



Veolia Water Technologies & Solutions

Corrosion In Cooling Water - Lisa Sweeney

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Veolia WTS Overview



Veolia Group Global Overview

Historically French, naturally European and operationally international, Veolia can **support you anywhere in the world**. In the forefront of ecological transformation, we are committed to the regions, where we contribute to their economic dynamism and attractiveness.



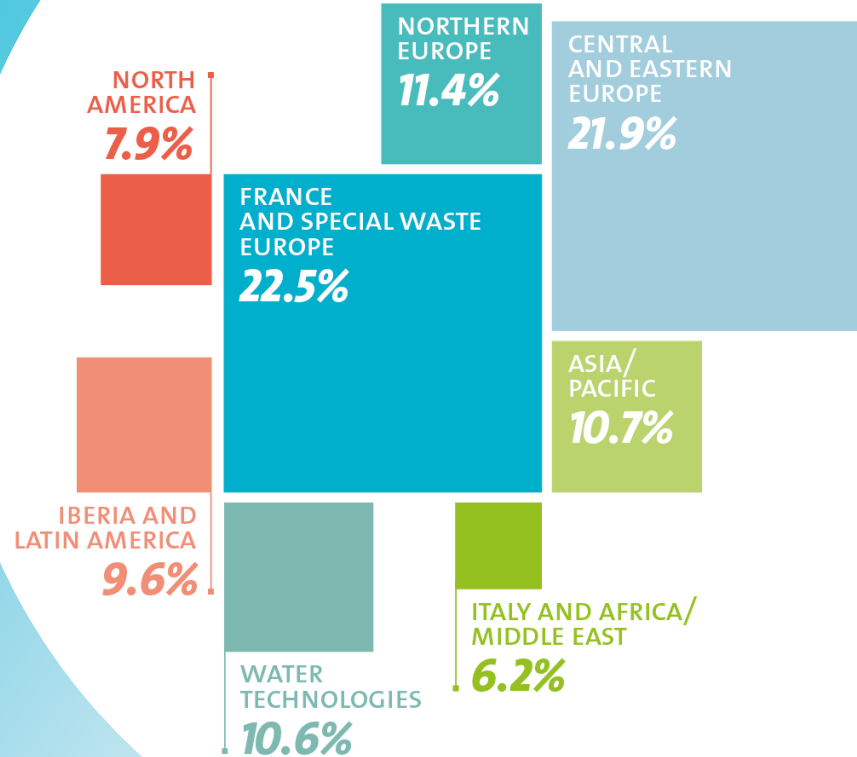
Close to
220,000
employees worldwide



58
countries⁽¹⁾



€42.9 bn
revenue



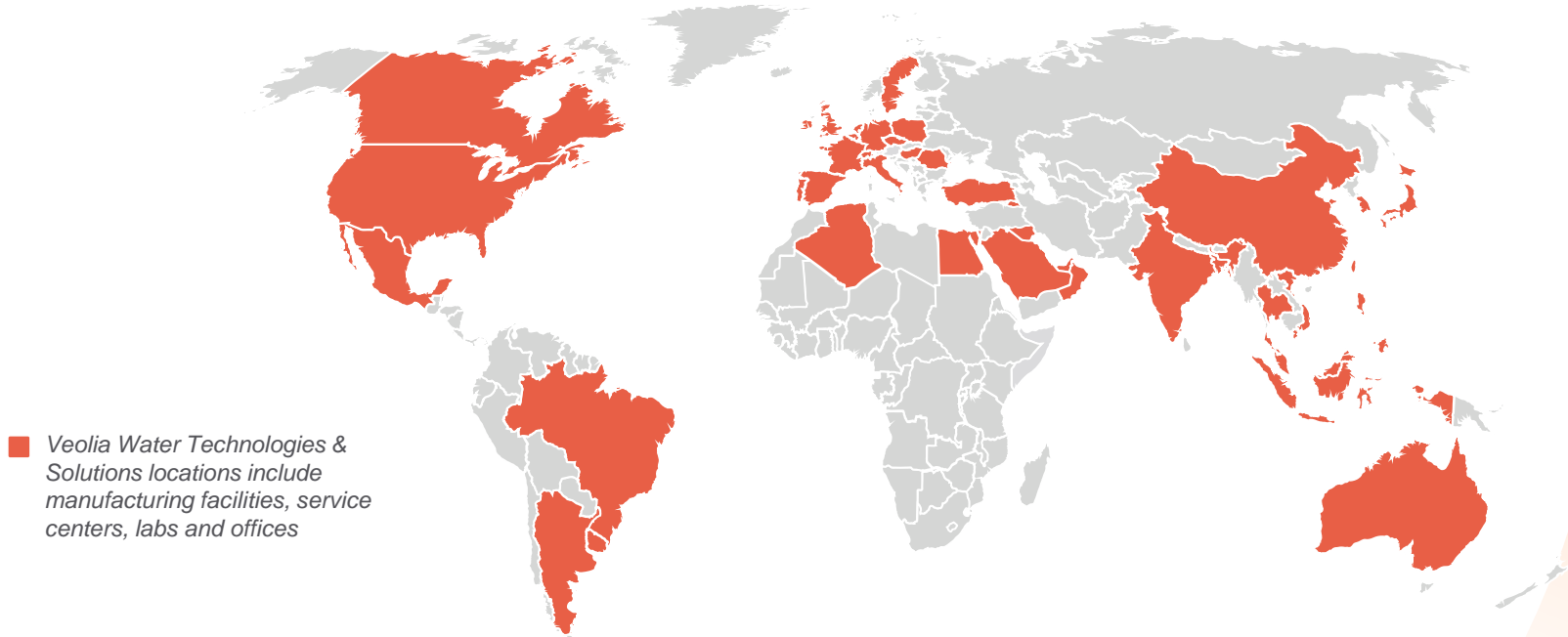
Veolia Water Technologies & Solutions

We partner with you to meet the needs of your industry, your region, and your business.

With industry-leading water technology and process expertise, we build optimized solutions for lasting success.



Drawing on Global Expertise & Infrastructure



Proven Experience, Offerings, & Results



10,000+
Employees

50,000+
Industrial and municipal
customers served worldwide

10,000+
Combined technologies

11.4 million m³
of water treated every day

Driving Results with a Comprehensive Portfolio of Advanced Solutions

Backed by digitally- enabled technologies & services



Industrial water treatment



Industrial process enhancement



Wastewater treatment



Zero liquid discharge



Ultrapure water



Tough to treat water



Desalination



Waste to energy



Water & process treatment chemistry



Monitoring & automation



Membrane separation tech



Thermal separation tech



Disinfection technologies



Anaerobic digestion



High-precision instruments






Mobile & outsourced water

Our 2 Main Businesses: CMS and ES

CMS - Chemical & Monitoring Solutions

Integrated solutions for chemical treatment utilities, hydrocarbon processing facilities and industrial applications.

Water Treatment Chemicals	Chemical treatments for Oil & Gas processes	Chemical treatments for industrial processes
		
<p>Advanced chemicals for the treatment of cooling circuits, waste water, boilers, membrane technologies for all industries</p>	<p>Integrated solutions for oil and gas refining and production</p>	<p>Services for dust control, fuel treatment and scaling control</p>

ES - Engineered Systems

Equipment and technology solutions for water and effluent treatment, water recycling and outsourcing.

