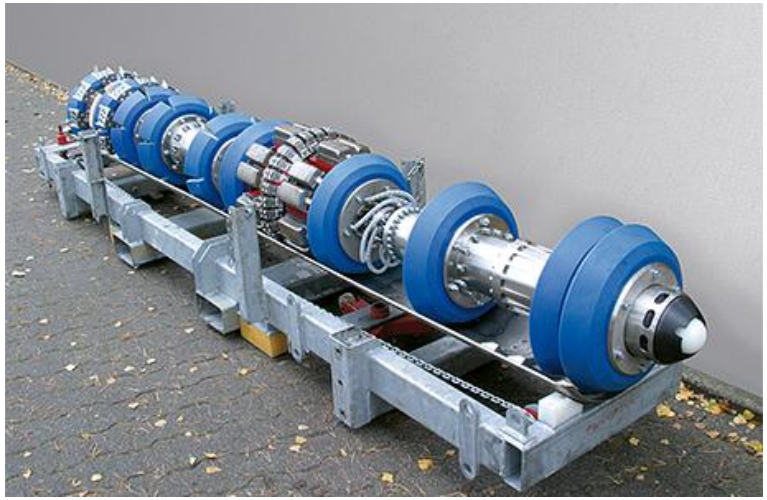
- Assessment methods:
  - API 579, 2007 – Fitness For Service:
    - Part 13: Assessment of Laminations.
    - Part 9: Assessment of Crack Like Flaws.
  - Assessment methods for manufacturing defects in pipelines, April 2002 – Penspen Report Nº NR99017/4238.1.77/R3

- Criteria:
  - Parallel: no integrity threat, API579 – Part 13.
  - Inclined laminations:
    - Open internally or externally: evaluated as crack, API579 – Part 9.
    - Slope (check UT1 and UT2 parameters): evaluated as crack, API579 – Part 9.

3- CLH's ILI campaign

- 5 year inspection program:
  - 4,000 km of pipelines inspected every 5 years.
  - CLH performed in 2009-2010 UT and MFL+UT inspection.
  - CLH used UT on 860 km of pipeline and UT+MFL on 350 km.

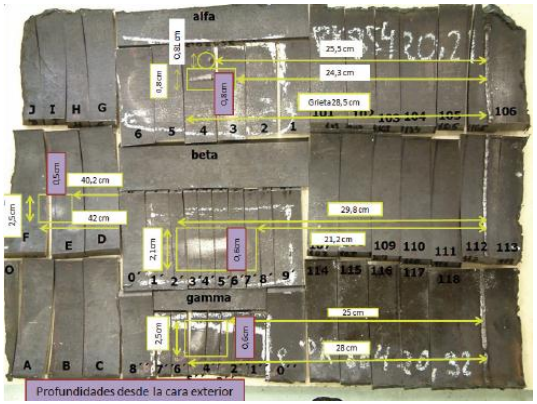
- During 2009-2010 a large amount of detected laminations wouldn't pass API579 and would require to be repaired. Field reports verified their characterization.

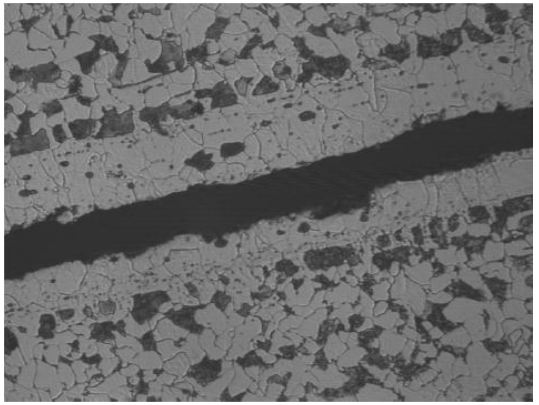


4 - Research by UPM

Most severe reported laminations (13) where deeply examined by destructive and non-destructive tests.

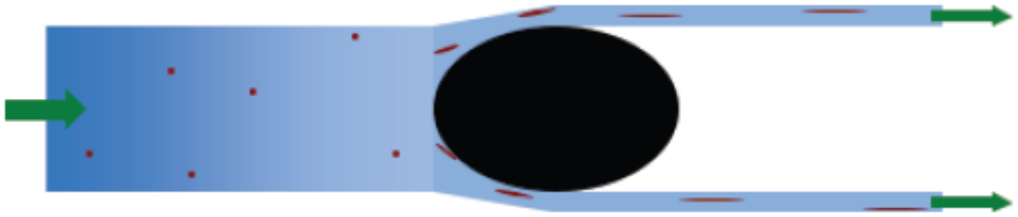
- Macroscopic inspection,
- X-rays,
- Magnetic particles,
- Manual and automated ultrasonic inspection,
- Sample cutting and preparation for inspection,
- Microscopic inspection,
- Quantification of morphologic characteristics (dimension, orientation, depth, etc.)





5 - Conclusions

1- All of them were parallel and associated with non-metallic inclusions during manufacturing.

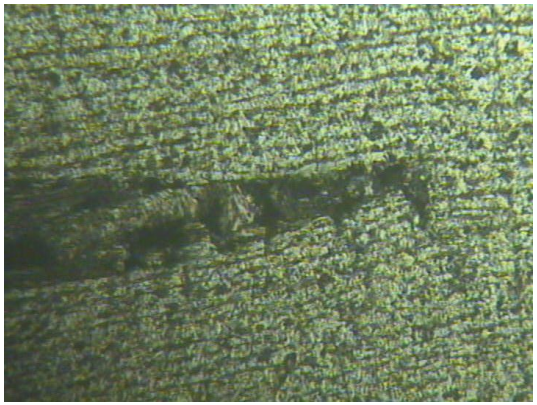


2- No inclined laminations were found. They were several laminations parallel to the wall on different heights.

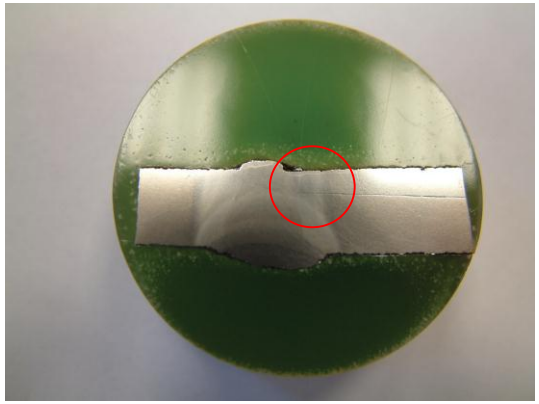
3- Laminations are always associated with manganese sulfur (non-metallic) and do not propagate beyond those inclusions.

5 - Conclusions

4- Laminations have a certain width but are not classified as cracks, the limits of the lamination had a carved like shape.



5- Laminations near to girth welds show no deviation in plane laminations.



5 - Conclusions

6- These results are applicable to all pipeline that have similar type of steel, manufacturing and construction conditions and inspection procedures.

7- Assessment according to API579 should be done as parallel laminations and not as inclined ones.

8- The ILI tool provider has refined his methodology in signal interpretation and now differentiates better parallel and inclined laminations.

9- The main concern is when laminations are combined with other anomalies.

Thank you

Compañía
Logística de
Hidrocarburos

CLH