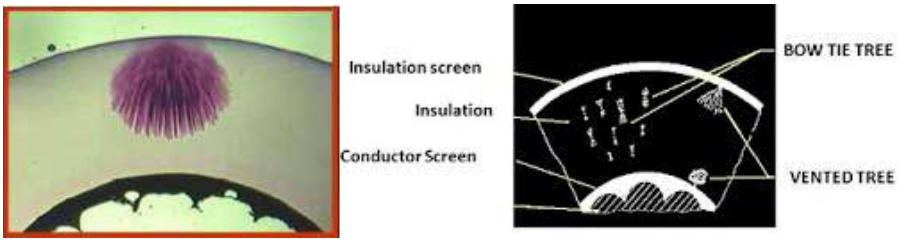
WATER TREE – Crack propagation in dynamic power cables

Background and motivation

The offshore energy sector is moving towards installation of floating offshore wind turbines and farms with tidal and wave energy devices. A challenge for these installations is the cable which hangs from the base of the installations to the seabed or a hub. This arrangement exposes the cable to the dynamics of the marine environment it is installed in creating concern for failure of these dynamic cables. One failure mechanism of subsea cables is the degradation of the insulation layers by so-called "water treeing" induced by strong electric fields in the defects in the material caused by mechanical stresses.



Objectives and goals of the project

The thesis project will contribute to the development of simulation models and a methodology that enable fatigue growth analysis of water trees in dynamic subsea cables due to mechanical and electrical loadings. It allows for prediction of the time it takes for a water tree to grow to a size that causes cable failure. The ability to predict when a dynamic cable is at risk of failure is crucial for planning of maintenance.

Methods and tools

Linear-elastic fracture mechanics (LEFM) will be used to analyse the fatigue growth of defects in an insulation material of a dynamic power cable that is submerged in water. The cyclic fatigue loads i.e. cyclic stresses will originate from two sources: variation of the electric field and motions of the cable in the ocean. The former will be calculated using ANSYS or ABAQUS and require development of a new model. The latter will be calculated using the DNV-GL SESAM software using an existing model that has been developed in the research group on the division. The thesis project will include several parametric studies in order to assess different factors' influence on the fatigue life related to growth of water trees.

The thesis should be written in Word using a template provided by the department.

The MSc thesis project should incorporate (at least) the following tasks:

- Literature study.
- Development of a simulation model that can be used to study how the electric field gives rise to Maxwell stresses which lead to growth of defects in insulation materials when these materials are submerged in water.
- Simulations using an existing simulation model of a wave energy converter system with a dynamic power cable. The model will be used to simulate the cable's motions for various sea state conditions, which in turn will give rise to cyclic variations of mechanical stresses.
- Develop a LEFM-based fatigue model which can simulate the growth of water trees by a superposition of the stresses from the two simulation models.
- Parametric studies.
- Write a thesis report and present it on a public seminar.

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