KLINGER United Kingdom

# CORROSION CONTROL STRATEGIES AND BEST PRACTICES

# Abstract:

Corrosion can lead to downtime, safety concerns, and increased costs. This white paper explores the fundamental principles, challenges, and best practices associated with corrosion control and explores the innovative solutions offered by KLINGER to address flange face corrosion, reduce downtime, and enhance operational efficiency. We introduce reactive gasket solutions, reactive machining services, and proactive solutions like the KLINGER Maxiflex Pro-X Gasket, demonstrating how these technologies contribute to corrosion control and improved asset integrity.

# 1. Introduction: The Costly Consequences of Corrosion

Corrosion is a pervasive issue that affects industries such as oil and gas, manufacturing, infrastructure, and transportation. The consequences of corrosion include:

**1.1 Safety Hazards:** Weakened structures, pipelines, and equipment can lead to accidents and pose safety risks to personnel and the environment.

**1.2 Financial Impact:** Corrosion-related maintenance, repairs, and asset replacements cost industries billions of dollars annually.

**1.3 Environmental Impact:** Leaks and spills resulting from corroded infrastructure can harm ecosystems and natural resources.

**1.4 Operational Disruption:** Downtime for maintenance and repairs can disrupt production schedules and impact profitability.

# 2. Understanding Corrosion Mechanisms

Corrosion occurs through various mechanisms, including:

**2.1. Uniform Corrosion:** A general and even loss of material from a surface due to chemical reactions with the environment. Protecting against uniform corrosion often involves the use of coatings and inhibitors.

**2.2. Pitting Corrosion:** Localised corrosion characterised by small pits or holes on a material's surface. Pitting can be particularly insidious as it can lead to rapid material failure.

**2.3. Galvanic Corrosion:** This occurs when dissimilar metals are in contact with the presence of an electrolyte, leading to corrosion of the less noble metal.

**2.4. Crevice Corrosion:** This happens in confined spaces or crevices where oxygen levels are low, accelerating localised corrosion.

**2.5. Stress Corrosion Cracking:** Corrosion that is caused by a combination of tensile stress and a corrosive environment, often leading to brittle fractures.

# 3. Corrosion Control Measures

Effective corrosion control strategies involve proactive and preventive measures to mitigate the impact of corrosion:

**3.1. Material Selection:** Choosing corrosion-resistant materials, coatings, and alloys appropriate for the specific environment and application. KLINGERS technical team can ensure you select the ideal gasket for any application.

**3.2. Protective Coatings**: Applying protective coatings such as paints, epoxy, or galvanisation to create a barrier between the material and the corrosive environment.

**3.3. Cathodic Protection:** Utilising sacrificial anodes or impressed current systems to prevent galvanic corrosion.

**3.4. Inhibitors:** Introducing chemicals that inhibit or slow down the corrosion reaction within the system.

**3.5. Design Considerations:** Designing structures and equipment with corrosion-resistant features, such as proper drainage, ventilation, and material compatibility.

**3.6. Regular Inspection and Maintenance**: Implementing routine inspection and maintenance schedules to detect and address corrosion issues early.

**3.7. Environmental Monitoring:** Monitoring environmental conditions such as humidity, temperature, and pH, which can impact corrosion rates.

# 4. Case Study: Successful Corrosion Control – UK Refinery

**Problem:**
Critical flanges on an HF plant were leaking during operation. The client was unsure of the root cause of the failures. The client had a 6-hour window to rectify the anomalies therefore Klinger offered a combined product and service solution that covered all eventualities.

**Solution:**
The KLINGER Safeguard gasket as well as flange facing machines were mobilised to the site as a contingency. On breaking containment, it was identified that the wrong gasket had been installed and the flange design was out of specification. Multiple flanges were re-machined and new gaskets were installed. The HF plant was restarted leak-free within the 6-hour window. Client response: **"KLINGER'S *engineering and the support leading up to and on the day provided a large element of confidence with a contingency of additional machining".***

# 5. KLINGER Solutions

### 5.1 KLINGER Safeguard Corrosion Control Gasket

The Safeguard Gasket, developed by KLINGER, is designed to seal corroded flanges, a prevalent issue, especially in offshore environments. Its key features include:

- Fire safe to API 6FB
- Continuous service up to 260°C
- Compatibility with RTJ, RF, mismatched RTJ to RF, and dissimilar metallurgy flange connection
- Applicability to sizes ranging from 1/2"-24" and pressure classes from 150-2500
- Utilisation of a fire-safe primary seal combined with structurally modified PTFE that conforms to pitting, with options for various metallurgies.

### 5.2 Galvanic Corrosion Solutions

Insulation Sets are specified in order to offer galvanic protection where two dissimilar flange materials are mated together. Preventing corrosion by removing the possibility of the systems acting as a galvanic cell.

The sets also facilitate cathodic protection by isolating protected piping systems and preventing the flow of electrostatic charges.

Both our C4430 and Shield insulation sets offer safe, high-integrity sealing solutions and the Shield offers API 6FB Fire Safe certification. All KLINGER insulation sets are supplied with insulating sleeves and washers.

# For Complex Corrosion Issues

### 5.3. Reactive Machining Solutions

KLINGER recognizes that machining flange faces is commonly the go-to solution when allowed. To address this, KLINGER Integrity Services provides a skilled machining team with considerable experience, a successful industry history, and advanced equipment to deliver quick, thorough, and safe on-site machining services.

