ANECHOIC COATING DESIGN KNOWLEDGE FIELDS

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Abstract: *One of threats for submarines is active sonar from surface ships. Anechoic coating is used to passively protect the submarine from this. Research and development are necessary to get optimal Anechoic coating design. This paper will introduce an overview of knowledge fields that apply for Anechoic coating design. This is based on four pillars:*

1 Operational use.
2 Applied Materials.
3 Measurements and
Calculations. 4 Integration
and maintenance

The paper describes briefly the different pillars and shows how Research and Development is applied to get operational anechoic coatings.

Keywords: Anechoic Coatings TS Tiles Target Echo Strength

1. INTRODUCTION

Modern submarines are mostly coated with Anechoic tiles. The reflection of acoustic waves from surface ship sonars back to the Sonar source is reduced by absorption or by scattering in directions other than the direction of the source. The development of those Anechoic coatings can be structured by road mapping so that all operational requirements are covered. The Defence Material Organisation of NL MoD uses road mapping to determine its research and development activities.

2. OPERATIONAL USE

The operational requirements of the submarine are the starting point for the requirements for the applied anechoic coating. Related to Anechoic materials the operational diving depth is one of the relevant parameters. This will determine the pressure dependency of the material. Deformation by static pressure will change the acoustic properties of the anechoic coating. This deformation will also set the requirements for gluing and aging of the coating.

Another factor is the expected sonar threat. These days several sonar systems are available such as LFAS (Low Frequency Active Sonar, towed behind surface ships), HMS (Hull Mounted Sonar), HELRAS (Helicopter Long Range Active Sonar, dipping sonars) and torpedo sonars. Each threat comes with a different frequency and detection range. The anechoic coating should be developed for the frequency ranges of the expected active sonar threats.

3. APPLIED MATERIALS

The development of materials is the key factor for anechoic coatings. The relation between the chemical parameters and the acoustic performances should be determined. The material should be buoyancy neutral so it has less influence on the buoyancy of the submarine. The density of anechoic coatings varies between 1100 and 1500 kg/m^3. Coatings that contain air are usually good reflectors due to the acoustic impedance mismatch with water. The acoustic performance of these coatings changes a lot with diving depth. The materials that "absorb" acoustic waves are usually thicker and around ¼ of the wave length of interest.

4. MEASUREMENTS AND CALCULATIONS

The acoustic performance can be measured in acoustic tubes with transducers and hydrophones to determine the reflection, transmission and absorption of the anechoic materials.

For material modelling the shear and bulk modules should be determined in order to reconstruct the material master curves in the relevant range of frequency, temperature and pressure. Shear and bulk modules can be measured with a DMTA (Dynamic Mechanical Thermal Analysis) apparatus, with a laboratory test rig for measuring the dynamic transfer stiffness of resilient mountings, and by measuring the longitudinal wave speed with ultrasound.

The material properties and their pressure dependency can be taken into account when modelling and calculating the Target Strength (TS) of a submarine. The optimisation of the TS will require several iterations.

5. INTEGRATION AND MAINTENANCE

Integration into the submarine design. Anechoic coatings will add extra weight to the submarine which should be compensated by extra volume. Also the previous mentioned deformation of the anechoic coatings will change the buoyancy of the submarine which must be compensated with pumps and ballast tanks. Absorption coatings are usually applied on structures that are air backed, such as the pressure hull. Reflection materials are applied on water backed structures, like the sail. But also combinations of reflection and absorption materials are applied. The shaping of the ship in combination with Anechoic coatings will also influence it's TS. Modern submarines have "Stealth" shapes at the sails and shaped hulls.

Maintenance will ensure that the performance of the anechoic coating is maintained. For example inspections of the hull underneath the cladding to detect corrosion. Also measuring the coating separately and the whole submarine to ensure the TS performance in relation with the operational requirements.

6. CONCLUSION

The different knowledge fields are the basis for developing Anechoic coatings and give guidance for Research and Development projects. Developing an anechoic coating for a submarine is an integral process.