## Understanding and optimisation of bubble screens in offshore wind sector installations

During model tests, MARIN has gained new experiences and insights into the hydrodynamics of bubbles within the Bubbles JIP. Ultimately, the research will lead to Linda Kemp Ikemp@marin.nl

Figure 1 Bubble curtain in the Offshore Basin (photos GROW)





• The double bubble keeping sea life out of trouble Listen to the GROW podcast in which Linda Kemp shows how bubbles can prevent wind turbine installation noise that harms sea life.



consortium of research institutes and industry partners involved in the offshore wind sector started the Bubbles JIP in 2019. The aim of the JIP is to achieve more efficient and effective use of bubble curtains deployed for noise mitigation in offshore installation projects by improved engineering of the bubble screen. Within the JIP, MARIN is involved in the laboratory tests and modelling of the hydrodynamics of the bubble curtain.

Improved engineering of bubble screen Bubble screens are currently used to mitigate noise during the installation of offshore wind turbines. The noise generated by high-energy piling of the turbine foundations could potentially harm marine life. Improved engineering of the bubble screen would lead to better control and therefore, risks with respect to specific noise requirements are reduced. To accomplish these goals, laboratory tests are conducted to investigate parameters influencing the noise attenuation by air bubbles. Additionally, the understanding of bubble generation and bubble growth over the water depth under the influence of waves and currents is also addressed. A more efficient use of the bubble curtains will limit the CO<sub>2</sub> footprint due to overcapacity of the compressors used to set up the bubble curtains.

## Fascinating insight into hydrodynamics

The tests are divided into two separate scopes. The first set of tests was conducted in the Concept Basin and focused on the bubble generation with different types of delivery hoses and a range of air supply rates. For each of these configurations, the gas fraction and bubble distribution are measured throughout the bubble plume. A new measurement system has been developed to be able to measure the gas fraction, based on conductivity measurement techniques and optical techniques. Combining the optical and conductivity techniques gave a fascinating insight into the hydrodynamics of the bubble screen as a result of a variation of various bubble generation hoses and different mass flow rates.

The second scope is performed in the Offshore Basin, to understand the behaviour of the bubble screen in different environmental conditions. No scaling is applied in these tests, since linear scaling would not deal with the laboratory environment and the size of the bubbles. due to water depth, temperature, salinity and other aspects. Based on previous acoustic tests, the Offshore Basin was suitable to perform acoustic and hydrodynamic tests on a bubble plume with a depth of 10 m in combination with environmental impacts such as currents. The influence of currents and waves is investigated in these tests and the same measurement system is used for these tests in waves and currents in deeper water. A linear bubble curtain over the width of the basin is produced, which is shown in figure 1. The bubble concentration, gas fraction and bubble distribution are investigated over the full depth of the bubble plume.

 Figure 2 Hydrodynamic measurement system operating in bubble curtain



This gives insight into how the bubbles rise and interact on their way up to the surface.

Acoustic tests performed To measure the noise mitigation of these bubble screens in a controlled environment, acoustic measurements are performed as well. With the assistance of TNO, the noise transfer of bubbles is investigated for all hose parameters, as well as for the influence of waves and currents. The results of the hydrodynamic, acoustic and measurements on air pressures and flow rates will be used in the numerical modelling of bubble curtains. It turned out that the bubble size distribution is different for different types of hoses and also depends on the environmental conditions and hydrostatic pressure. Within this project the expertise of all the partners contributes to the optimisation of bubble screens in offshore wind applications.

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