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Welcome to MCF – Marine Corrosion Forum / ICorr – Institute of Corrosion (ABZ), 2021 April Webinars.

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Institute of Corrosion (ABZ) and MCF partnering with:

- ROSEN
- 30th April 2021

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“Addressing the risk of Hydrogen-Induced Stress Cracking on pipelines”

ROSEN - Daniel Sandana |
Principal Engineer ,

30th April 2021

About Me / HISC

- Addressing the risk of Hydrogen-Induced Stress Cracking (HISC) on pipelines, Daniel Sandana | Principal Engineer | ROSEN UK.
- The role that hydrogen could play in the transition to low-carbon economy has refuelled the emphasis on hydrogen-related cracking mechanisms, and how these could affect the integrity of the energy infrastructure. Hydrogen-cracking mechanisms can nonetheless occur on our existing pipelines, when the effect of CP or H2S is considered. Such mechanisms will actually occur at a greater scale, than what would be considered when looking at the sole effect of gaseous hydrogen.
- The purpose here is to get a better understanding of the problem of HISC due to CP on materials, used onshore and subsea, and how to address it.

Daniel Sandana | Principal Engineer | ROSEN UK

Q&A

- Selection of Questions to **ROSEN**,
  Post-Presentation 30/04/2021

Questions and Answers – MCF / ICorr Joint Event Aberdeen – April.2021

- Q1. what is the **lowest** % of gaseous hydrogen that can safely be introduced into conventional grade of pipelines? Is repurposing existing hydrocarbon lines for hydrogen safe from long term integrity perspective?

- A1. Conc. of only 1%. 0.4 bar pp, has already a significant impact on Materials Props. such Fracture Toughness (<50%). Lab results may be conservative though. Repurposing, is a topic in itself ! Ea. Pipeline must be considered on a 'case by case' basis, considering all parameters. Just understanding Material Grade alone is not enough. Microstructural sampling must be performed.
- Published (Lab) data alone is not enough guidance.

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- Q2. In Hydrogen Pipelines / Transportation, H permeation will occur by a different mechanism from the introduced?

- A2. Yes, agree for the purposes of Gas Transportation. Must consider from the point of view of H2 Absorption.
- H2 Saturation may be reached later, after continued operations.

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- Q3. Should the lower carbon content in higher grade steels make them less susceptible to hydrogen embrittlement?

- A3. Yes, in generalised terms but always check specific pipeline data thoroughly. Actually, installed grade may differ from specified grade, suppliers are required to meet minimum material specs but sometimes exceed them.

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- Q4. If we have NACE MR 0103 requirements for H2 service than HIC testing shall be carried out for equipment. What are the criteria for HOC requirements for H2 service?

- A4. There are not Testing Protocols in place yet to properly qualify against '**time dependent'** threats.

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- Q5. How was it assessed that absorption caused by CP overprotection is some 100 times greater than that possibly induced by gaseous hydrogen flowing in the pipeline? Would not the calcareous deposit formed by CP current restrict the absorption?

- A5. It was a private industry report that I cannot disclose. Yes, calcareous deposits are protective to some degree in most instances. But having '**effective CP alone is not a guarantee of cracking protection'.**

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- Q6. What laboratory test methods would you recommend as part of qualification process for commissioning pipelines (existing O&G lines, or new) for HE resistance in the H energy industry? i.e., SSRT or Fracture mechanics methods. Also do you consider electrochemical charging methods suitably equivalent to replicate H gas pressures?

- A6. Sorry, I am not able to assist right now but will provide more information later to you.

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- Q7. Excellent. BUT please understand that for onshore pipelines existing ISO Standard 15589-1 limits pipe/soil potentials to -1.2V Cu/CuSO4 and any CP design that breaks these, including near impressed current installations, are FLAWED. For pipeline steels >550 N/mm2 the Standard requires determination of safe potential limits. Can you explain in the failure that you recently involved, IF either or both of these requirements were breached?

- A7. Yes, there was overprotection in this case. Many CP standards do not quote overprotection criteria. In this case when breached, we had an X52 Grade with martensitic structures present.

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- Q8. For hydrogen absorption from corrosion or CP we can obviously put mitigation methods in place to reduce or stop the mechanism. In hydrogen blend transportation, do you think pipelines might end up with an "expiry date" i.e. the maximum time before the material properties are affected too much by hydrogen, or do you think we will be able to accurately assess long term effects using our knowledge from corrosion?

- A8. This was not fully covered in today's presentation, but you need to aware that certain components of overall composition have side effects. Lab results do indicate risk's but again in-service testing is not yet implemented. Long term absorption must be fully understood.

THANK YOU FOR ATTENDING

This Webinar was brought to you by MCF working in partnership with ICorr Aberdeen and **ROSEN.**