Services	Projects	Analytical Instruments	Products
			
<p>Outsourcing of water treatment and mobile solutions. One-time and long-term service contracts.</p>	<p>Technologies, products and expertise in process engineering</p>	<p>Products and services for monitoring total organic carbon for the pharmaceutical industry, water and wastewater</p>	<p>Filters, membranes, reverse osmosis, electro-separation technologies</p>

CMS IN EMEA

Sustainable solutions to:

- *Optimize resources*
- *Protect assets and extend their lifespan*
- *Enhance profitability*
- *Protect the planet*

A Unique Integrated Offering

Technical Solutions & Services



Water Chemistry

Boiler
Cooling
Wastewater
Membrane
Dust control



Process Chemistry

Corrosion inhibitors
Emulsion breakers
H₂S scavengers
Fuel additives
Antiscalants



On-Site Services

Commissioning
Mobile water
Advisory
Outsourcing



Equipment Solutions

Water
Wastewater
Desalters
Evaporators
Analyzers

Complete solutions to design, build, & operate at existing and new production facilities

Enhanced & Proven



Digital Tools

Analytics
InSight*
TrueSense*
COMS



Innovation

In-house R&D
Industry partners
Training



References

Global customers
Remote support
Local service & support

Proven Experience, Offerings, & Results



800+

Employees in Europe,
Middle East and Africa

70%

Employees in the field
supporting customers

3

Chemical manufacturing sites

1

Analytical service lab

Our Locations in EMEA

EMEA Headquarters

- Heverlee, Belgium

R&D Analytical Testing & Service Lab

- Heverlee, Belgium

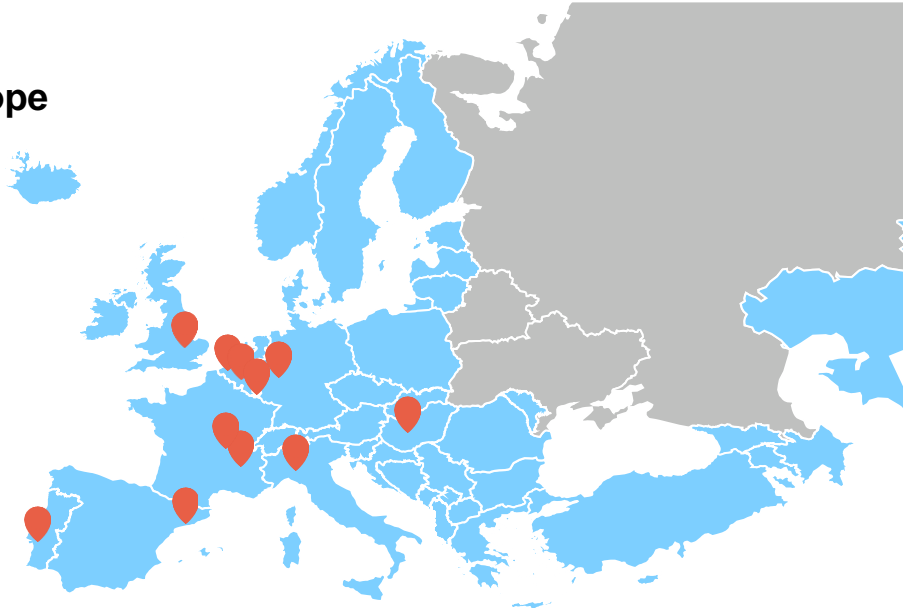
Main CMS Offices

- Heverlee, Belgium
- Herentals, Belgium
- Herstal, Belgium
- Lyon, France
- Chalon, France
- Ratingen, Germany
- Budapest, Hungary
- Milan, Italy
- Lisbon, Portugal
- Barcelona, Spain
- Dubai, UAE
- Peterborough, UK

