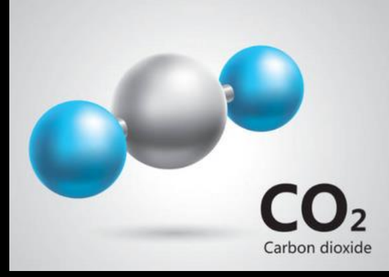
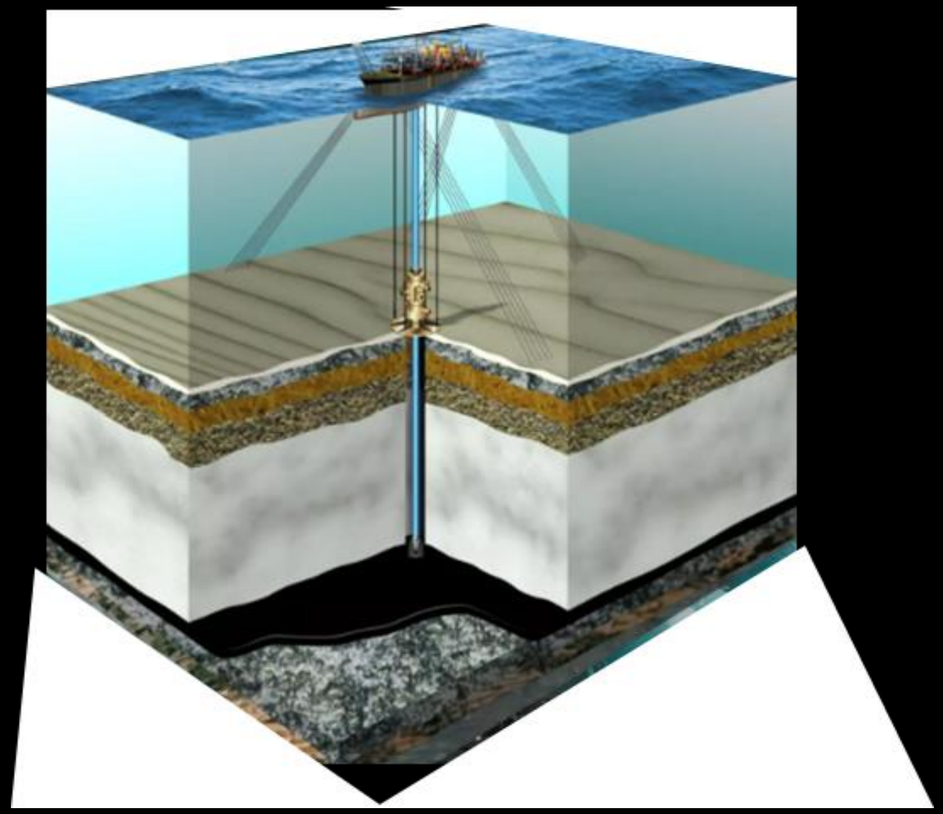
Desenvolvimento de dispositivos e metodologias experimentais para o estudo de problemas de corrosão pelo CO_2 relacionados à indústria de óleo e gás

