TRIBOCORROSION IN OFFSHORE APPLICATIONS

Researcher(s): Kannaki Pondicherry
Supervisor(s): Patrick De Baets, Dieter Fauconnier
Partners(s): OCAS, VUB, KU Leuven

Funding organisation: SIM-vzw, Flanders and VLIAO Flanders
Start date: December 2014 – November 2018
Duration: (optional) 4 years

Keywords: ***Tribocorrosion, Abrasion, Offshore, Dredging***

Motivation

Global warming is causing a precarious rise in the sea levels thereby causing an immense loss in the coastal landmass. Dredging is an important tool to facilitate beach nourishment to protect the coastline by sand replenishment. Offshore application in general and dredgers, in particular, suffer perpetually by operating in harsh conditions. They often experience severe abrasive action of sand as well as the corroding action of seawater. This is especially true in case of the suction pipes of the dredgers used to transport the sand from seabeds to the storage hoppers and chains being moored on sand beds. Therefore, the coupled damage due to wear and corrosion referred to as tribocorrosion becomes of the essence.

Figure 1 Abrasion-corrosion in suction pipes of dredgers. Picture courtesy: Jan De Nul

The main focus of the current work is to experimentally simulate two-body abrasion-corrosion, by means of sliding a metal test specimen against hard abrasive particles embedded on a disc, while coupled with a three-electrode electrochemical system to attain the desired tribological environment with corrosion. This coupled abrasion-corrosion study would help in taking a small step forward in the direction of understanding the underlying material removal mechanism and quantifying the synergy.

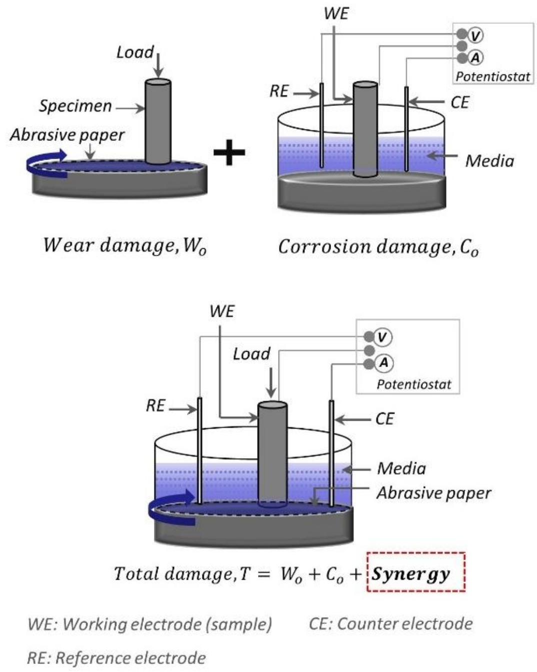

Figure 2 Synergy in tribocorrosion.

Objectives

In the context above, the objective of this thesis encompasses two topics below

1. Design and construction a multifunctional tribocorrosion tester that simulates the interaction of abrasive particles sliding against a metal surface (ASTM G132) in an electrochemically controlled corrosive environment.
2. Quantifying the synergy of the abrasion-corrosion system conforming to ASTM G132 and G119 and qualitatively analyse the mutual influence of the damage mechanisms.

GHENT UNIVERSITY · SOETE LABORATORY · FLANDERS INNOVATION & ENTREPRENEURSHIP · SIM Clusters for Growth

APPROACH

The present research focuses only on the combination of wear and corrosion, i.e. tribocorrosion. 'Tribocorrosion' in general refers to the coupling between electrochemical corrosion and one or more particular mechanical wear processes such as fretting wear, adhesive wear, erosive wear etc. More specifically the mutual impact or synergy typically results in an acceleration of both mechanisms. Indeed, synergy is the term used to describe the interaction or cooperation of two or more individual elements to produce a total effect that is greater than the sum of individual elements. Since the current work is mainly motivated from the perspective of offshore infrastructure and equipment, listed below are a few examples of offshore critical components that experience tribocorrosion:

- mooring equipment: anchor chains, bollards
- dredging components: pump impellers, suction pipes, sand hoppers
- wind turbines: support structures, i.e. monopoles and jackets, turbine blades

Typically, offshore applications are assumed to correspond to either closed three-body abrasive wear processes or to open two-body erosive wear systems. The former is represented at lab scale by dry sand rubber wheel test, while the latter can be simulated using a jet erosion tester. Nevertheless, in some cases, offshore equipment is subject to closed two-body sliding abrasion. Indeed, this tribological configuration occurs for example in the case of sand being transported in the suction pipes of dredgers and mooring chains on sandbeds.

The synergy of the novel two-body abrasion-corrosion system, according to the guidelines in ASTM G119, was quantified for two low alloy abrasion-resistant steel grades, i.e. martensitic steel and complex phase steel, which are exposed to three different aqueous electrolytes, namely distilled water, aqueous salt solution containing 3.5 wt% NaCl, and seawater obtained from the North Sea. The mutual influence of the individual damage mechanisms of two-body abrasive wear and corrosion were delved into in detail.

Additionally, five potentiostatic tests in seawater are performed for both the steels. These tests characterize the surface friction conditions and material loss rates under three different polarization conditions, namely, open circuit potential, cathodic protection and anodic corrosion.

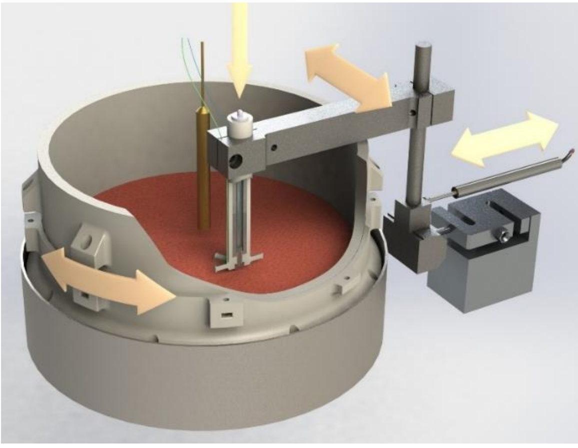

Figure 3: Novel electrochemical abrasion-corrosion tester at Soete laboratory.

Contact Details

Researcher(s):

Kannaki Pondicherry KannakiShanmugham.Pondicherry@UGent.be, Bibliography

Supervisor(s):

Patrick De Baets Patrick.DeBaets@UGent.be, Bibliography

Dieter Facounnier Dieter.Fauconnier@UGent.be, Bibliography