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Multiphase flow induced corrosion: undestanding interactions between crude oils and emulsion

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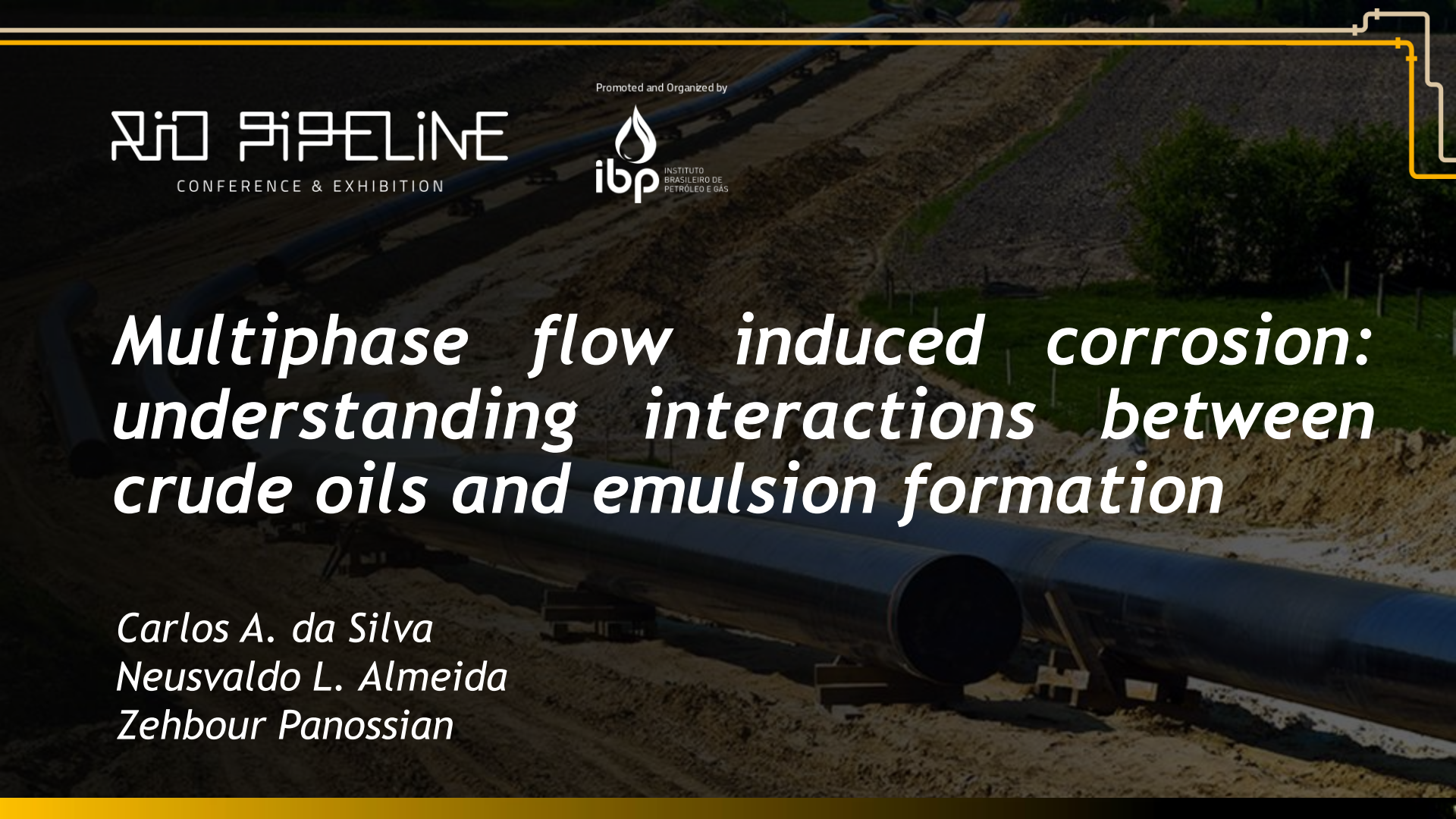

Multiphase flow induced corrosion: understanding interactions between crude oils and emulsion formation

