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Data Science Driven Framework for Leak Detection in LNG Plants using Process Sensor Data

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Liquefied natural gas (LNG) is a promising fuel. However, a major component of LNG is Methane, which is a greenhouse gas. Shell aims to reduce methane emissions intensity below 0.2% by 2025.
Existing leak detection techniques have limitations, such as limited coverage area or high cost. We explore data science driven framework using existing process sensor data to localize and estimate leak magnitude. However, sensor noise and process changes can make leak detection challenging. Algorithms developed are tested on synthetic flow and composition chemical measurements data generated using process simulations of an LNG plant (Fernández, 2015).
We present a leak detection and localization framework comprising different techniques. First the use of wavelet analysis combined with mass balance to localize leaks, followed by a maximum likelihood estimation of leaks (Bakshi, 1998). Different optimization-based approaches, as well as Kalman filters with fine-tuned covariance matrices, utilizing mass balance, are also being adapted to determine the potential leak magnitude in each unit, enabling confirmation of leak detection and localization using hypothesis testing. Alternatively, statistical metrics such as Kantorovich distance are being explored, coupled with classical Multivariate Statistical Process Control methods (Kourti and MacGregor, 1995), for the analysis of mass balance residuals at each unit to detect and localize leaks, by studying deviations in the metric (Arifin et al., 2018).
References
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Both methodology and application

Primary authors: VARGHESE, Stephen (Shell India Markets Private Limited); RAVI, Arvind; SURESH, Resmi; ABDUL RAZAK, Rihab; POTU, Shirish; GONZALEZ-MARTINEZ, Jose M.

Presenter: SURESH, Resmi

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