Can we identify leaking wells in the North Sea through inexpensive modelling?

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Fugitive methane emission through active and abandoned wells is a concern with respect to its negative climate effects. Regulations in various parts of the world mandate operators to measure, report, and remediate such leakages. However, there may be thousands or up to hundreds of thousands of wells in a particular jurisdiction, and measuring a significant portion of them is cumbersome. Therefore, there is value in identifying wells that have a high likelihood of leakage to narrow down the scale of field measurements and find high-emitters as early as possible.

There have been several attempts at developing qualitative methodologies to identify wells with higher potential for leaks. These methods usually focus on well attributes such as age, deviation, plug status, etc. However, a robust quantitative and predictive approach is currently lacking in literature. Well leaks typically occur due to failure or insufficient quality of cement sheaths. We argue that the state of stress in the cement sheath controls the potential for failure (e.g., microannuli formation) and leakage. In this work, we use our established modelling framework to evaluate the level of cement sheath stress at depths just above intervals containing gas. We hypothesize that wells that intersect gas sources and have lower level of cement stress are at higher risk of leakage.

Recently, 3 independent studies in the Dutch, Norwegian and UK-parts of the North Sea found leaking wells that were drilled through shallow gas. We conducted our analysis on 22 of the surveyed wells in the North Sea. 15 of the wells were from the Dutch sector, while 3 and 4 were from the Norwegian and UK sectors. 10 of the 22 wells do not show leakage at the seabed while the rest have confirmed leaks reported by these independent studies. The modelling results show a clear relationship between the leak status and the cement stress above the shallow gas zone. These results show promise in identifying potentially leaking wells only through evaluating the well design parameters that are usually available in well reports. This methodology may provide a cost-effective way to evaluate the leakage potential in wells both in the context of fugitive methane emissions and legacy wells in CCS projects. Additionally, this methodology can help identify wells that require additional measures during abandonment and improving designs for new wells to avoid future leakage issues.