Carlos A. da Silva
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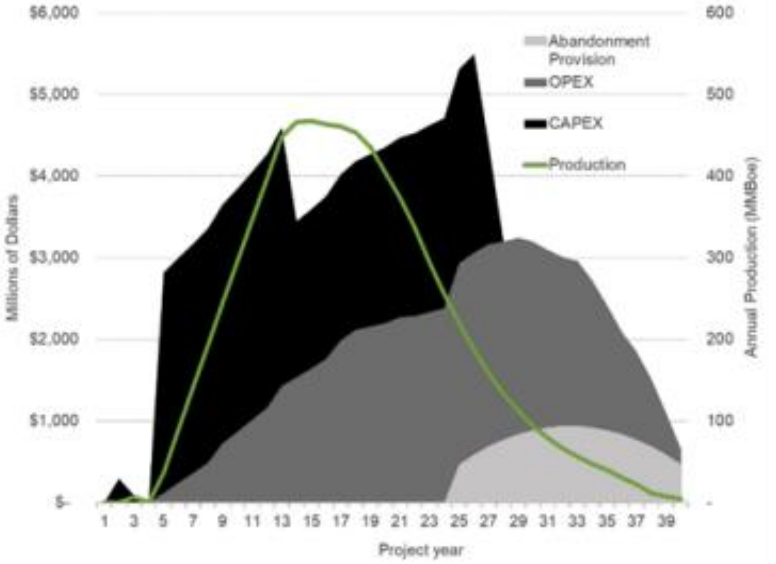
Background

The **impacts of corrosion** damages on the Oil and Gas industry:

• material selection criteria for projects and topside or subsea structures.

• provide technological solutions and flow assurance.

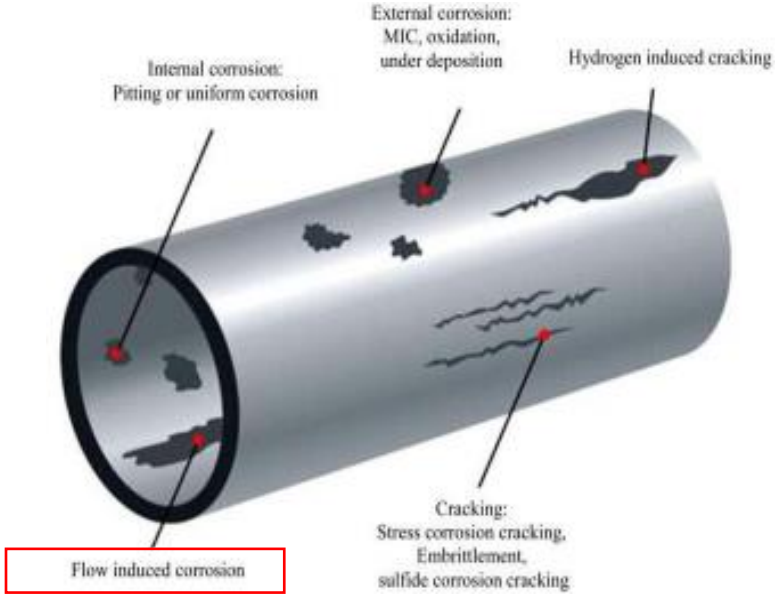
• CAPEX, OPEX and HSE.



Furtado, Gonçalves e Costa [5]

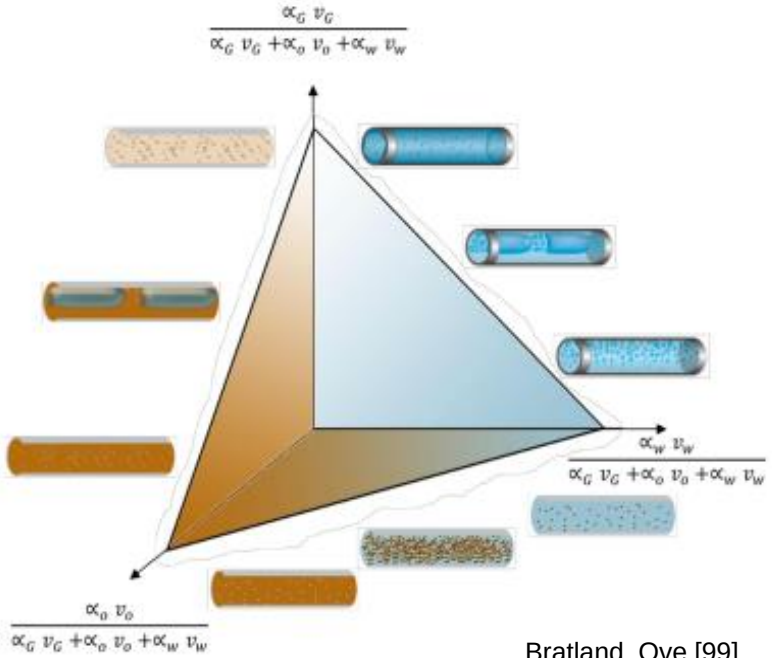
What is flow-induced corrosion?

