

Different Types of Corrosion

- Recognition, Mechanisms & Prevention

Flow-Accelerated Corrosion (FAC)

Recognition of Flow-Accelerated Corrosion

What is Flow-Accelerated Corrosion (FAC)?

Flow-Accelerated Corrosion (FAC) refers to the combined actions involving the removal of magnetite (Fe_3O_4) layer by fluid flow and the subsequent increased corrosion of the exposed metal, leading to wall thinning (metal loss) to the extent of perforation. Susceptible components include carbon steel and low alloy steel piping, tubing and vessels exposed to flowing water (single-phase) or wet steam (two-phase), particularly at bends/elbows, Tees, orifices, downstream of distributors and valves, and any location where turbulent flow exists.

Figure 1a FAC at pipe elbow



Mechanisms of Flow-Accelerated Corrosion

What causes Flow-Accelerated Corrosion?

The mechanical effect of fluid flow or velocity of a fluid combined with the corrosive action of the fluid causes accelerated loss of metal. The initial stage involves the mechanical removal of a metal's protective film (magnetite Fe_3O_4) and then corrosion of bare metal by a flowing corrosive occurs. The process is cyclic until perforation of the component occurs.

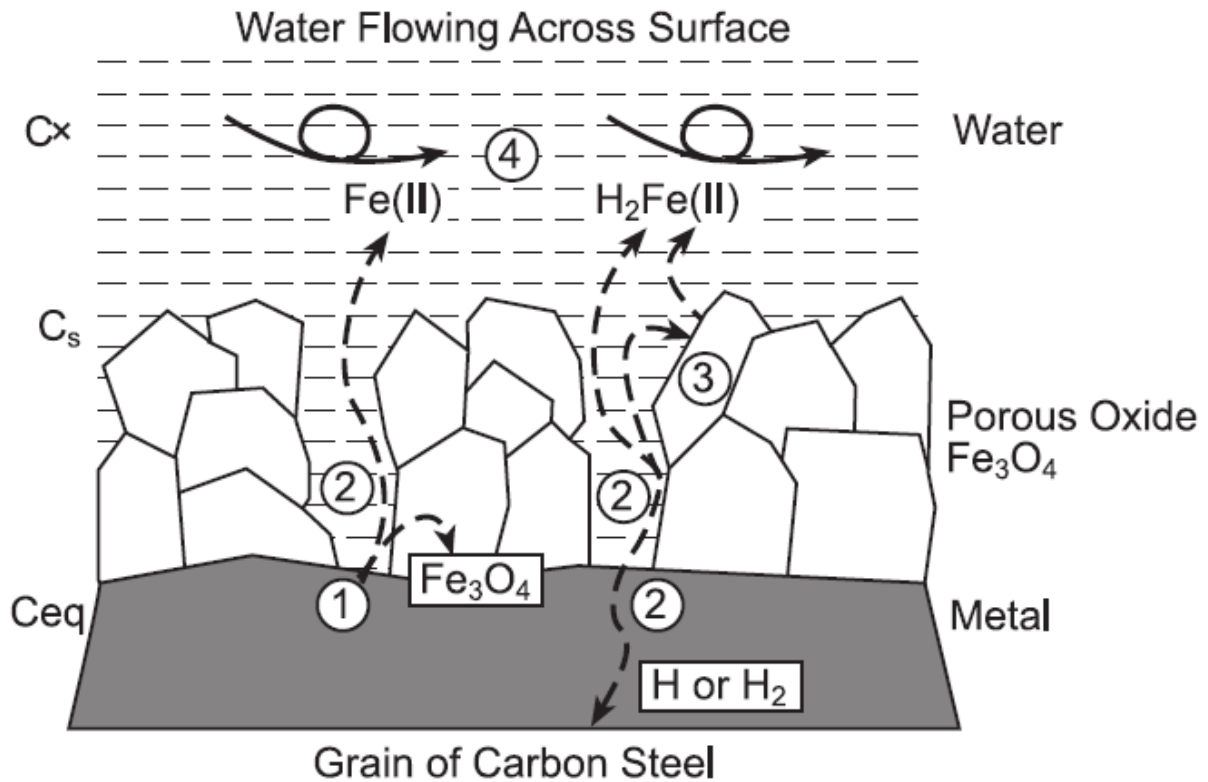


Figure 1b Mechanisms of Flow-Accelerated Corrosion

Flow-accelerated corrosion is usually found at high flow rates around pipe/tube blockages, tube inlet ends, or in pump impellers. The photo above shows flow-accelerated corrosion of pipe elbow in a wet steam line due to excessively high flow rate of the wet steam.

What are the Factors Influencing FAC?

(a) Metallurgy: Cr%, Mo%, Cu%, C% content in carbon steels and alloy steels

The metallurgy determines the component's resistance to FAC. Some steel metallurgies are inherently not resistant to FAC while other steel metallurgies are highly resistant to FAC. [FAC-Compass](#) (Figure 3 below) computes the FAC resistance index, R, based on the specified steel metallurgy.