LABORATÓRIO DE ENSAIOS
NÃO-DESTRUTIVOS,
CORROSÃO E SOLDAGEM

INDÚSTRIA DE ÓLEO E GÁS

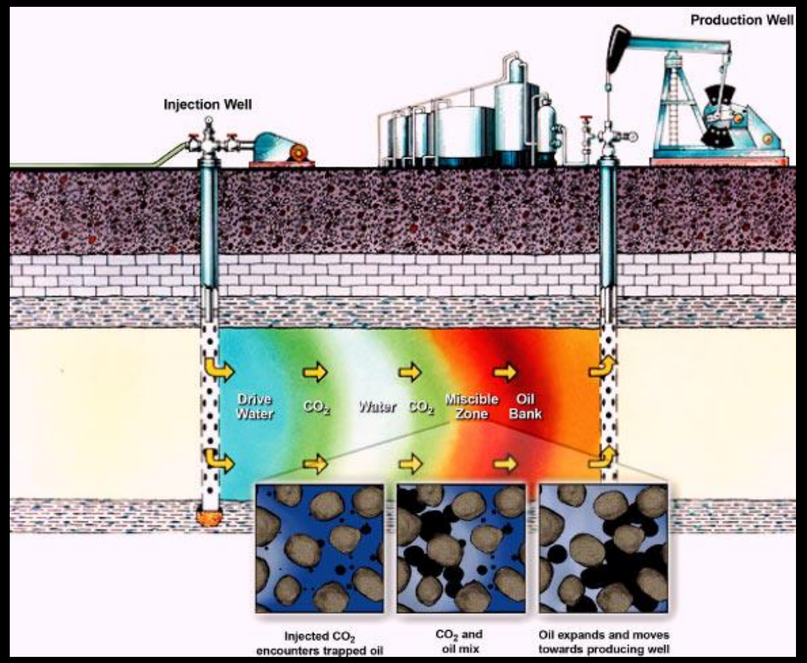




PRODUÇÃO DE ÓLEO NO PRE-SAL

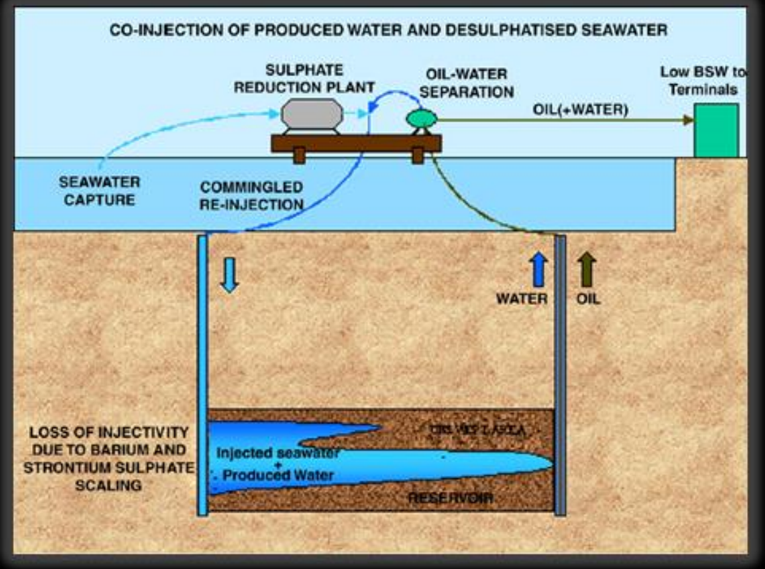
Elevados teores de CO_2 e de NaCl

CORROSÃO PELO CO_2



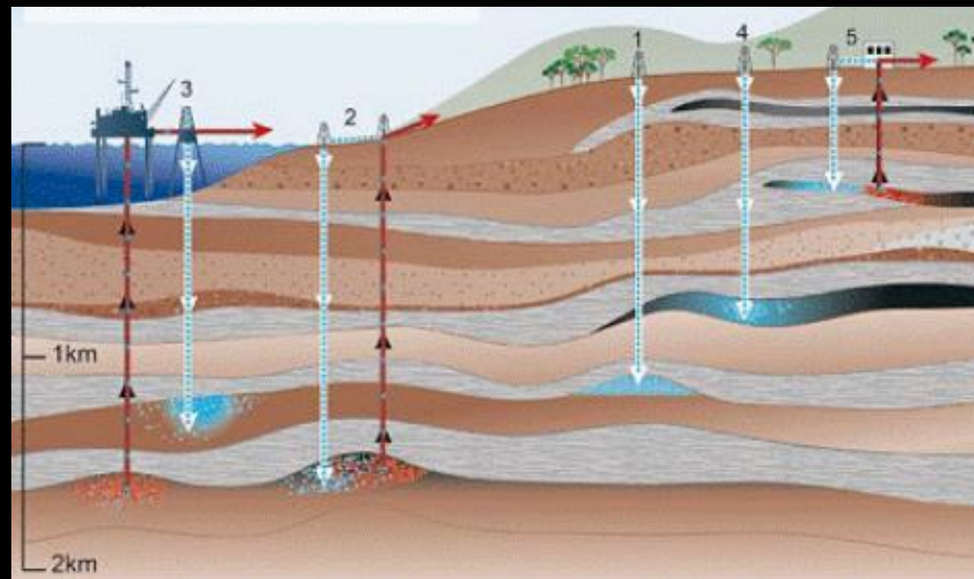
RECUPERAÇÃO AVANÇADA DE PETRÓLEO (EOR)

H_2O e CO_2



REINJEÇÃO DE ÁGUA PRODUZIDA OU ÁGUA DO MAR

Diferentes teores de NaCl e baixos teores de CO_2



ARMAZENAMENTO DE CO_2 EM RESERVAS GEOLÓGICAS

Fluido supercrítico

O QUE SABEMOS?

CO_2

AUMENTO NA CORROSÃO

Aumento da reação de evolução de hidrogênio

MECANISMO CATÓDICO

$$2H^+ + 2e^- \rightarrow H_2$$

$$2H_2CO_3 + 2e^- \rightarrow H_2 + 2HCO_3^-$$

REDUÇÃO DIRETA

$$2H^+ + 2e^- \rightarrow H_2$$

$$H_2CO_{3(aq)} \rightleftharpoons HCO_{3(aq)}^- + H_{(aq)}^+$$

MECANISMO DO EFEITO TAMPÃO

C. De Waard, D.E. Milliams, Corrosion 31 (1975) 177–181. | T.C. Almeida et al. Corros. Sci. 120 (2017) 239–250. | E. Remita et al, Corros. Sci. 50 (2008) 1433–1440. | T. Tran et al. Corrosion 2015: Paper no. 671.

