The corrosion rate of munitions dumped in the Baltic Sea

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Introduction:
Within the framework of the project "DAIMON" tests of rate and type of corrosion of metallic construction materials of chemical (conventional) munitions, and containers in which CWA dumped in the marine environment were stored, was carried out using coupon corrosimetry method.

Materials:
Materials examined in the form of coupons, were obtained from two original elements from the WWII (projectile artillery shell and barrel cover), but also from materials currently manufactured (steel sheets), however with a composition similar to the chemical composition corresponding to the construction materials of ammunition produced before and during WW II. The research on the rate of corrosive dissolution was carried out in two parallel experiments: ex-situ and in-situ.

Conclusions:

EX-SITU EXPERIMENT
- after 70 years of deposition the thickness of barrels covered with sediment decreased by 0.6 mm to 4 mm,
- barrels are completely destroyed and unsealed, and the CWA have already been released into the environment
- aerial bombs covered with sediment the thickness of their bodies decreased by 0.1 mm to 6 mm
- bombs may already be destroyed or heavily corroded, in case of their recovery, they may break

IN-SITU EXPERIMENT
- after 70 years of deposition of the munitions in the marine environment, the thickness of barrels has decreased by approx 1.7 mm to 6 mm
- CWA from the barrels have already been released into the marine environment
- thickness of the artillery projectiles shell has decreased by 5.7 mm to 8.5 mm, therefore it can be assumed that they are corroded, but they can still be tight
- thickness of aerial bombs decreased by 1.3 to 7.5 mm, and CWA probably have been released into the environment

Materials used in experiments:

<table>
<thead>
<tr>
<th>No.</th>
<th>Material type / origin</th>
<th>Material markings (symbols)</th>
<th>Type of experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Materials from the barrel of German production</td>
<td>8</td>
<td>In-situ</td>
</tr>
<tr>
<td>2.</td>
<td>Materials from a 75mm artillery projectile of German production</td>
<td>75</td>
<td>In-situ</td>
</tr>
<tr>
<td>3.</td>
<td>Steel S235</td>
<td>ST</td>
<td>In-situ</td>
</tr>
<tr>
<td>4.</td>
<td>Steel S355J2</td>
<td>S3</td>
<td>In-situ</td>
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<tr>
<td>5.</td>
<td>Stal Steel S235J</td>
<td>S2</td>
<td>In-situ</td>
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<td>6.</td>
<td>Stal Steel S 235 JR=+N II</td>
<td>S2N</td>
<td>In-situ</td>
</tr>
<tr>
<td>7.</td>
<td>Aluminum alloy AlMg</td>
<td>PA11</td>
<td>In-situ</td>
</tr>
<tr>
<td>8.</td>
<td>Aluminum alloy AlMg</td>
<td>PA63</td>
<td>In-situ</td>
</tr>
</tbody>
</table>

Conclusions:

EXPERIMENT EX-SITU
- PNA laboratory

EXPERIMENT IN-SITU
- Racks with coupons

Images:
- Coupons cleaned after exposition to corrosive factors
- Corrosion rate [mm/yr] for the barrel in the experiment
- Corrosion rate [mm/yr] for the barrel in the experiment
- Corrosion rate [mm/yr] for the barrel in the experiment