**Reduction of Underwater Noise Propagation by Bubble Curtains**

Pile driving is a well established offshore construction technique for building structures like wind turbines, converter and accommodation platforms, but also bridges or harbor facilities. Steel piles of large diameter are driven into the sea ground by a hydraulic hammer. The driving of piles causes high acoustic pressure levels propagating through the water and sediment for long distances. The noise chases marine mammals out of their territory and can even cause temporal or permanent hearing damage. One technique to reduce this noise is to apply a Small Bubble Curtain (SBC). It consists of a system of perforated hoses or pipes attached to compressors and injecting bubbles enclosing the entire pile in close distance. The bubbles lead to a decrease of the sound speed within the gas-water mixture causing a reduced radiation of noise into the water-gas mixture. Furthermore, the pressure wave is reflected within the bubble cloud due to the inhomogeneity of the plume. Additionally, the pressure wave forces the bubbles to vibration which absorbs acoustic energy.

In this thesis, a numerical model to predict the rate of noise attenuation due to the application of an SBC is developed. Previously, the efficiency of SBCs has only been proven by measurements, because no effective and reliable simulation was possible. For this purpose, a finite element model of the noise emission without noise protection combined with a far field propagation model enabling the computation of the pressure level as well as the sound exposure and peak level in a certain distance from the pile are developed and validated by true scale offshore measurements. The distribution of the bubbles around the pile is analyzed by applying a Computational Fluid Dynamic analysis considering the geometry of the pile, the injection of the bubbles as well as the drift because of the current. Two different models to compute the attenuation of the noise due to the SBC are compared. The first model determines the reduced speed of sound within the gas-water mixture and maps the bubble distribution of the CFD analysis onto the finite element near field model. The second approach computes the frequency dependent complex sound speed within the mixture considering the bubble size distribution and damping due to bubble oscillation. Then, the different components of attenuation mentioned above are investigated individually by solving the linear one-dimensional Helmholtz equation. The results comprising the frequency dependent attenuation as well as the reduction of the sound exposure level of both methods are compared to full scale offshore tests at different measurement positions.

Additionally, a time dependent solution of the nonlinear oscillation of a single bubble is analyzed by solving the Keller equation. Steady state and transient forcing pressure and different bubble sizes and ambient pressures are compared in order to evaluate the limitation of the linear theory.