Chemical Manufacturing Facilities

- Herentals, Belgium
- Chalon, France
- Dubai, UAE

Europe



Middle East – North Africa



CMS EMEA Solutions Portfolio

CHEMICAL TREATMENTS



BOILER

Boiler, Steam & Condensate
HP & LP Systems



HPI / CPI PROCESS

Separation, Corrosion,
Fouling, Additives &
Scavengers, Amine



COOLING

Open Evaporative &
Closed Cooling Systems



INDUSTRIAL PROCESS

Dust control, Metals Process
& Scaling, Fuel, Oil Removal



MEMBRANES

On-line / Off-line and
Clean in Place



FOOD & BEVERAGE

Pasteurising, Biological, pH
control



WATER & WASTEWATER

Clarification, Filtration, Biological,
Odour, Foam

TECHNOLOGY



MONITORING

InSight*, Remote
Diagnostics, Analytics,
Data Capture



CONTROL

On-line analysis, Dose
rate control, optimization



INTEGRATED

Combined Engineered
Water & Chemical Offer

SERVICES



TECHNICAL

Technology CoE,
Laboratory Services



LEGIONELLA

Management Services
& Compliance



ON-SITE SERVICE

Audits, Surveys,
Trials, Cleanings

Solving Customer Problems With Integrated Applications across Industries



POWER

Gas, Nuclear, EfW, Biomass



MINING

Gold, Iron, Lithium



PRIMARY METALS

Steel, Aluminium, Minerals



MICROELECTRONICS



FOOD & BEVERAGE

Biofuels & Ethanol
Beverage Processing
Food Processing
Dairy Processing
Brewing



CHEMICAL PROCESSING

Ethylene
Styrene
Ammonia/Urea



OIL & GAS

Refining
Upstream
Heavy Oil
Midstream



COMMERCIAL & INSTITUTIONAL

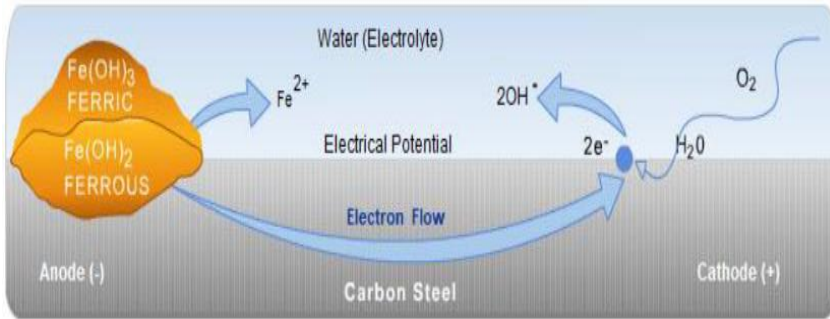
Offices
Data Centers
District Energy

Cooling Water Corrosion Overview

Corrosion Overview

How Corrosion Occurs

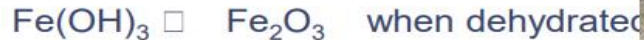
Attack on the metal surface by means of an electrochemical reaction with its environment.



Corrosion Overview

Anode

- is the place where corrosion occur – loss of metal
- typical anodic oxidation reaction;



Corrosion Overview

Cathode

- is the place where electrons are accepted
- typical cathodic reaction is (in neutral or alkaline media):



- hydroxide production **creates localized high pH**, approximately 1 – 2 pH units above bulk water pH
- corrosion rate is controlled by oxygen diffusion

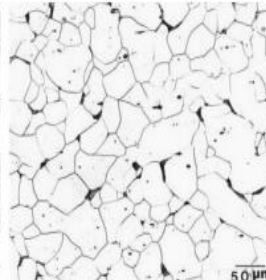
Corrosion Overview

Why Anodic And Cathodic Sites Form?

- impurities in the metal
- localized stress
- grain size or composition difference
- discontinuities on the surface
- differences in local environments, (temperatures, oxygen, salt concentration)