Our capabilities include:

- Weld repair
- RTJ machining
- Hub re-machining
- Full exchanger machining service
- Pipe cutting and prepping
- Drilling and line boring
- Gantry milling


### 5.4. KLINGER Maxiflex Pro-X Gasket

The Maxiflex Pro-X Gasket provides a proactive approach to corrosion control. It is a standard spiral-wound-style gasket engineered to prevent the ingress of potentially corrosive media into the flange sealing area. Key features and benefits include:

- Fire safe to API 6FB
- Design compliant with ASME B16.20 2017
- Standard factors (M: 3, Y: 10,000)
- Standard construction: 316SS winding strip / MGM filler / 316L Kammprofile-type inner / PTFE facing, with options for alternative metallurgies.

By combining Mica and Graphite in the sealing element and incorporating a KammProfile-based inner ring faced with multi-directional PTFE, the Maxiflex Pro-X Gasket offers a secure, tight, and long-term solution for industries exposed to hydrocarbons and saltwater.

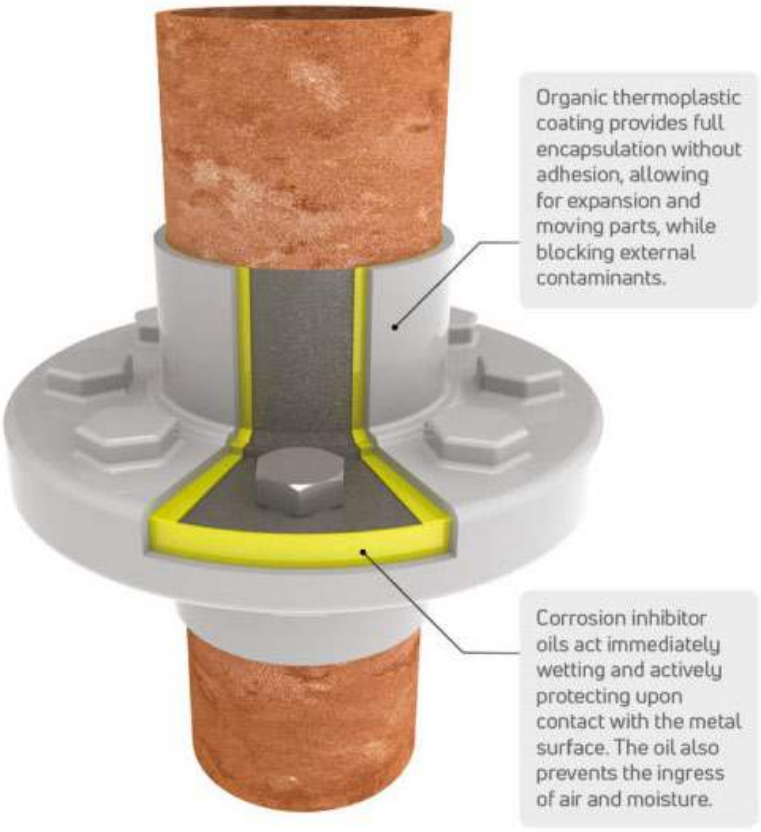
### 5.5 Active Anti-Corrosion & Contamination Coating – OXIFREE TM198

Oxifree TM198 is a thermoplastic coating for the protection of metal assets from corrosion and contamination, it offers:

- Savings to both operational and capital expenditure
- Reduces equipment and process downtime, which can be applied to live equipment
- Solves asset life extension challenges faced by the industry
- Easy inspection and maintenance without damaging substrate
- Minimal surface preparation is required, providing protection immediately
- Protects complex metal assemblies including those with moving parts
- Proven to withstand years of exposure in harsh environments
- Comprehensive solution for corrosion under pipe supports (CUPS)

Organic thermoplastic coating provides full encapsulation, blocking the ingress of contaminants, moisture, and oxygen**.** Corrosion inhibitor oils act immediately and actively protect when in contact with the metal surface.

Oxifree material has been thoroughly tested to 11,688 hours of “industry standard” Salt Spray test, which complies with ASTM B117 corrosion testing which is equivalent to in excess of 50 years ‘in the field’. Oxifree has also been through ASTM G56 UV/Weathering test and again exceeded the required longevity with ease.



# 6. Conclusion: Investing in Corrosion Control

In conclusion, corrosion control is a critical aspect of asset management and safety in various industries. Understanding corrosion mechanisms and implementing effective control measures can mitigate the adverse effects of corrosion, reduce operational disruptions, and protect personnel and the environment.

KLINGER offers a comprehensive range of corrosion control solutions for flange face integrity. From reactive gasket solutions to reactive machining services and proactive gasket technologies like the Maxiflex Pro-X Gasket, our offerings are designed to reduce downtime, enhance safety, and provide cost-effective solutions for combating corrosion-related challenges.

With a commitment to innovation and excellence, KLINGER is at the forefront of corrosion control in the industry, helping businesses maintain the integrity of their assets and optimize operational efficiency. Industries that invest in corrosion control not only extend the lifespan of their assets but also strengthen their bottom line through reduced maintenance costs and increased safety and reliability. By prioritising corrosion control as an integral part of their operations, industries can achieve long-term sustainability and resilience against the costly and detrimental effects of corrosion.