Unalloyed cast iron

Like unalloyed steel, cast iron is attacked by phosphoric acid [2, 5, 6, 8, 12–15, 18, 26, 36, 37]. The corrosion rates exceed 1.27 mm/a (50 mpy) in aerated and non-aerated acid at room temperature at all concentrations [8].

The corrosion rate at room temperature in 3.34 % phosphoric acid is 0.6 mm/a (23.6 mpy) [26]. In spite of this higher corrosion rate, cast iron is said to have better behavior in phosphoric acid than steel (0.1–0.5 mm/a (3.94–19.7 mpy)) [26].

The corrosion behavior of cast iron is comparable to that of unalloyed steel (see Section Unalloyed steels and cast steel).

Like unalloyed steel, cast iron is also the anode in combination with Ms 60 (CuZn40, CW509L) in phosphoric acid as the corrosion medium. It corrodes faster than brass. Table 3 contains the corresponding corrosion rates [36, 38]. As can be seen from this table, the increase in corrosion in combination with brass is considerable.

H_3PO_4 concentration mol/l	Cast iron	Cast iron in contact with Ms 60
	Corrosion rate, mm/a (mpy)	
0.32	5.4 (213)	11.3 (445)
0.63	13.8 (543)	20.0 (787)
0.93	19.2 (756)	25.0 (984)

Table 3: Corrosion behavior of cast iron (2.96 % C, 2.05 % Si, 1.01 % P, 0.11 % S, 0.41 % Mn, balance Fe) in phosphoric acid and in a conductive combination with Ms 60 (CuZn40, CW509L) at 298 K (25 °C) test duration 6 d [36, 38]

According to [38], corrosion of cast iron is reduced after relatively severe initial corrosion in phosphoric acid as a consequence of the formation of a deposit. After 14 days, the cast iron achieved only 10 % of its initial corrosion rate in phosphoric acid. The studies were carried out in 500 ml acid at 298 K (25 °C). The weight loss measurements were made daily. The same acid was used. It was renewed only in cases where the removal of material was too great. These cases were not identified in the work. Additions of other acids, such as sulfuric acid and hydrochloric acid, increase the corrosion rates [36, 38].

The effect of inhibitors on the corrosion behavior of cast iron in phosphoric acid at 298 K (25 °C) can be seen from Table 4.

Phosphoric acid is the only mineral acid which is capable of forming a surface film on iron and cast iron even in dilute acid solution. In comparison with hydrochloric acid or sulfuric acid, it is considerably more weakly dissociated. Because of this weak dissociation of phosphoric acid, it is even possible, by addition of Na_2HPO_4 alone, to suppress the dissociation of phosphoric acid still further, to reduce the dissolving capacity of the acid and to improve the film formation. These processes are represented in a graph for 0.63 mol/l H_3PO_4 according to Table 4 in Figure 1.

H_3PO_4 mol/l	Addition	Inhibition efficiency, %				
		After 1 d	3 d	5 d	7 d	14 d
0.32	+ 2 % gelatine	51	47	45	− 2	− 2
0.32	+ 5 % Na_2HPO_4	40	51	52	23	23
0.32	+ 2 % gelatine + 5 % Na_2HPO_4	51	63	69	40	52
0.63	+ 2 % gelatine	41	28	21	4	− 3
0.63	+ 2 % Na_2HPO_4	12	23	25	11	8
0.63	+ 2 % gelatine + 5 % Na_2HPO_4	53	52	55	41	30
0.93	+ 2 % gelatine	31	28	33	3	− 1
0.93	+ 5 % Na_2HPO_4	4	16	25	7	8
0.93	+ 2 % gelatine + 5 % Na_2HPO_4	51	40	41	22	16

Table 4: Effect of inhibitors on the corrosion resistance of cast iron (see Table 3) in phosphoric acid solutions at 298 K (25 °C) [36, 38]

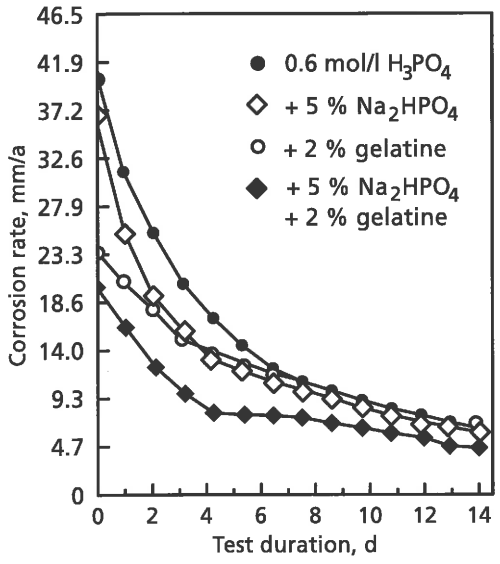

Figure 1: Influence of additions on the corrosion behavior of cast iron in 0.6 mol/l H_3PO_4 at 298 K (25 °C) (see Table 4) [36]
* calculated from g/m² d