ASME SA213-T22, Steel for Boiler Tubes

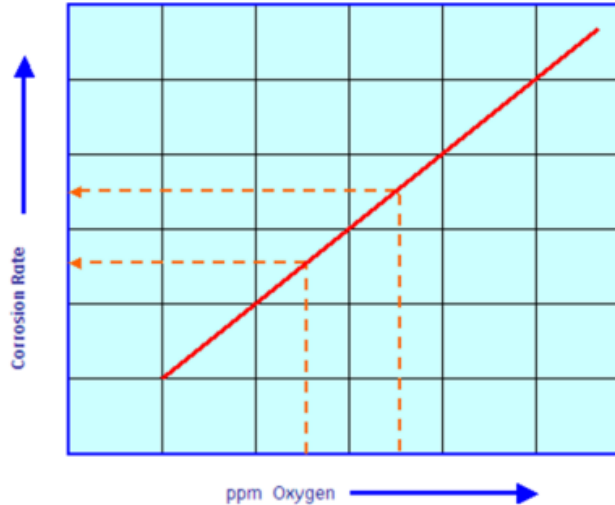


Low-carbon AISI/SAE 1010 Steel

Corrosion Overview

Factors Affecting Corrosion

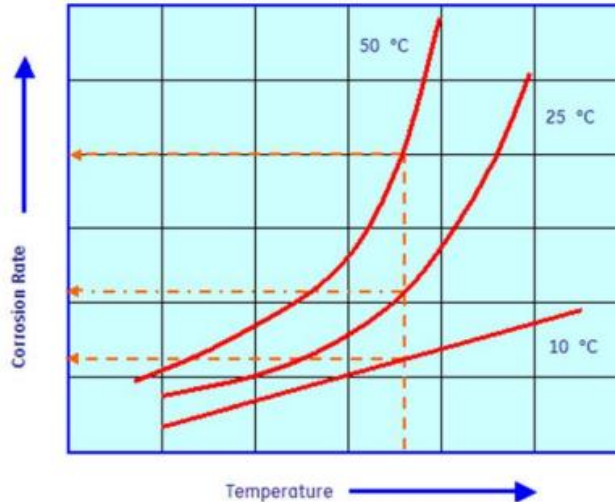
- OXYGEN
- main driving force for corrosion
- corrosion rate is limited by the rate of oxygen diffusion to the unoxidized metal surface



Corrosion Overview

Factors Affecting Corrosion

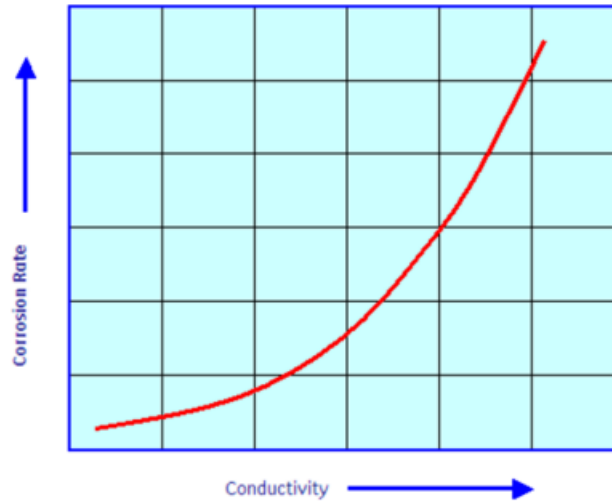
- TEMPERATURE
- corrosion rate approximately double for every 10 °C rise in temperature
- temperatures increases water hydrolysis
- affects solubility of gasses



Corrosion Overview

Factors Affecting Corrosion

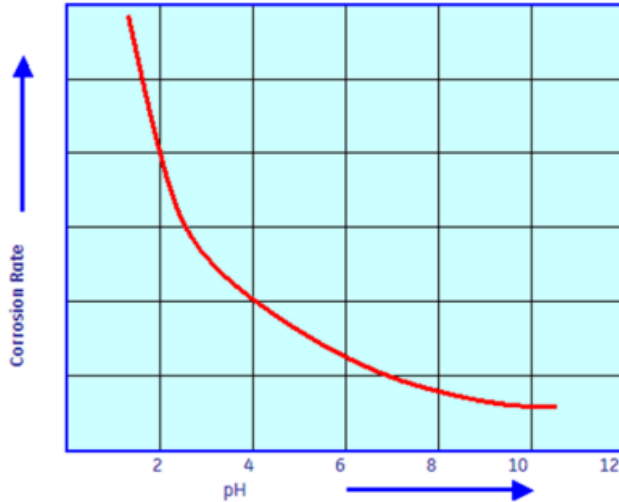
- CONDUCTIVITY
- anions like chloride and sulphate has most impact on steel corrosion
- lowers electrolyte resistance



