



GUIDE

An Engineer's Guide to Erosion

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Introduction

Erosion is one of the most persistent and destructive challenges engineers face across aerospace, energy, flow control and industrial manufacturing. It silently degrades surfaces and eventually leads to catastrophic failures if left unchecked. As industries push the boundaries of performance and sustainability, the need for advanced protection against erosion has never been greater.

This guide explores the mechanisms of erosion, why traditional coatings fall short, and how Hardide's innovative CVD tungsten carbide coatings are redefining protection in harsh environments.



Shift towards a sustainable industrial future

Leading the way in the field of sustainable metal coatings, Hardide have developed pioneering CVD tungsten carbide coatings that tackle environmental challenges directly. Our REACH-compliant coatings are free from harmful substances like hexavalent chromium and offer exceptional resistance to wear, corrosion, and erosion.

[Learn more](#)

What engineers need to know about erosion

Erosion is the progressive loss of material due to mechanical interaction between a surface and impinging particles or fluid droplets. It typically manifests in three core forms:

Solid particle erosion:

Caused by abrasive particles in gas or liquid streams bombarding surfaces at speed.

Water droplet erosion (WDE):

Caused by high-speed droplets or particles, this form of erosion attacks turbine and compressor blades, degrading their sharp profiles and reducing aerodynamic efficiency.

Cavitation erosion:

Pressure variations form and collapse vapour bubbles that violently impact surfaces.

Unlike wear, erosion does not require contact with another surface. Instead, the attacking media (sand, slurry, or water) has enough energy to erode even the hardest materials over time. Components at greatest risk include turbine blades, valve seats, pump impellers, actuators and pipe internals, leading to different types of wear and failure.

Seal failure:

Eroded shaft surfaces roughen over time, destroying elastomeric seals and causing leakage.

Leading edge erosion:

Caused by high-speed droplets or particles, this form of erosion attacks turbine and compressor blades, degrading their sharp profiles and reducing aerodynamic efficiency.

Valve erosion:

Fast-moving, abrasive media erodes valve seats, cages and internals, compromising sealing integrity and causing control failures in critical flow systems.

Pump erosion:

Cavitation and entrained solids erode impellers, volutes and internal surfaces from within, severely affecting flow performance and reliability.

The impact of erosion on components

Erosion may start at the surface, but its impact quickly penetrates deep into component performance and reliability. Without the proper protections in place, it can reduce the efficiency of components as well as increase the frequency of maintenance and operational downtime. All of these factors lead to increases in costs and inconveniences, highlighting the importance of proper protective coatings and solutions.

Why traditional metal coatings fall short when it comes to erosion

Despite the widespread use of hard coatings to combat erosion, many traditional technologies fall short when exposed to the complex, high-stress environments faced in many industries.



Hard Chrome Plating (HCP)

It may have been widely used, but hard chrome plating is slowly being replaced by alternatives. This is for two reasons. Firstly, the coatings contain a network of micro-cracks that act as entry points for erosion and corrosion. Under load, these cracks grow, leading to early failure. Secondly, its use of toxic hexavalent chromium puts it under growing regulatory pressure, making it less viable for future applications as more companies are switching to safer alternatives.



Thermal spray coatings (HVOF)

HVOF coatings offer passable hardness but struggle with internal surfaces and complex geometries due to their line-of-sight application. Over time, their cobalt binders degrade, exposing sharp WC particles that damage seals and accelerate wear. This is a problem engineers often refer to as the "cheese-grater effect", and is a major issue when it comes to erosion.



PVD and DLC Coatings

PVD and DLC coatings are ultra-thin and visually precise, but they lack the thickness and toughness needed for erosive environments. Their limited durability and inability to coat non-visible surfaces make them unsuitable for high-stress or complex component designs. Abrasive slurry would easily erode through these coatings on any seal or turbine blade.

The Hardide CVD advantage to protect against erosion

Hardide's proprietary chemical vapour deposition (CVD) process creates tungsten/tungsten carbide nanostructured coatings that directly address the failures of traditional technologies. The coating is crystallised atom-by-atom from gas media, forming a tough, pore-free layer that adheres metallurgically to the substrate. As a result, this provides components with sufficient erosion resistance to greatly extend their lifespan and minimise costs.

Property	Hardide Coatings
Hardness	Up to 1600 Hv (77 HRc)
Thickness	50-100 microns (customisable to 300 µm)
Porosity	<0.5% - effectively pore-free
Adhesion	>70 MPa (metallurgical bond)
Fatigue debit	Between -10% and +10% (exceptional)
Temperature resistance	Up to 400°C in-service (coating at 450-500°C)

Key benefits that set Hardide CVD apart

Wear and erosion resistance

Hardide-T is up to 12x more erosion-resistant than hard chrome and 6x better than HVOF WC-Co. It also retains surface finish under abrasive attack, protecting seals and mating parts.

Protection against water droplet erosion

Hardide-A and Hardide-T coatings withstood 90 hours of WDE testing at 300 m/s water droplet speed with minimal damage, compared to deep scarring on uncoated blades in 7 hours. This is ideal for turbines, compressors and many other components with complex geometries.

Coating complex geometries

Coats internal channels, threads and blind bores with uniform thickness unlike HVOF or PVD. No "dog bone" build-up on edges, no need for grinding in most cases.

Chemical and corrosion resistance

With no porosity or cobalt binders, Hardide resists acid, brine H₂S, and other aggressive media. It also passes 480+ hour salt spray tests with no pitting.

Environmentally compliant

Fully REACH-compliant and eliminates the need for hexavalent chromium and cobalt-based coatings.



A new standard for erosion control

For engineers seeking to extend component life and meet sustainability targets, erosion resistance is essential. Hardide's nanostructured CVD coatings deliver unmatched performance in the most erosive environments, surpassing legacy coatings in durability, surface finish retention and environmental safety.

Regardless of whether it's WDE on turbine blades, abrasion in slurry pumps or seal failure from shaft degradation, Hardide coatings offer a proven, high-performance solution. Want to explore how Hardide can protect your components from erosion? Contact us today to request a technical consultation or sample.

[Contact us today](#)