MECANISMO ANÓDICO

CO_2

Curva de polarização

$$Fe \rightarrow Fe^{2+} + 2e^{-}$$

REAÇÃO DIRETA NA SUPERFÍCIE DO FE

$$Fe + CO_2 \rightarrow (FeCO_2)_{ads}$$

S. Nesic et al. Corrosion/96, paper no. 3, (Houston, TX: NACE International, 1996b) | A. Kahyarian et al. Corros. Sci. 129 (2017) 146–151.

NOSSA METODOLOGIA E DESENVOLIMENTOS

$H_2O + CO_2$

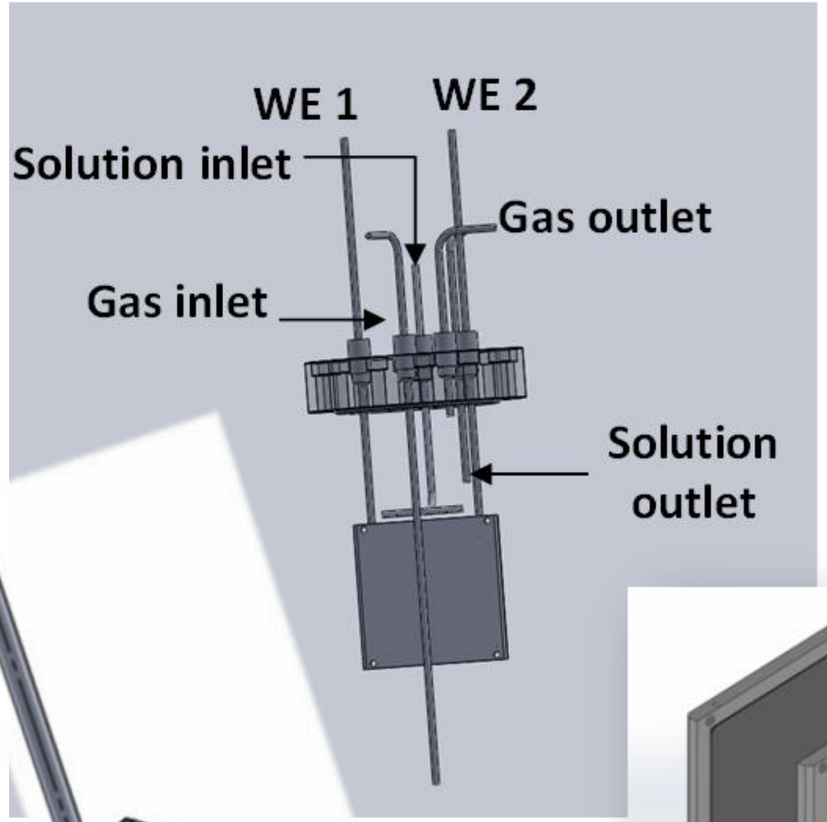
Célula de 2 eletrodos (impedância OCP)

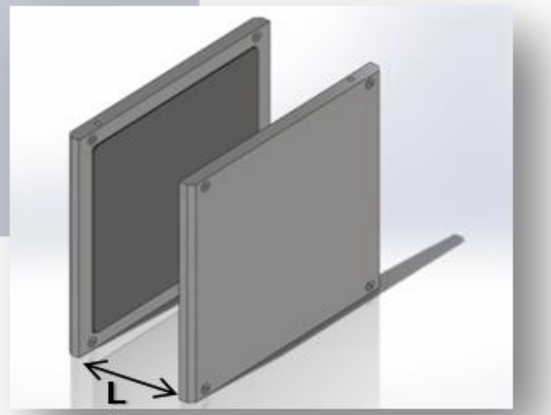
Aço carbono API 5L X65

L = 2 e 4 mm

A = 130 cm²

pH = 4





$$R_\Omega = \frac{L}{A} \cdot \rho$$

T.C. Almeida, M.C.E. Bandeira, R.M. Moreira, O.R.Mattos. Corros. Sci. 120 (2017) 239