The **combined effect** of a corrosive environment, flow pattern and emulsification process.



FIC

(H. AL-MASHHADANI et al., 2020)

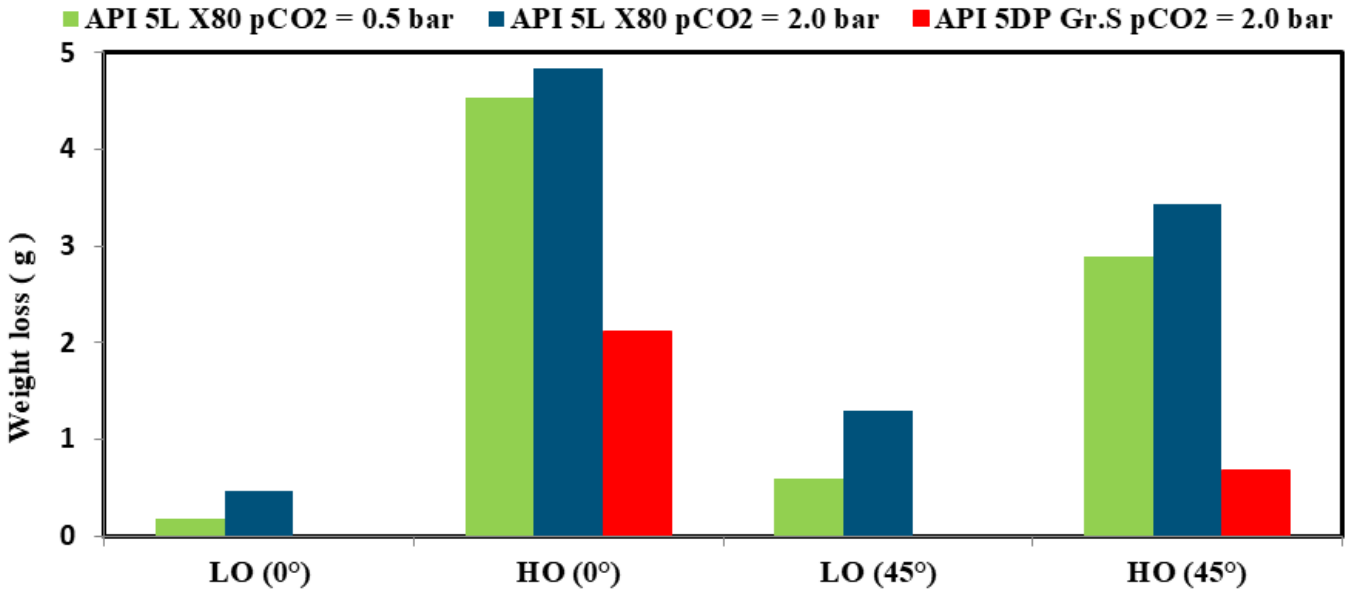


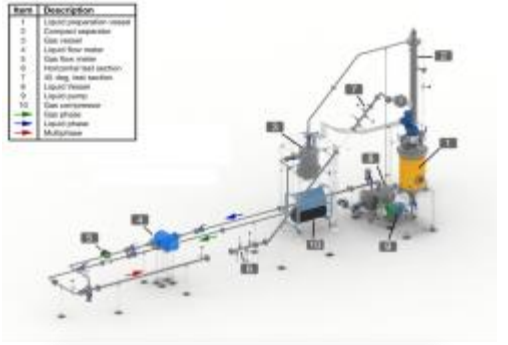
Bratland, Ove [99]

