

# Operational Considerations for Dissolving Iron Carbonate with Paratene<sup>®</sup> M390

## REACTIONS AND THEORY

Iron Carbonate or Siderite is a common corrosion by-product seen in systems with high partial pressures of Carbon dioxide. Chemically siderite is  $\text{FeCO}_3$  and is a hard crystalline mineral. The reactions of Siderite with acid are almost identical to the reactions of the more common calcium carbonate with acid.

- 1)  $\text{FeCO}_3 + 2\text{H}^+ \leftrightarrow \text{Fe}^{2+} + \text{H}_2\text{CO}_3$
- 2)  $\text{H}_2\text{CO}_3 \leftrightarrow \text{H}_2\text{O} + \text{CO}_2$

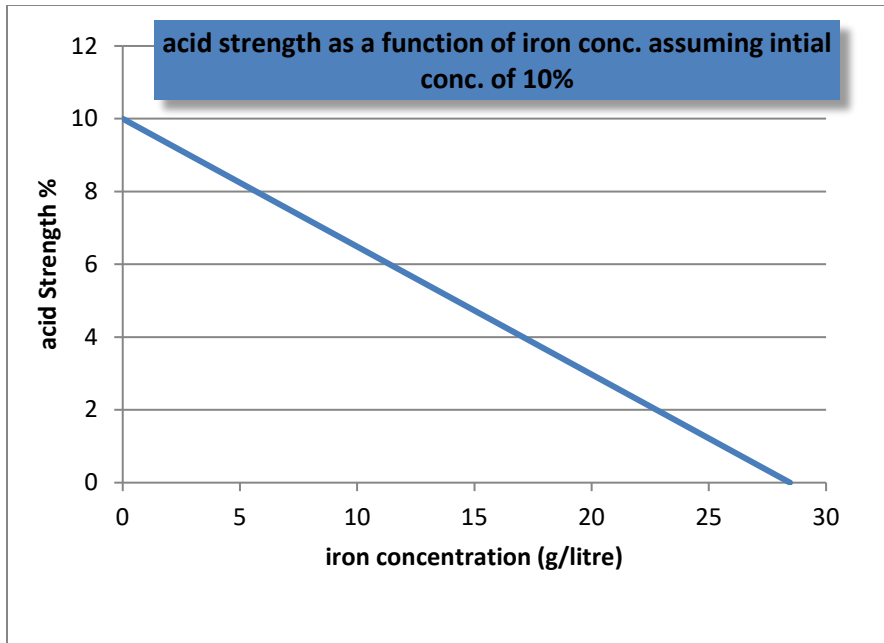
Normally the presence of a gas in the ultrasonic tank is a problem. Ultrasonic cavitation requires that the dissolve gasses be removed. In this case the reaction generates gas. The high frequency waves cause the  $\text{CO}_2$  released by the reaction to be driven rapidly from the solution. This shifts the equilibrium of reaction 2 reducing the amount of carbonic acid in the solution and further driving the reaction 1 to the right. As a result the presence of the ultrasonic has very low effect from cavitation on the deposit surface but by removing the gas causes the acid to react much faster.

## CALCULATIONS

Two moles of acid are required for every mole of iron carbonate dissolved.

Substance	Molecular Weight
MSA (active ingredient in M390)	98.11 g/mole
Siderite ( $\text{FeCO}_3$ )	115.86 g/mol

As 2 moles of acid are need per mole of  $\text{FeCO}_3$  the ratio of acid to scale is  $2 \times 98.11 / 115.86 = 1.69$  kg of acid per kg of scale



When used in an ultrasonic cleaning tank with a volume of 35000 litres a 10% by weight solution of MSA (or 25% solution of Paratene® M390) has a capacity of dissolving 2065 kg of  $\text{FeCO}_3$

## MEASUREMENTS

As can be seen above there is a linear relationship between the decrease in acid concentration and the increase in the iron concentration. A simple acid base titration cannot be used because of interference by the iron in the titration. The addition of  $\text{OH}^-$  to the solution will cause the precipitation of  $\text{Fe}(\text{OH})_2$ , giving an apparent acid strength far higher than that which can be calculated by the iron count.

The solution must be monitored by measuring total iron, then calculating the residual acid concentration. If there is more than 2000 kg of deposit additional acid can be added until the total iron concentration approaches 100 g/litre. (no ferric iron is expected because of the nature of ultrasonic cleaning). At this point if the equipment is not clean the solution should be replaced with fresh acid.