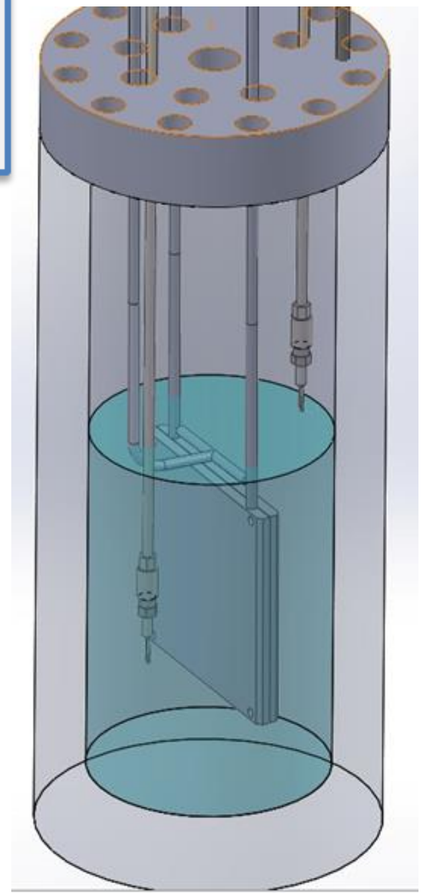
$H_2O + CO_2$

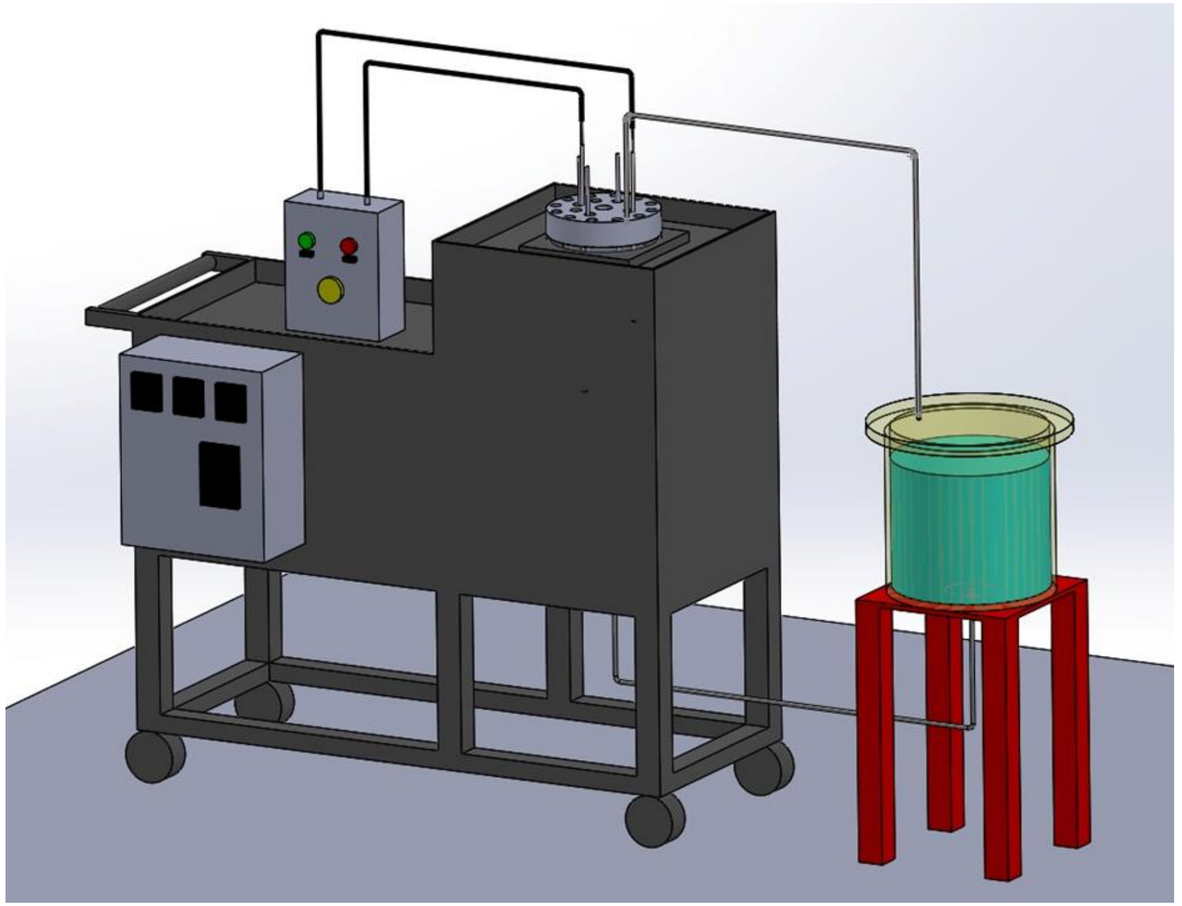
Conductive level sensor

≈ 50 L of solution

pH 4

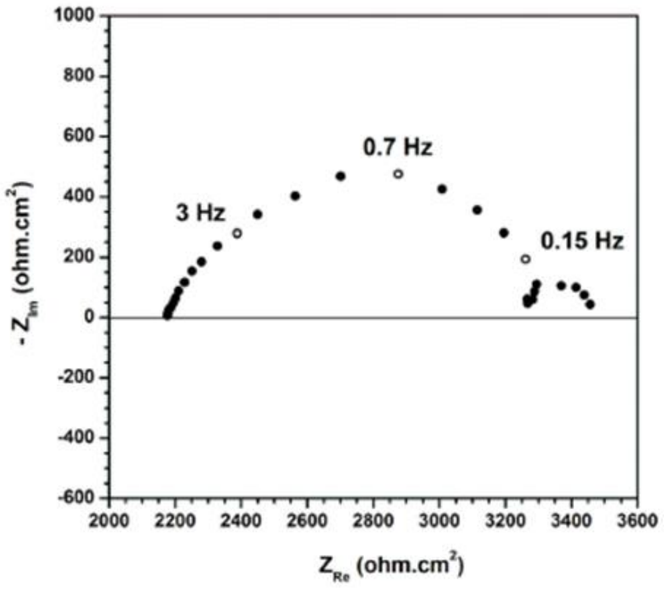