Methodology

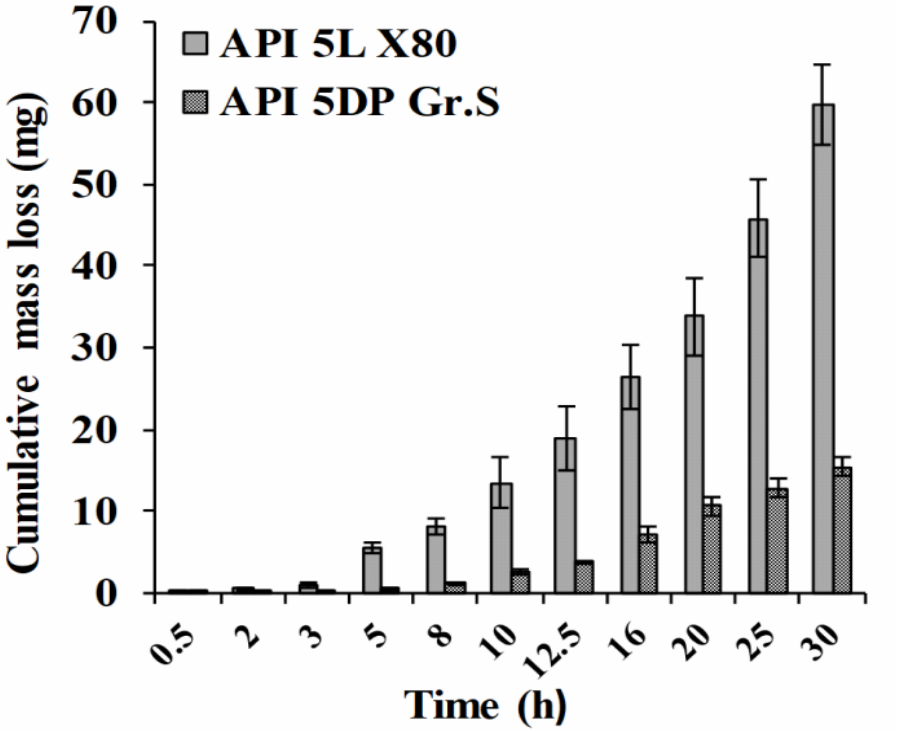
FIC	Material	Gas phase	Liquid phase	Temperature	Parameters
Loop test [1]	API 5L X80 API 5DP S	0.5 and 2.0 bar (CO_2) Balance 2.5 bar (N_2) O_2 < 10 ppb	80 % brine (15 % NaCl) + 20 % LO (15 cP) or 20 % HO (150 cP)	40 °C	Slug flow Tests duration: 30 h
Cavitation-erosion test according to ASTM G32 [2]	API 5L X80 API 5DP S	Environment conditions	Deionized water	25 °C	Vibration frequency: 20 kHz Amplitude: 50 µm peak-to-peak Tests duration: 30 h
Autoclave test [3]	API 5L X80	2.0 bar (CO_2) O_2 < 10 ppb	80 % brine (15 % NaCl) + 20 % HO (150 cP)	40 °C	Rotation: 1200 rpm Tests duration: 30 h
RCE test	API 5L X80	2.0 bar (CO_2) O_2 < 10 ppb	80% brine (15% NaCl) + 20% LO (15 cP) or 20% HO (150 cP)	40 °C	Rotation velocity: 1200 rpm The polarization resistance (*Rp*) was monitored Tests duration: 30 h