(b) Fluid Chemistry: Temperature, pH, Oxygen, Steam Quality

(c) Flow Pattern (Geometry): Bends/Elbows, Tees, Orifices, Distributors, Turbulence

[FAC-Compass](#), the FAC modeling and prediction software, takes account of the above influencing factors in FAC modeling and prediction. The outputs from [FAC-Compass](#) include the metallurgy's FAC resistance index, the FAC rate in mm/y, the remaining life of the component, and plots of the FAC rate as a function of temperature, pH, oxygen, (Cr+Mo)%, and velocity (Figure 3).

What is the difference between Erosion Corrosion and Flow-Accelerated Corrosion?

In the corrosion literature, erosion corrosion and flow-accelerated corrosion have been frequently used interchangeably. There does not exist a well-defined boundary between the two. Some argue that there is a subtle difference between Erosion Corrosion and Flow-Accelerated Corrosion. In FAC, fluid flow removes

magnetite (Fe_3O_4) layer, exposing steel to corrosion, leading to wall thinning. There is no or thinner magnetite on surface at FAC location due to the flow effect than at locations not subjected to FAC. Figure 2a below shows that the magnetite layer on the tube ID surface was completely removed by high velocity wet steam while Figure 2b shows classic erosion corrosion pattern on the magnetite covered tube ID.

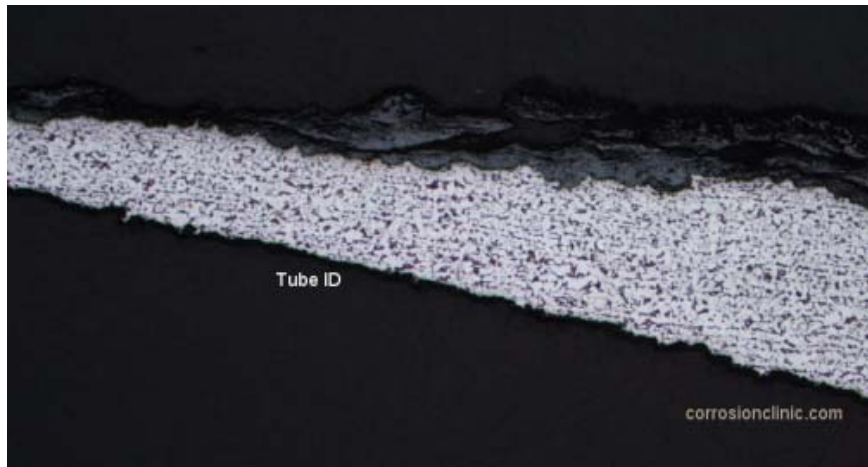


Figure 2a Flow-Accelerated Corrosion showing complete removal of magnetite layer on tube ID surface by high velocity wet steam



Figure 2b Erosion Corrosion showing classic pattern of erosion corrosion on the magnetite-covered tube ID surface

FAC Modeling, Prediction and Prevention

[How to prevent Flow-Accelerated Corrosion?](#) Flow-accelerated corrosion can be prevented through:

- streamline the piping to reduce turbulence
- control fluid velocity
- using more resistant materials

Flow-accelerated corrosion and the remaining life of components can be predicted with software such as FAC-Compass. [FAC-Compass](#) is a powerful software tool for Erosion Corrosion/Flow-Accelerated Corrosion Modeling, Life Prediction and Materials Selection in Water-Steam Systems. Click [this link](#) for details on the features and functions of the latest version of FAC-Compass for predictive modeling and remaining life prediction.

FAC

Geometry

FAC-Compass®: Flow-Accelerated Corrosion Modeling, Life Prediction & Materials Selection

Component ID		Elbow in steam line to Cell #6				
Component Age	year	3.000	Steel Grade	SA105		
Wall Thickness	mm	6.000	Steel Density	kg/cm ³	7.870	
Fluid Chemistry and Flow Pattern			Component Metallurgy and FAC Resistance			
Phase of Flow	Wet Steam		C %	0.170	Cr Equivalent	0.030
Mass Flux	kg/m ² .s	2000.000	Cu %	0.020	FAC Index: R _k	0.767
Steam Quality	% dry	95.00	Cr %	0.050	This metallurgy is not resistant to FAC.	
Temperature	°C	170.00	Mo %	0.010		
			Predicted FAC Rate and Remaining Life			
pH	at 25°C	9.00	FAC Rate, mm/y	0.832	Remaining Life, yr	4.214
Oxygen Content	µg/kg	15				
Flow Pattern (Geometry Tab)	A to P	Default	Plot Option	FAC Rate (mm/y) vs ToC		

Temperature (°C)	FAC Rate (mm/y)
50	0.100
100	0.500
150	0.900
200	0.500
250	0.100
300	0.050
350	0.020

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Figure 3 Overview of FAC-Compass for FAC Modeling and Prediction

For more details on Flow-Accelerated Corrosion (FAC)

More details on Erosion Corrosion and FAC are included in the following corrosion courses which you can take as in-house training courses, course-on-demand, online courses or distance learning courses:

A Basic Course in Corrosion Control and Its Prevention (5 days)

Corrosion, Metallurgy, Failure Analysis and Prevention (5 days)

Marine Corrosion, Causes and Prevention (2 days)

Materials Selection and Corrosion (5 days)

Stainless Steels and Alloys: Why They Resist Corrosion and How They Fail (2 days)

If you require corrosion expert witness or corrosion consulting service on flow-accelerated corrosion, our NACE certified Corrosion Specialist is able to help. Contact us for a quote.