The corrosion rate of the gas shells at the “Paardenmarkt”

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The “Paardenmarkt” is one of many munition dumpsites in our seas and oceans (Liebezeit, 2002). A few meters below the sea surface, a huge quantity of WWI chemical munition is buried (Missiaen & Henriet, 2002). Estimations vary between 9.000 tons up to 35.000 tons or more. The exact origin, quantity and composition are unknown. Little is known about the state of the munition. Shells discovered by accident on the seabed during expansion works at the port of Zeebrugge in the early 1970’s were described as being ‘in a remarkable good condition’. The munition became buried under 2-4 m of marine sediment afterwards and regulations prohibit any new salvages to date (Vandeweyer, 2015, Koninklijk besluit tot vaststelling van het marien ruimtelijk plan voor de periode van 2020 tot 2026 in de Belgische zeegebieden, 2019). In order to assess the physical state of the munition to date, it is necessary to build a statistical model taking into account all different corrosion processes (aerobic, anaerobic, galvanic, chemical) and all governing environmental parameters at the “Paardenmarkt”.

The first part of this project is a pilot set-up consisting out of a three year sampling campaign, based on a protocol developed by Petersen *et al.* (2019). About 4000 metal plates (60x60x3mm) will be immersed in seawater, fresh and brackish water for 2 and 6 months, 1, 2 and 3 years. Besides the water quality, the influence of certain gasses such as CO2, CH4, nitrogen will be taken into account. Other criteria such as microbially induced corrosion (MIC), composition of the marine sediment, the corrosiveness of the chemical content of the grenades, formation of concretion, orientation of the shells on the bottom and the galvanic effect will also be considered. The metal plates represent the construction materials present in a typical German 77 mm grenade being brass, iron and zamac. They will be put in smaller containers in different positions: completely buried, lying upon the sand and standing upright (half buried). Besides new test coupons, the corrosion rate of fragments of real grenades will be measured in close collaboration with Dienst voor Opruiming en Vernietiging van Ontploffingstuigen (DOVO).

The second part of the project will be focused on developing a model, based on Melchers (2003), to describe and predict the amount of corrosion of the munition shells at the “Paardenmarkt” as a function of exposure period and various influencing factors. Both mass loss and corrosion pit depth will be considered. Research on the corrosion rate of shipwrecks in the Belgian North Sea (De Baere, *et al.*, 2020) showed that the corrosion rate is significantly influenced by local environmental conditions. The parametrization of the model will be modified to represent the environmental conditions at the “Paardenmarkt” and finetuned according the observations during the pilot project to minimize the difference between the observed values and the values predicted by the model. The model will be parametrized with the data from the samples and validated using the data from the fragments of the real shells. The model will then be used to assess the current physical state of the munition shells and to predict their future condition in function of the time. A well-tuned model will be an important tool allowing faster and better conclusions when the time comes to decide what to do with the “Paardenmarkt”.

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