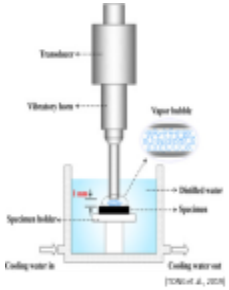
Loop test results



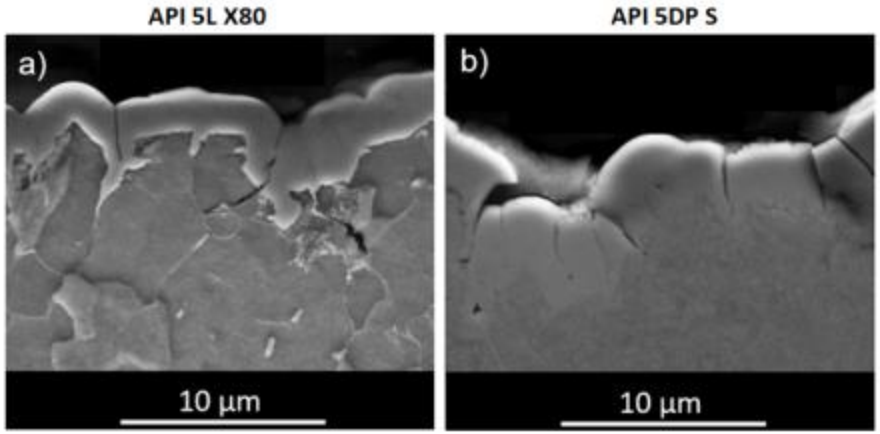


Cavitation-erosion test results

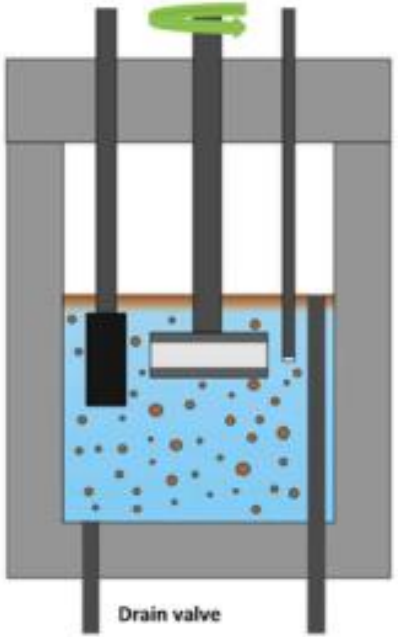




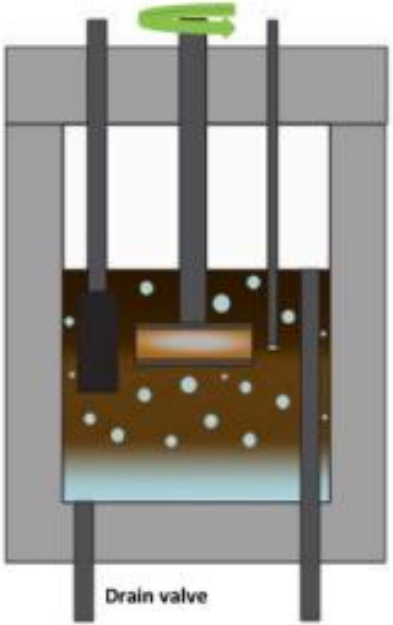
(ASTM G32)



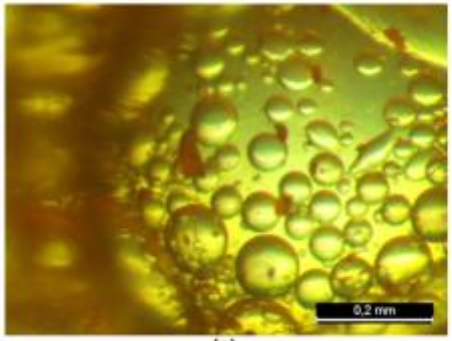
Autoclave test results



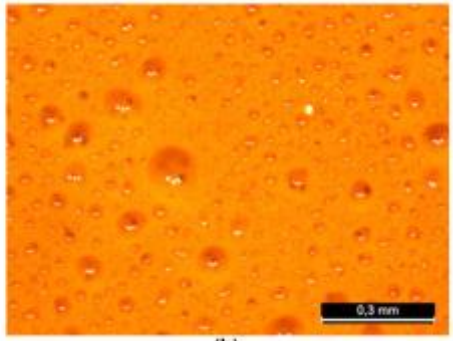
(a) Light crude oil in brine



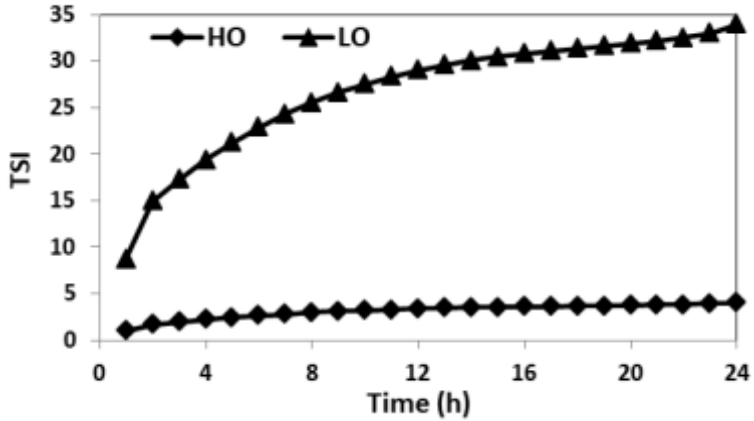
(b) Brine in heavy crude oil



(a)

