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Methane emissions from LNG ships: measurements and abatement

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Content

- FUMES2 study
- Engine slip
- Fugitives
- Vents
- CEMS
- Methane abatement

Key messages

- Methane emissions include engine slip, plus fugitives and vents
- For engine slip, more measurements needed to uncover variability... improved emission factors
- Fugitives typically small, but must not be ignored
- Vents: several small emissions, and rare very large emissions...
- Continuous emissions monitoring could be useful but must be validated and improved outputs
- More measurements across stacks, fugitives and vents!



FUMES2 study is underway!

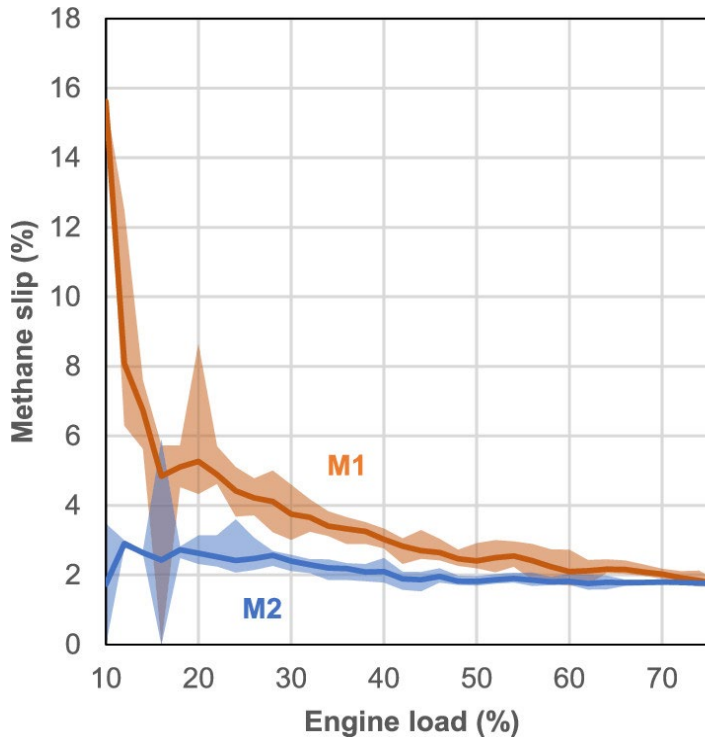
- 2-year research project
- ***How much methane is emitted when ships use or transport LNG?***
- More, new data, source-specific
 - Engine direct measurements (5 – 10 engines)
 - Fugitive and vents measured (5 – 10 ships)
 - Loading/ unloading measured (20 operations)
- Comprehensive, robust methodology
- Peer-reviewed publication outputs