Corrosion Overview

Factors Affecting Corrosion

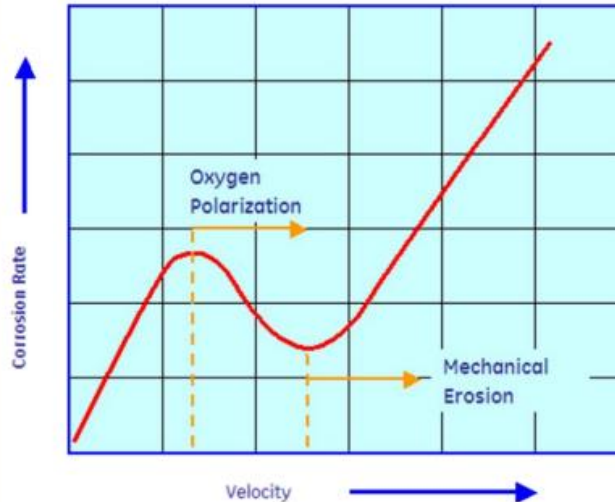
- pH
- at pH < 4 the corrosion rate of steel increase rapidly
- between 4 – 10 pH, oxygen reduction is predominant
- at pH > 10, formation of passive iron oxide film



Corrosion Overview

Factors Affecting Corrosion

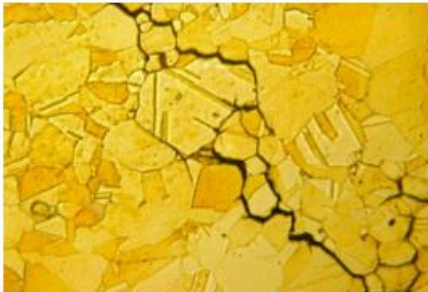
- VELOCITY
- increasing velocity increases the mass transport of O_2
- at sufficient high velocity, enough oxygen may reach the surface to cause partial passivation and the corrosion rate decrease slightly



Corrosion Overview

Factors Affecting Corrosion

- AMMONIA
- has relatively little effect on steel corrosion
- has ability to complex copper – can cause general corrosive attack and stress corrosion cracking



- HYDROGEN SULPHIDE
- sour water will corrode steel and copper alloys forming insoluble sulphide deposits
- H₂S increase potential for hydrogen damage including hydrogen cracking and blistering



Corrosion Overview

Factors Affecting Corrosion

- HYDROCARBONS
- can cause oily deposits on metal surface which affect oxygen reduction at the cathode
- this can cause the formation of an oxygen differential cell – resulting in under deposit attack.

