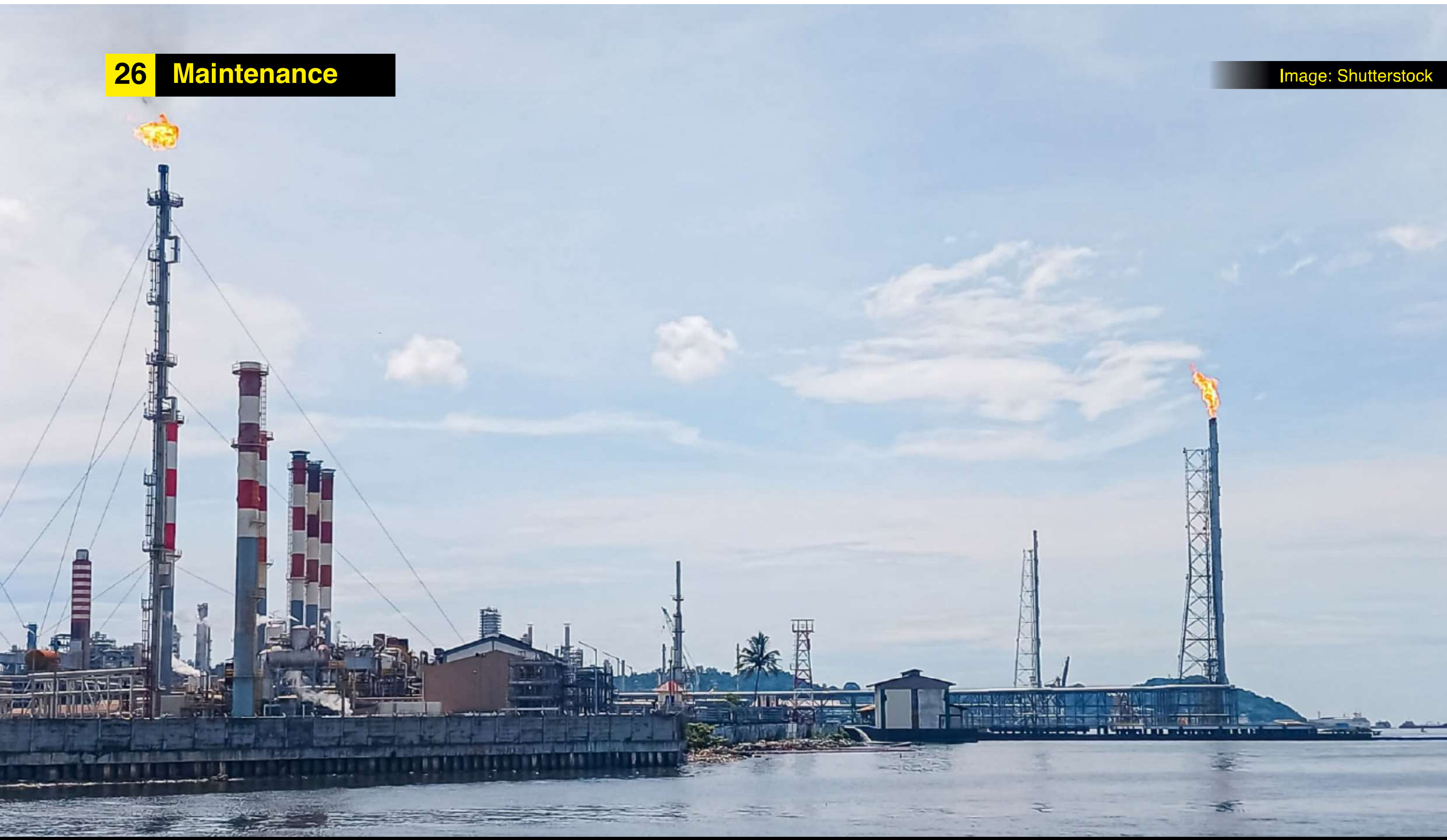
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Corrosion issues and coatings for hazardous area equipment

Although corrosion is not a primary focus of the ATEX Directive, it remains a critical factor for safety and, over time, has led to the widespread adoption of aluminium-silicon alloys and stainless steel as the materials of choice for manufacturers operating in this highly demanding industrial sector.

Many industrial plants operating in areas with a risk of explosive atmospheres are installed outdoors, often in regions exposed to extreme temperature ranges – from -60°C up to +60°C – such as deserts or arctic environments. In these conditions, temperature fluctuations, humidity, and proximity to the sea make corrosion resistance a key factor in ensuring the long-term reliability of equipment.

Materials and alloys used in ATEX-certified equipment

The ATEX Directive mainly focuses on preventing ignition and containing potential explosions, while corrosion resistance is only marginally covered in the regulatory framework[1].Nevertheless, an overview of ATEX-certified equipment on the market shows that premium metals such as aluminium and stainless steel (particularly AISI 316 and AISI 316L) are commonly used.