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Engine slip

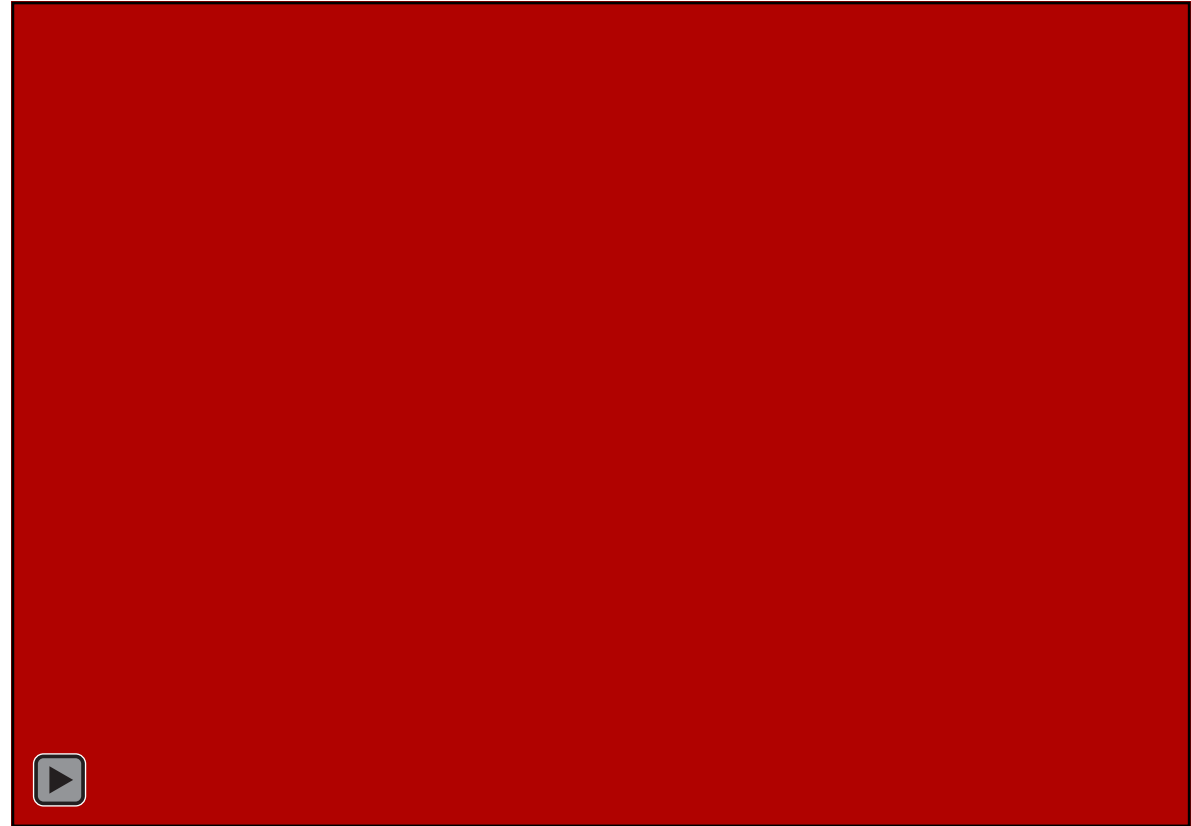
- Several new measurements conducted in the past 5 years (including FUMES and FUMES2)
- Some variability uncovered (engine tech, load, temps)
- But not all... how do emission change with
 - Age
 - Operational differences
- More measurements will help us improve emission factors and identify mitigation solutions