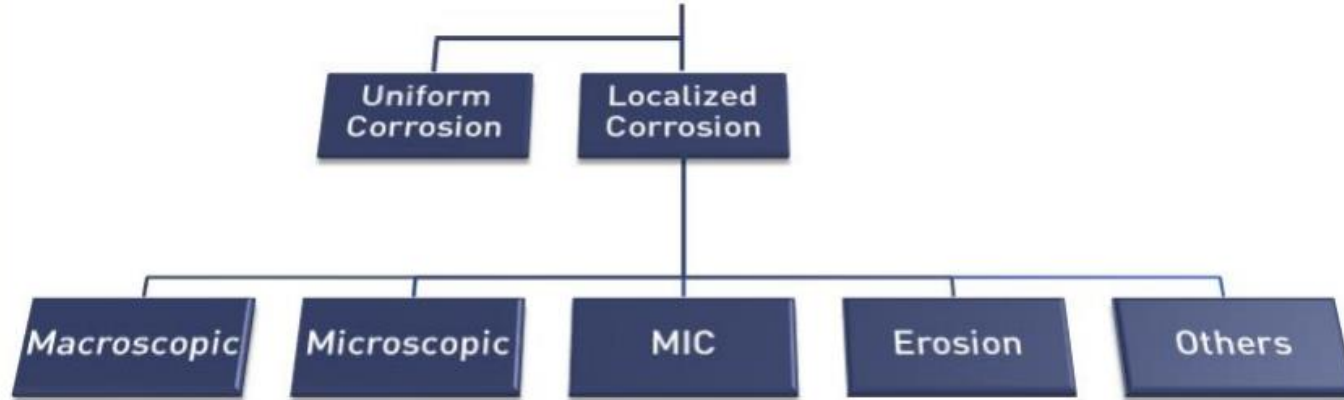


- COPPER
- soluble copper can impact steel corrosion if the copper is plated out on the steel – galvanic corrosion



Corrosion Overview

Types of Corrosion



Corrosion Overview

What Is The Result of Corrosion?

- Destruction of costly equipment
- Failure of equipment
- Cost of the replacement and plant downtime
- Decreased plant efficiency
- Loss of heat transfer – accumulation of corrosion products



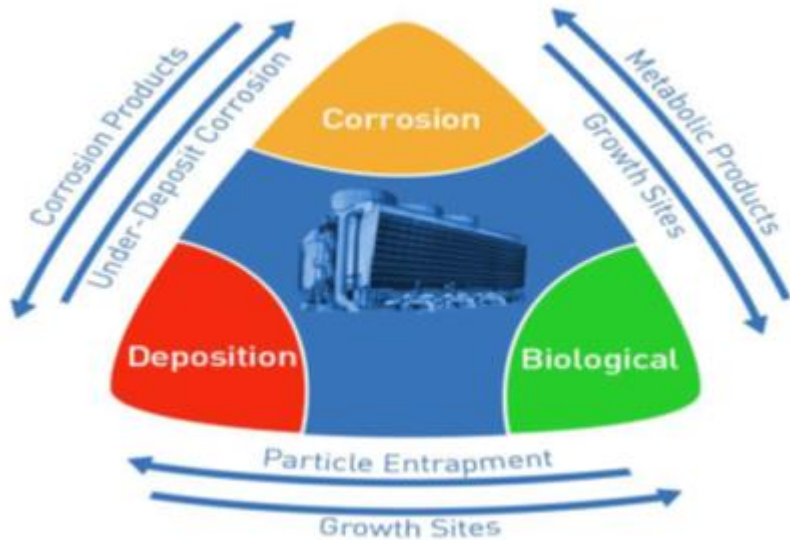
Mitigation of Corrosion

Corrosion Mitigation & Control

Ways To Retard And Control Corrosion

- Design and fabrications considerations
- Deaeration
- Metallurgy
- Protective coatings
- Sacrificial anodes / Cathodic protection
- Chemical Treatment
 - pH adjustment
 - Corrosion Inhibitors

Corrosion Mitigation & Control



Ineos KG Cooling Microbiological Corrosion

Ineos KG Cooling MIC

Microbiological Corrosion

Caused by metabolic activity of microorganisms.

- SRB
- Iron and Manganese Bacteria
- Slime Formers - bacteria/fungi/algae

These types of Microbiological life can excrete acids, which can lower the pH of the water, where corrosion is occurring and accelerate it.



Ineos KG Cooling MIC

Background

- During the TAR 2019, a number of HEX were fouled with suspected Microbiological Fouling/Induced Corrosion
- This initiated an investigation with INEOS and Veolia.



Ineos KG Cooling MIC

Investigation Steps

- Deposit Analysis Performed
- Review of Cooling Water Analysis
- Review of the chemical treatment plan



Ineos KG Cooling MIC

Mitigation and Monitoring

- Re-started the Bio-Dispersant Chemical on a trial basis
- Measured Microbiological Activity by using ATP method and off site analysis



Thank You!

