Calibration of multibeam echosounder bubble plume measurements using a controlled bubble plume generator

By: Laurens van der Marel[1,2], Geert de Bruin[1,3], Peter Urban[4] and Gert-Jan Reichart[2,3]

Recently, the EU imposed new regulations to measure and report methane emissions originating from the oil and gas industry (EU/2024/1787). Because of these regulations there is an urgent need for easy and reliable methods for quantification of leakage rates in the marine domain. Offshore monitoring of methane release remains challenging for satellite-based systems and consequently in-situ observations are essential.

Several studies used multibeam echosounders (MBESs) to identify leaking abandoned wells. Quantifying rates of methane leakage on the other hand, is usually done using a remotely operated vehicle (ROV), which is costly and time consuming. Novel studies such as performed by Urban et al. (2023) suggest that MBES water column measurements may be used to estimate gas flow rates acoustically, providing an economic alternative to accurately measure methane leakage from leaking wells. However, the conversion of acoustically measured backscattering cross sections into bubble volume flow rates requires a reference. Urban et al. (in press) used an acoustic inversion approach which was subject to high uncertainties due to challenging acoustic calibration of the MBES and imperfect knowledge of bubble size distribution parameters needed for the backscatter modeling.

This study aims to calibrate MBES flow rate measurements by directly comparing the acoustic signatures of artificially created bubble plumes with their known release rates. Such direct in-situ calibration promises substantially lower uncertainties and enables both validation and real-world uncertainty quantification of MBES based gas flow quantification in a controlled setting.

We build a custom bubble generator (fig 1) that produces a bubble stream with uniform bubble sizes, while allowing variation in flow rates. This generator is deployed in the vicinity of a leaking well in the North Sea. By measuring the corresponding plume backscattering for several known flow rates, a field-calibration can be made for the relationship between bubble plume leakage rates and the acoustic backscatter volume. Then, the acoustic backscatter volume of the leaking well is measured, and the flow rate is computed using this relationship.

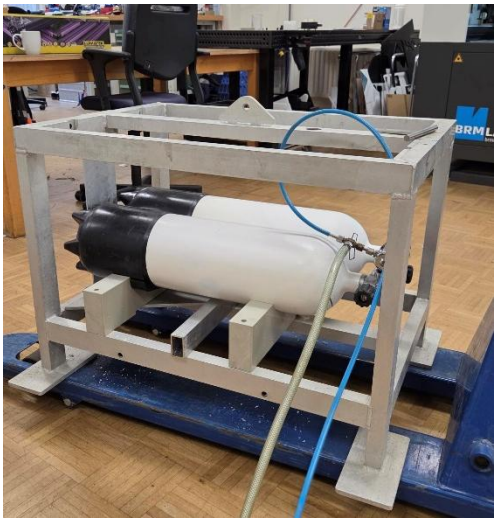

Figure 1: The bubble generator consists of a lander frame with two compressed air tanks, a fixed regulator valve ensuring a constant pressure of 10 bar, a needle valve which makes it possible to adjust the flow rate and a sparger that creates bubbles with consistent bubble sizes.

1) TNO Geological Survey of the Netherlands
2) Utrecht University, The Netherlands
3) NIOZ The Royal Netherlands Institute for Sea Research
4) Ghent University, Belgium