

Effect of CO₂ partial pressure on the corrosion inhibition of N80 carbon steel by gum arabic in a CO₂-water saline environment for shale oil and gas industry

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Table S1 Corrosion rate and inhibition efficiency obtained from weight loss measurements for the N80 carbon steel at various concentrations of GA and CO₂ partial pressures after 24 h of immersion time.

C _{inh} (g L ⁻¹)	Corrosion Rate (mm y ⁻¹)			IE (%)		
	1 bar	20 bar	40 bar	1 bar	20 bar	40 bar
25 °C						
Blank	1.28 ± 0.18	5.86 ± 0.68	10.95 ± 0.85	-	-	-
0.6	0.51 ± 0.08	1.87 ± 0.25	2.80 ± 0.46	60.30	68.12	74.45
0.8	0.44 ± 0.06	1.54 ± 0.37	2.22 ± 0.43	65.57	73.66	79.74
1.0	0.37 ± 0.09	1.24 ± 0.33	1.69 ± 0.46	71.09	78.77	84.53
2.0	0.38 ± 0.08	1.25 ± 0.39	1.70 ± 0.25	70.31	78.66	84.47
60 °C						
Blank	4.57±0.45	18.25±1.05	33.17±1.28	-	-	-
0.6	2.59±0.17	8,10±0.55	12.31±0.71	43.33	55.60	62.88
0.8	2.21±0.18	7.04±0.48	10.25±0.51	51.56	61.42	69.10
1.0	1.84±0.19	5.82±0.59	9.46±0.78	59.84	68.13	71.47
2.0	1.86±0.25	5.86±0.41	8.11±0.65	59.33	67.88	75.56

Table S2 Comparison of reported inhibition efficiency of some other corrosion inhibitors used in a CO₂ saturated saline solution (3.5 wt.% NaCl).

Inhibitors	Metal Substrate	pCO ₂ (bar)	C _{inh} (g L ⁻¹)	T (°C)	Time (h)	IE (%)	Reference
Benzimidazole derivatives	J55	60	0.4	60	24	83.6	[1]
Berberine extract	C11O P11OSS	60	1.0	120	168	60 78	[2]

	N80					92	
Momordica charantia	P11OSS	60	1.0	25	-	89	[3]
Thiourea, Mercaptoethanol	Q235	1	-	60	72	77.5 77.6	[4]
Gingko Biloba	J55	1	1.0	25	-	97	[5]
Chitosan, Carboxymethyl cellulose, Commercial inhibitor	API 5L X60	1	0.1	25/60	24	45/35 39/48 88/87	[6]
Chitosan Schiff Base	J55	60	0.15	65	1	95.2	[7]
Synthesized Guar gum and methylmethacrylate	P110	60	0.4	50	-	90	[8]
Imidazoline-Based	X52	60	0.1	60	24	93	[9]
Gum arabic	N80	40	1.0	25 60	24	84.53 71.47	Present study

Table S3 Corrosion rate and inhibition efficiency obtained from weight loss measurements for the carbon steel (N80) carried out at 1.0 g L⁻¹ of GA and CO₂ partial pressures after 168 h of immersion time at 25 °C.

C _{inh} (g L ⁻¹)	Corrosion Rate (mm y ⁻¹)			IE (%)		
	1 bar	20 bar	40 bar	1 bar	20 bar	40 bar
Blank	1.88 ± 0.84	6.53 ± 0.81	11.59 ± 0.88	-	-	-
1.0	0.73 ± 0.13	1.86 ± 0.27	2.85 ± 0.55	61.41	71.53	75.41

Table S 4 XPS analysis of sample steel surface after 24 h of immersion in test solution at P_{CO₂} = 40 bar and at 25 °C in the presence of 1.0 g L⁻¹ of GA .

Peak Assignment	Gum arabic		Adsorbed gum arabic	
	Binding Energy (eV)	Atomic concentration (%)	Binding Energy (eV)	Atomic concentration (%)
O1s	-	33.6	-	42.9
O ²⁻	-	-	529.7	28.7
O-C	531.3	16.0	531.2	32.2
O-C-O/O=C	532.6	84.0	532.7	39.1
C1s	-	61.6	-	48.8
C-C/C-H	284.8	25.3	284.8	40.3
C=O/C-OH/C-N	286.3	54.7	286.3	38.5
O-C-O/N-C=O	288.0	20.0	287.9	21.2

Fe2p	-	-	-	4.9
Fe ³⁺ (Fe ₂ O ₃)	-	-	710.5	47.1
Sat	-	-	713.0	15.2
Fe2p _{1/2}	-	-	719.0	14.9
N1s	-	4.8	-	22.8
N-C	400.00	100	399.8	2.4
N-Fe	-	-	397.6	71.5
				28.5

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