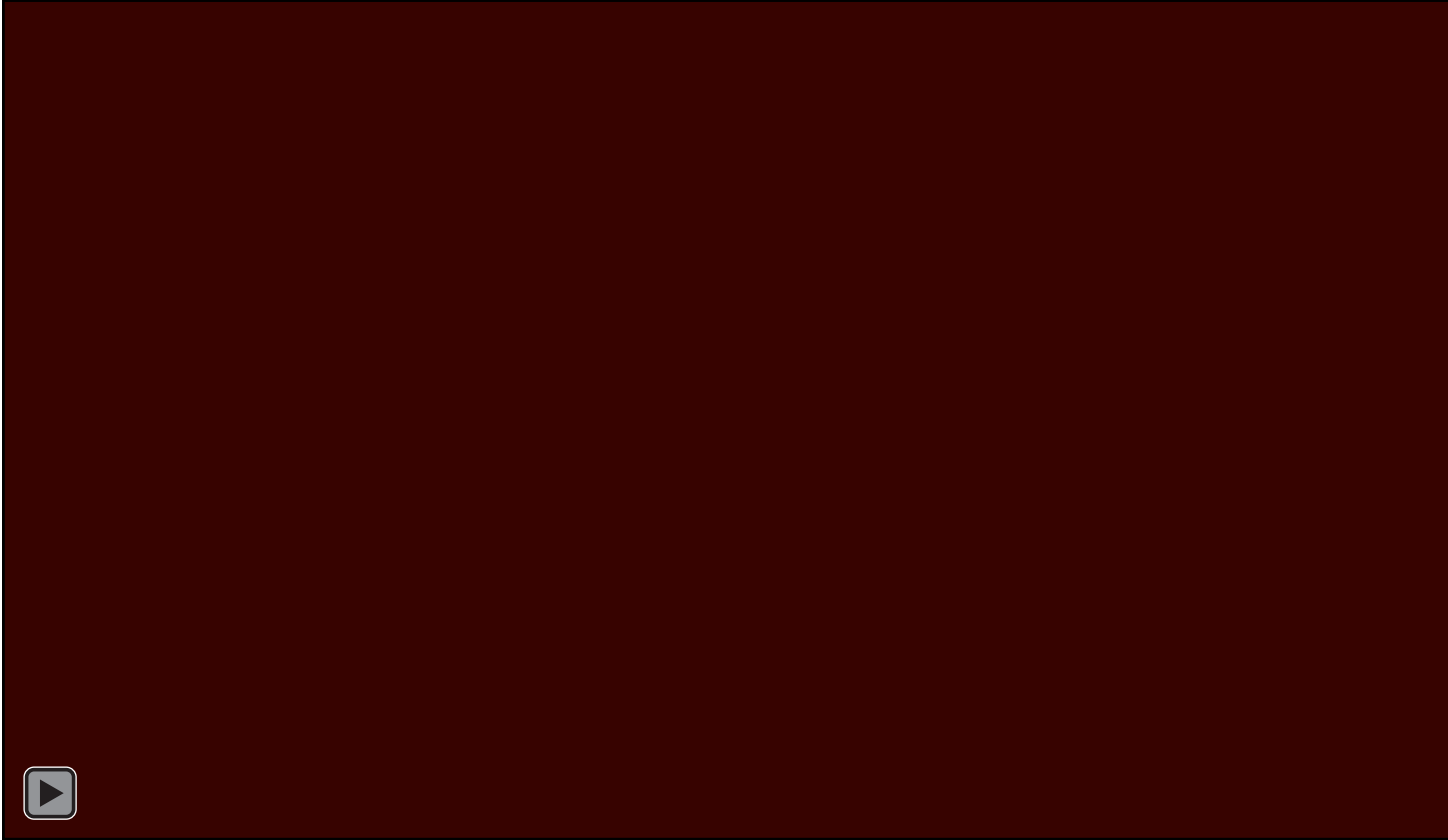
Fugitive leaks

- It is often assumed that fugitives are zero
- But we have found leaks on every ship we have surveyed.
- 2 – 8 leaks identified for the 3 last ships
- All relatively low rates (0.1 – 1 kg/hr)
- If you don't look, you cannot fix them: they won't get smaller

- Optical gas imaging cameras are of limited use on their own for LNG leaks
- Combine with open path laser and experience



Venting for tank warm-up pre dry dock



- Venting generally very low, but...
 - Routine venting low but non-zero
- 1) Fuel switchover vents
 - 2) Pre-dry dock venting is large but rare (every 5 or 2.5 years)
- Levelised: ~ 0.1 kgCH₄/t LNG delivered additional methane emissions
 - But where are they accounted for in reporting?

Improving Continuous Emissions Monitoring Systems (CEMS)

- Many ships have CEMS for methane slip now
- But there is a lack of trust in their outputs amongst some operators
- Some spurious data, outputs unreliable/ unfeasible
- But why... calibration error/ sensor error/ reporting error/ genuine variation in emissions/ inherent inaccuracy in measurement system?
- What we need: independent research and verification
 - Validation of CEMS with spotcheck measurements
 - Collection of longer term CEMS data to assess performance over time
 - Calibration logs
- New project proposal for research to address this issue and improve our systems

Methane slip abatement

- Oxidation catalysis has potential to drastically reduce methane
- But low exhaust temperatures have limited effectiveness
- And sulphur poisoning has until now made catalysts untenable

- Methane abatement catalysts are progressing
- Methanox have developed a cat with resistance to sulphur
- Potential for retrofit/ drop in for SCR
- Engine tests underway, ship trials aiming for end of 2026



 **METHANOX**

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