Operating capacity ⩽ 200 bar

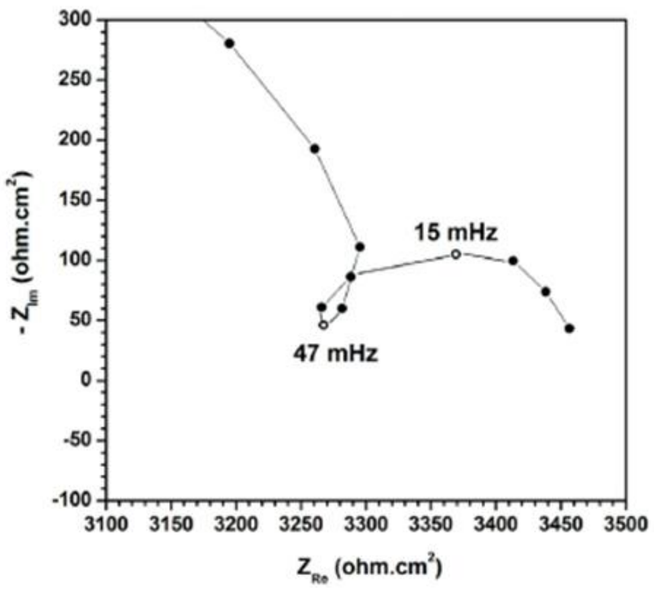




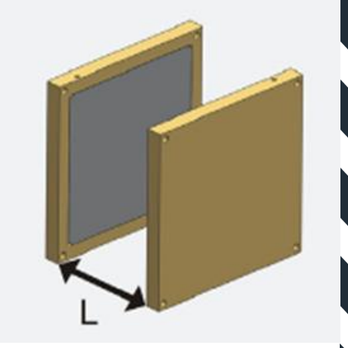
R.M. Moreira, C.F.C. Nascimento, M.C.E. Bandeira, O.R.Mattos, Intercorr2018, n°133

