World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:15, No:04, 2021

Development of Bilayer Coating System for Mitigating Corrosion of Offshore Wind Turbines

Authors : Adamantini Loukodimou, David Weston, Shiladitya Paul

Abstract : Offshore structures are subjected to harsh environments. It is documented that carbon steel needs protection from corrosion. The combined effect of UV radiation, seawater splash, and fluctuating temperatures diminish the integrity of these structures. In addition, the possibility of damage caused by floating ice, seaborne debris, and maintenance boats make them even more vulnerable. Their inspection and maintenance when far out in the sea are difficult, risky, and expensive. The most known method of mitigating corrosion of offshore structures is the use of cathodic protection. There are several zones in an offshore wind turbine. In the atmospheric zone, due to the lack of a continuous electrolyte (seawater) layer between the structure and the anode at all times, this method proves inefficient. Thus, the use of protective coatings becomes indispensable. This research focuses on the atmospheric zone. The conversion of commercially available and conventional paint (epoxy) system to an autonomous self-healing paint system via the addition of suitable encapsulated healing agents and catalyst is investigated in this work. These coating systems, which can self-heal when damaged, can provide a cost-effective engineering solution to corrosion and related problems. When the damage of the paint coating occurs, the microcapsules are designed to rupture and release the self-healing liquid (monomer), which then will react in the presence of the catalyst and solidify (polymerization), resulting in healing. The catalyst should be compatible with the system because otherwise, the self-healing process will not occur. The carbon steel substrate will be exposed to a corrosive environment, so the use of a sacrificial layer of Zn is also investigated. More specifically, the first layer of this new coating system will be TSZA (Thermally Sprayed Zn85/Al15) and will be applied on carbon steel samples with dimensions 100 x 150 mm after being blasted with alumina (size F24) as part of the surface preparation. Based on the literature, it corrodes readily, so one additional paint layer enriched with microcapsules will be added. Also, the reaction and the curing time are of high importance in order for this bilayer system of coating to work successfully. For the first experiments, polystyrene microcapsules loaded with 3-octanoyltio-1-propyltriethoxysilane were conducted. Electrochemical experiments such as Electrochemical Impedance Spectroscopy (EIS) confirmed the corrosion inhibiting properties of the silane. The diameter of the microcapsules was about 150-200 microns. Further experiments were conducted with different reagents and methods in order to obtain diameters of about 50 microns, and their self-healing properties were tested in synthetic seawater using electrochemical techniques. The use of combined paint/electrodeposited coatings allows for further novel development of composite coating systems. The potential for the application of these coatings in offshore structures will be discussed.

Keywords : corrosion mitigation, microcapsules, offshore wind turbines, self-healing
Conference Title : ICEMC 2021 : International Conference on Electrochemical Methods in Corrosion
Conference Location : Venice, Italy
Conference Dates : April 12-13, 2021