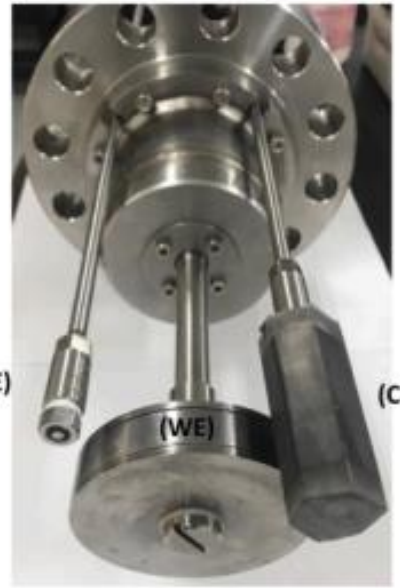


(b)



RCE test results

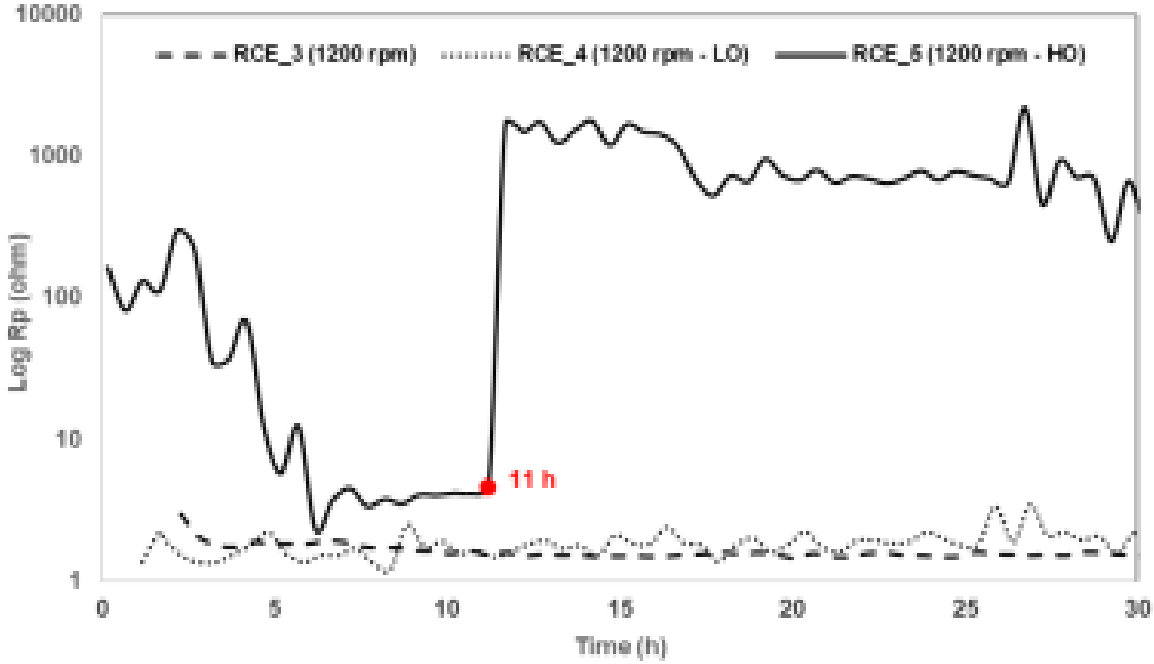
electrochemical test results:



RE – Reference Electrode

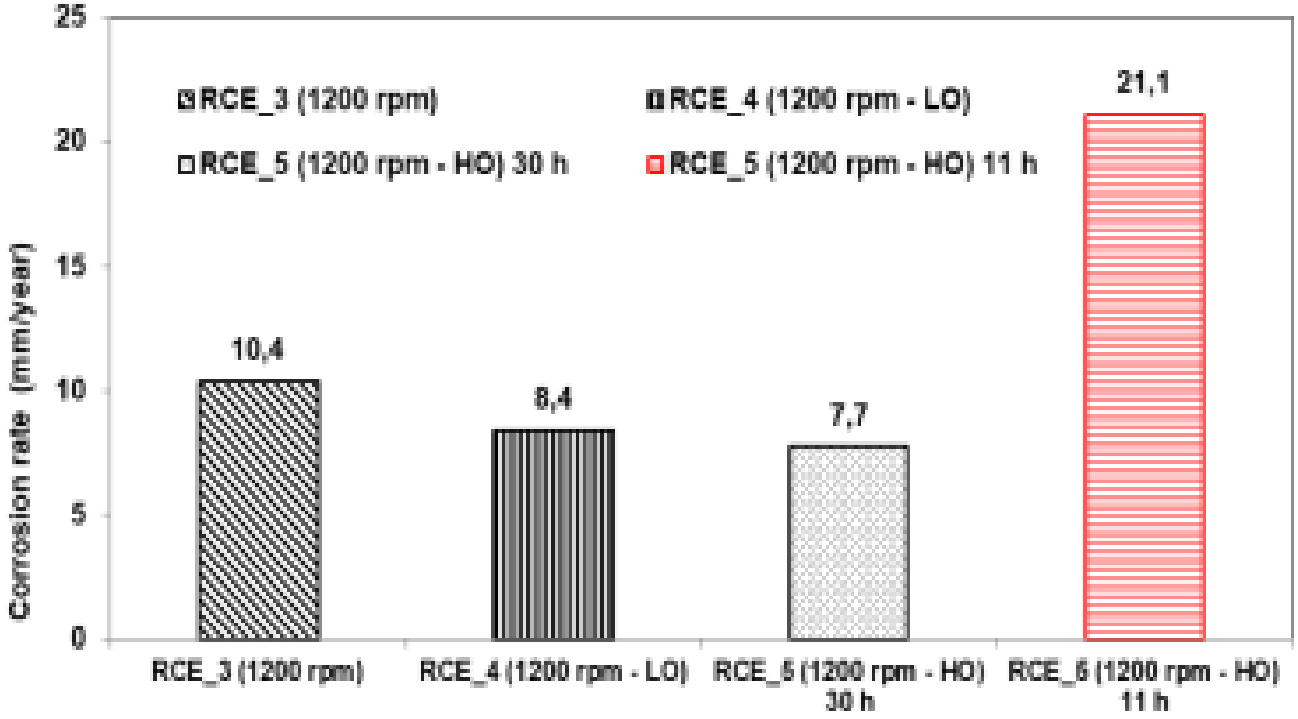
WE – Work Electrode

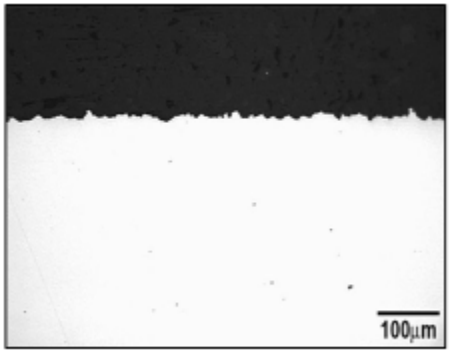
CE – Counter Electrode



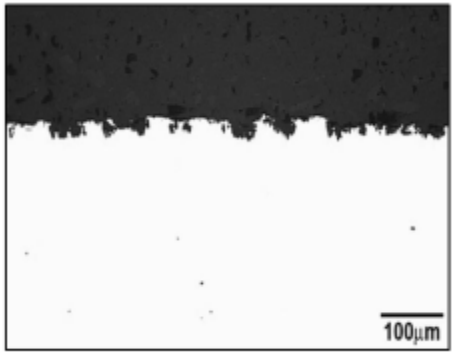
RCE test results

corrosion rate results:





(a) LO longitudinal section



(a) HO longitudinal section

Final Remarks

- corrosion tests conducted in the **multiphase flow loop** showed **high weight loss of the API 5L X80** as a consequence of simultaneous effect of the **hydrodynamic effect associated with the type of emulsion.**

- The weight loss of the **HO was much higher than the obtained with the LO**, which was unexpected. The reason of this discrepancy was attributed to the **type of emulsion formed** with each oil. The **HO formed O/W emulsion with high viscosity and free water.** The **intermittent wetting of the steel surface with free water and the high viscosity emulsion promoted the higher corrosion rate.**

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