$H_2O + N_2$



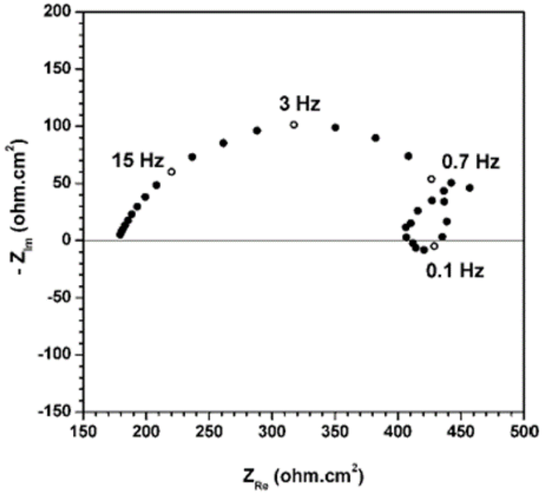


OCP



1 bar | 24°C | pH 4

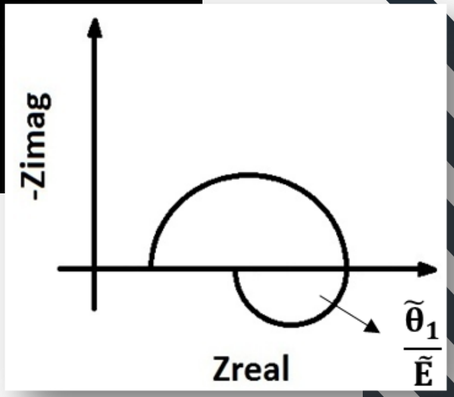
$H_2O + CO_2$



110 bar | 24°C | pH 4

$$Fe + H_2O \longrightarrow (FeOH)_{ads} + H^+ + e^-$$

$$\frac{\tilde{\theta}_1}{\tilde{E}}$$

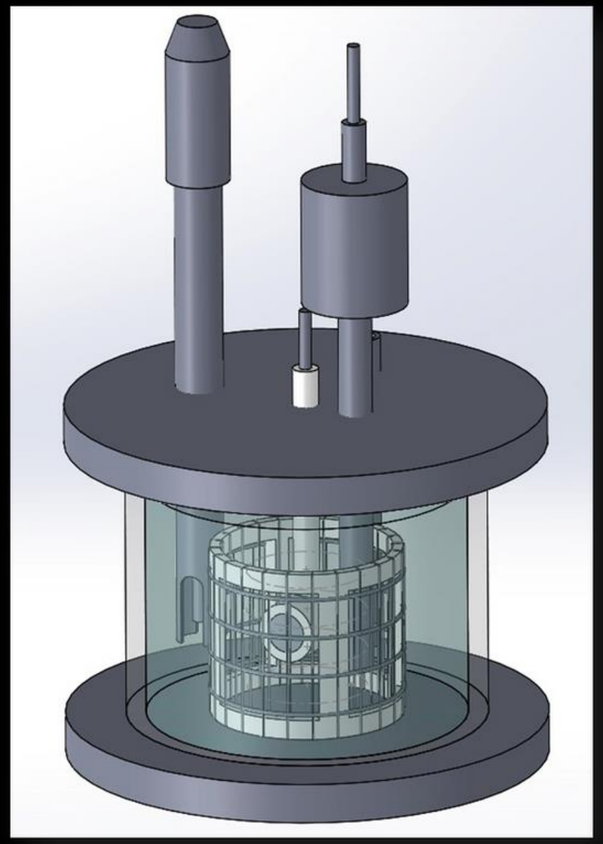


T.C. Almeida, M.C.E. Bandeira, R.M. Moreira, O.R.Mattos. Corros. Sci. 120 (2017) 239

EVOLUÇÃO DA METODOLOGIA

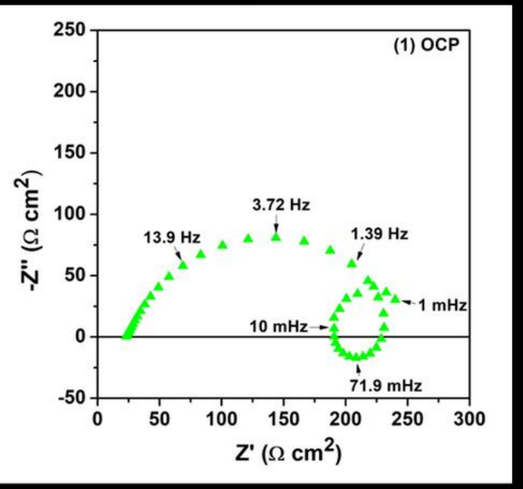
IMPEDÂNCIA POLARIZADA

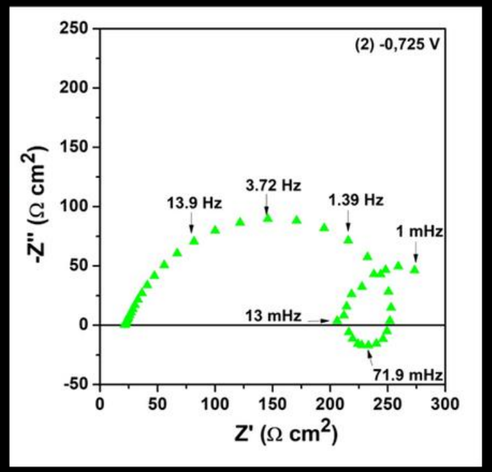
- ❑ 1 wt% NaCl + CO_2
- ❑ 1 wt% NaCl + N_2
- ❑ pH 4
- ❑ 1 bar
- ❑ 24 °C

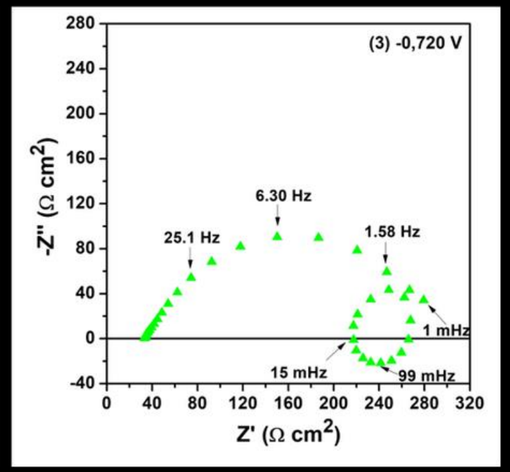


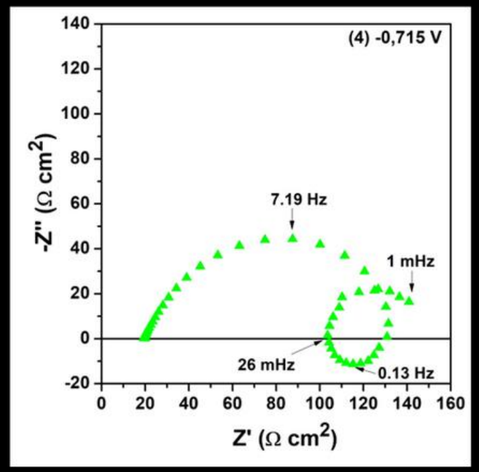
CUNHA, JÉSSICA N. ; ALMEIDA, T. C. ; MOREIRA, R. M. ; DELIA, E. ; MATTOS, O. R. . EUROCORR 2023. In: Eurocorr 2023, 2023, Bruxelas. CO2 corrosion: Effect of carbonic species on the carbon steel dissolution mechanism - a discussion, 2023

