PL1 PLENARY ABSTRACTS

Chemistry in Action - Chemical Challenges to Preserve the 380 Year-Old Warship Vasa

Lars Ivar Elding
Department of Chemistry, Lund University, Lund, Sweden, and the Swedish National Maritime Museums, Stockholm, Sweden. E-mail: larsi.elding@inorg.lu.se or lars-ivar.elding@maritima.se

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Vasa was built in Stockholm in 1627-28 aimed to become an efficient machine of war – heavily armed, impressively decorated, and fully timbered – ready to join the Swedish fleet in the Baltic Sea at the initial stage of the 30-years war in Northern Europe. However, due to a number of fatal construction mistakes, the ship capsized and sank in August 1628, fully equipped, on its maiden voyage out of Stockholm harbor, after having sailed less than one nautical mile.

There it stayed on the seafloor of Stockholm harbor for 333 years, 33 m below the surface and partly buried in sediments, until it was raised in 1961. The absence of shipworms in the low-salinity Baltic, together with the anaerobic conditions and the low temperature at the seafloor, contributed to its preservation, but the surface of the timbers were attacked by sulfur-metabolizing and cellulose-degrading microorganisms. Several tons of iron compounds from rusting cannon balls and sulfur compounds from the polluted waters impregnated the timbers. In addition, the hull was conserved during 1962-79 by use of large amounts of polyethylene glycol and boron compounds. Thus, the timbers contain a complex cocktail of chemicals.

After salvage, exposure to atmospheric oxygen initiated a multitude of chemical reactions threatening the strength of the timbers and the long-term preservation of this valuable artifact, attracting more than 1 million visitors every year. Such processes include redox reactions of sulfur and iron compounds, free radical reactions, Fenton processes, cellulose acid hydrolysis and oxidative degradation reactions, polyethylene decay processes, formation of organic acids and the relations between chemical status and mechanical properties and strength of wood. An international research project has dealt with these problems since 2003.

In particular, the kinetics of decay processes will be of great importance for the strategy and development of future novel preservation protocols. Almost all processes involve consumption of oxygen, directly or indirectly, which means that methods for evaluation of oxygen consumption rates in wood is an important method for evaluation of reaction rates. Other experimental efforts involve acid neutralization and iron extraction methods and the use of inert gas treatments. A review of this work will be presented in the lecture.

Further reading

http://www.vasamuseet.se/sitecore/content/Vasamuseet/InEnglish/Research/Research.aspx
http://www.vasamuseet.se/sitecore/content/Vasamuseet/InEnglish/Research/Preservation.aspx
http://www.vasamuseet.se/~/media/PDFER/Vasa/Bevara_Vasa_rapport.ashx
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