

Innovative and sustainable corrosion protection solutions for foundation structures of offshore wind turbines

Frank Prenger
Grillo-Werke AG
Weseler Str. 1
47169 Duisburg
Germany

Kathrin Hesnaoui
Grillo-Werke AG
Weseler Str. 1
47169 Duisburg
Germany

ABSTRACT

The steel structures of offshore wind turbine foundations have so far only been protected cathodically (galvanic anodes/impressed current systems) in the underwater area. More recent German regulations recommend an additional coating in order to reduce the required anode masses (1). In most cases, organic top coatings are used for this purpose, which significantly reduces the necessary protective current requirement. However, organic top coatings lose their barrier protection effect due to damage, defects and ageing, which increases the protective current requirement again. Mechanical loads already during transport and installation ("pile driving"), as well as (hydro-)abrasion by sand near the seabed during the period of use, make it useful to consider the tribological properties.

INTRODUCTION

Metallic coatings as a protective coating are characterized by excellent corrosion protection behavior and show extreme resistance to mechanical loads as well. Pure metallic coatings or duplex systems are already being used successfully in other areas of offshore structures. For example, areas in the tidal water zone, such as boat landings, usually receive a duplex system consisting of thermal sprayed coating and a fitting topcoat. Add-on parts are often protected exclusively by a metallic zinc coating. A thermal spray coating in the submerged zone thus represents a logical alternative to the organic topcoat system.

THERMAL SPRAYING ZINC-ALUMINUM IN SUBMERGED ZONE

Thermal spraying has also been used in the offshore wind energy sector for a long time. Components such as the boot landings (Fig 1) on the offshore towers and other



Figure 1: Boatlandings and ladders duplex coated (2)

components in the area of the water exchange zone are specified as duplex coating, consisting of a zinc-aluminum spray coating (TSZA) and a subsequent multi-layer paint coating. This design is a proven system. In field tests carried out over many years by the MPA Stuttgart (Federal Materials Testing Institute of the State of Baden Württemberg) (3) together with the Grillo company, the corrosive resistance of thermally sprayed zinc coatings and in particular of zinc alloy coatings with up to 22 wt.% Al without subsequent color coating could be proven (Fig 2). Up to these alloy contents of aluminum in the zinc alloy, the cathodic corrosion protection remains completely intact.

	Zn	ZnAl 2	ZnAl 4	ZnAl 15	ZnAl 22
Maritime Atmosphere					
Splash-Water Zone					
Tidal Zone					
Immersed					

**11 year Helgoland study of MPA Stuttgart:
ZnAl15 +ZnAl22 with nearly no loss in thickness**

- TS layer thickness 100 micron/4 mil
- No Sealer, no top coat

	< 1 $\mu\text{m/a}$
	<1-5 $\mu\text{m/a}$
	>5-10 $\mu\text{m/a}$
	>15 $\mu\text{m/a}$

Figure 2: Results of the field tests with TS layers without top coating over 11 years

The almost absent effect of the cathodic corrosion protection of the aluminum or of alloys with a high aluminum content is clearly shown on 55 inches long steel plates with a 4 inches area sprayed with different materials in Fig 3.