Anodic

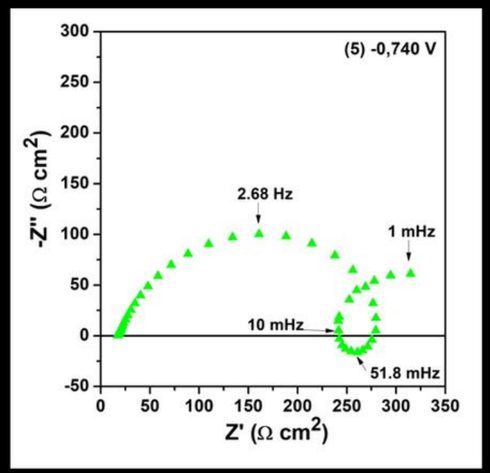


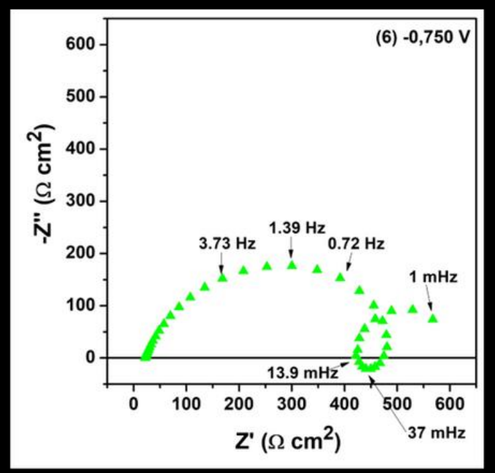


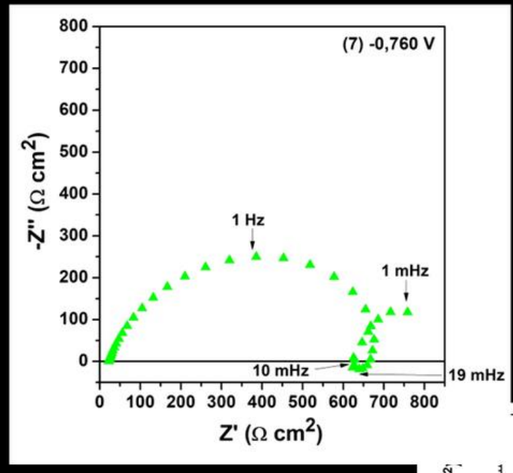




Cathodic





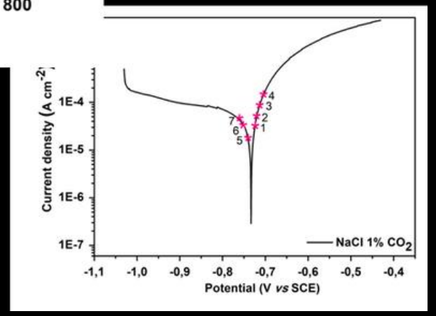


$$Fe + H_2O \xrightarrow{k_1} (FeOH)_{ads} + H^+ + e^-$$

$$(FeOH)_{ads} \xrightarrow{k_2} Fe^{2+} + OH^- + e^-$$

$$H^+ + e^- \xrightarrow{k_3} H_{ads}$$

$$H^+ + H_{ads} + e^- \xrightarrow{k_4} H_2$$



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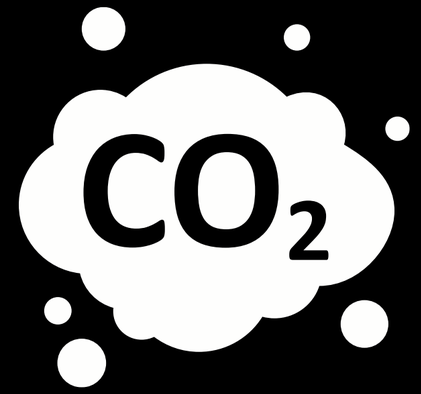
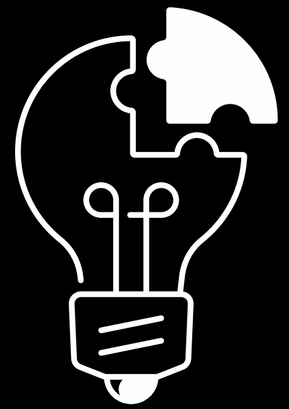
O QUE QUEREMOS SABER?



