The economic benefit of a long-term coating strategy

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When a ship reaches the end of its service life it is broken down at a demolition site to recover steel and other useful items. The recycling process itself imposes risks to the human health and safety, as well as to our habitat by sending toxic components into the atmosphere and the maritime environment. Not all parts and products can be recycled and thus waste, toxic and non-toxic, is generated. Extending the service life of a ship can contribute to the protection of human life and the environment.

The same is valid when looking at the service life from the ship construction point of view. If the service life of a ship is extended less ships have to be built. To estimate the energy consumption of steel production Javaherdashti (2008) suggests that the energy required to produce one ton of steel is approximately equal to the energy an average family consumes over 3 months and roughly worldwide one ton of steel turns into rust every 90 seconds (Javaherdashti, 2008). The service life of a ship is not determined by the external battering of the ship's hull by wind and waves but mainly by the internal gradual corrosion of the ballast tanks (Thapar, 2013). The latter implicates that a coating with a longer service life will have a direct impact on the life cycle of the ship, the toxic components send into the atmosphere and the energy consumption.

Most ballast tanks are prepared and coated according to the IMO Performance Standard for Protective Coating (PSPC), using a light-coloured epoxy coating that, when on board maintenance is being performed by the crew, should remain in a good condition for 15 years. Ship owners are not only pushed by international legislation (IMO, 2009) but also by commercial needs in preserving a good reputation, to keep the ballast tanks of their vessels in a good condition to avoid extra inspections and costs. Aiming to extend the service life of your vessel to 25 years with ballast tanks in a good condition, a full-recoat must be considered. Recoating is bad for the environment as toxic components are sent into the atmosphere.

Monitoring as a tool to continuously assess the state of health of metallic structures in marine conditions

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Ships tend to spend most of their operational life in challenging marine conditions. Other than for fixed structures the environment they reside in as well as the loads they are subjected to can vary significantly over the full operational life. This means that, in order to track the true 'state of health' of a ship in time one cannot only rely on design assumptions: a thorough follow-up based on continuous sensor readings turns out to be the way to go in optimal structural health management.

When on a trip as well as when in port ships are subjected to various kinds of loads:

- Periodic mechanical loads through waves, currents, wind as well as rotating equipment
- Extreme mechanical loads in case of storms or collisions
- Corrosive loads that vary in time with location, temperature, state of health of the coating

- Abrasive loads in case of special cargo such as bulk goods or in the dredging industry
- Various kinds of fouling

These in turn have a significant influence on the ship's availability and performance, thus on the economic value to be gained from operating it. Unexpected or excessive degradation can lead to unplanned downtime. Cracks or leaks can lead to spills or even loss of the ship. Excessive abrasion leads to increased replacement costs and fouling results in increased fuel consumption and reduced cooling/heating capacity.

The good thing however is that all of these phenomena can be followed nowadays using a well-chosen combination of sensors. Mechanical loads and deformations, including fatigue, can be tracked using accelerometers and strain gauges. Corrosion activity can be followed using ER probes, coupons or PermaZen technology. Fouling can be made visible by specific sensors as well or tracked from derived parameters such as heat transfer coefficients. Finally, all of these are coupled with operational parameters such as temperatures, speed, fuel consumption, metocean conditions, position, ...

In order to avoid downtime, minimize fuel consumption and have a maximal return on investment (ROI) it is paramount to be able to predict failure in order to allow for cost-effective maintenance. Based on modern-day big data techniques together with solid physics and a number of the listed (novel) sensoring techniques such can be achieved through continuous monitoring. Additional benefits include the ability to determine the real age of the vessel compared to the design life set forward, leading to an improved and quantitative decommissioning strategy. Furthermore, the knowledge obtained in a solid integrity monitoring program is ready to be implemented in future generations of ships that will in turn be gifted with a more extended operational life. The presentation will provide an overview of the available sensor techniques and how these can be combined into an efficient monitoring tool for the state of health of an operational vessel.