This choice is driven by the need for long-term durability in harsh outdoor environments. For example, aluminium alloys are widely adopted in flameproof enclosures thanks to their natural resistance to oxidation. When exposed to air, aluminium forms a thin protective oxide film that prevents further corrosion, unlike untreated carbon steel which readily forms rust[2].

Until the 1970s, cast iron was still widely used for enclosure casting because it was easy to process and suitable for mass production. Being a ferrous material, it required cadmium plating to avoid oxidation – a process later abandoned due to the toxicity and carcinogenicity of cadmium. With the development of aluminium casting technologies, cast iron was progressively phased out.

Today, aluminium-silicon alloys are the preferred choice for manufacturing flameproof enclosures. These alloys offer better corrosion resistance than aluminium-copper alloys, which are more typical in general industrial applications. While copper increases mechanical strength, it reduces resistance to saltwater and humid environments.

For this reason, the term “copper-free aluminium alloys” is often used to describe aluminium-silicon alloys with low copper content (below 0.4%) – not completely copper-free but optimised for corrosion resistance in challenging environments.

Coating of equipment suitable for potentially explosive atmospheres

Today, polyester-based powder coatings provide high corrosion resistance even in harsh and extreme ambient temperature conditions. Their application process – and, of course, their formulation – is of great importance.

As discussed already, among the metallic materials most commonly used in classified areas with a risk of explosive atmosphere formation are low-copper aluminium alloys and low-carbon austenitic stainless steels, primarily AISI 316L.

One potential critical issue for installations using such devices is the marine environment, where salt dissociates into chloride ions and water becomes an effective electrical conductor. Corrosion is, in fact, an electrochemical phenomenon.

The presence of chlorides can trigger pitting corrosion[3], which is why protective coatings, such as specific paint systems, are required to safeguard the metal against corrosion.

Coating of equipment and mitigation of electrostatic charge hazards

For devices intended for use in classified Zones with a risk of explosive atmosphere formation, the general standard EN/IEC 60079-0 establishes several requirements for paint layers. Paints, being non-metallic materials, can lead to the accumulation of electrostatic charges.

The requirements differ depending on whether the potentially explosive atmosphere is due to gases or dusts, since dusts are subject to brush discharge phenomena[4]. The primary strategy for mitigating electrostatic charge hazards consists in applying an antistatic coating, defined by the standard as a coating with a surface resistivity < 10^9 Ω.[5]

If this requirement cannot be met, and the equipment belongs to Groups I or II, it is possible to limit the coating thickness to 0.2 mm. In the case of potentially explosive atmospheres due to dusts (Group III equipment), the risk of brush discharges renders this strategy ineffective.

For fixed installations, it is possible to mark the equipment with an “X”, potentially accompanied by a specific warning

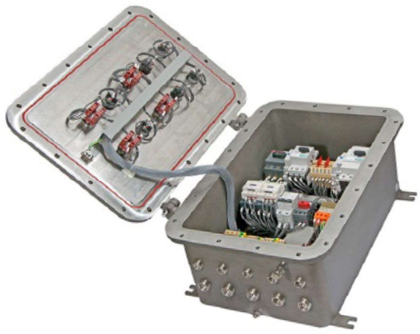

Image: Cortem Group

plate, and to include instructions in the user manual that guide the operator in eliminating the risk of electrostatic discharges.

Corrosion resistance requirements

Regarding corrosion resistance of coatings, the normative reference that has become widely adopted in recent years is ISO 12944. This standard describes, through its various sections, how to classify the environment in relation to corrosion risk, how to prepare the surface to be coated, the coating systems, and finally the selection of coating systems. Originally developed for painted steel structures, it has also become a useful reference for other metals where it can provide valuable guidance.

Over time, coating systems have become a subject of interest both for their antistatic properties and for their corrosion resistance. Today, polyester-based powder coatings provide high corrosion resistance even in harsh and extreme ambient temperature conditions. Their application process and, of course, their formulation is therefore of great importance. ■

References

[1] *Relevant guidance on corrosion can be found in Annex GB of CEI 31-108, ISO 12944, and IEC 61892-6.*

[2] *When exposed to air, aluminium oxidizes immediately, forming a thin (approximately 2–5 µm) layer of aluminium oxide (Al^2O^3) that protects the base material.*

[3] *Form of localised galvanic corrosion.*

[4] *The discharge does not originate from a precise point (as in the case of a spark discharge), but spreads over an area, producing small luminous filaments similar to hairs or bristles.*

[5] *Measurement performed according to the procedure in IEC 60079-0[4] CEI 31-108 GB.3.1*

About the author

Andrea Battauz is R&D Manager of Cortem Group. After graduating in mechanical engineering, he worked on the design of robotic machines and automation and, since 2004, he approached the ATEX Directive, and the design of equipment intended for explosive atmospheres. In 2008 he joined Cortem Group where he developed new explosion-proof products, specializing in signaling and lighting devices based on LED technology. He also carries out training activities on topics related to explosion protection. Since 2010 he has been a member of the national Italian committees CT 31 and SC 31J.