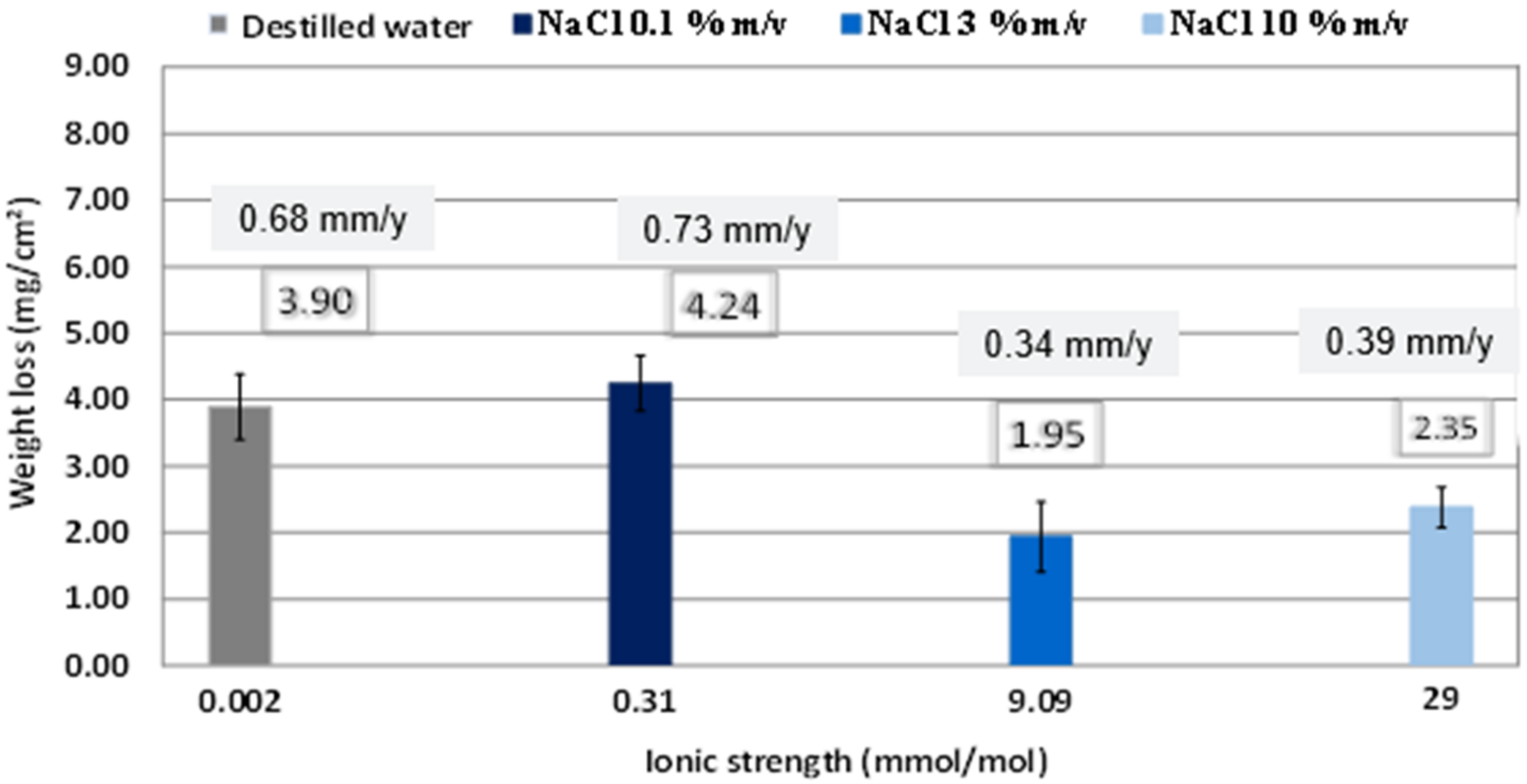
Qual o papel do CO_2 no mecanismo de corrosão?

Qual o efeito das diferentes impurezas na corrosão pelo CO_2?



PAPEL DO CLORETO

Metodologia para estudar a influência da salinidade na corrosão por CO_2 do aço carbono



pH 4
22 °C
665 ppm CO_2

ALMEIDA, T.C.*; GARCIA, R. F.; Merlin C. E. Bandeira; MOREIRA, R. M.; MATTOS, O. R. **The Influence of Ionic Strength on CO2 Corrosion of Mild Steel**, 2019. *Additional references: EUROCORR 2019, Sevilla, Spain.*

AINDA TEMOS MUITO A ENTENDER!

Thank you!

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+55 213938-8536

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