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CONCAWE Project Update: Heavy Fuel Oil (UN 3082) - air emissions and worker exposure during barge loading

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ADN Safety Committee

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Note: Contents of this presentation represent 'work-in-progress' and should not be cited or relied upon for any action

Project background

- Re-classification of Heavy Fuels Oils of category UN 3082 for environmental effects in 2010 led to introduction of the requirement that the gas/air mixture shall be returned ashore through a gas recovery or compensation pipe during loading operations.
- All HFO's are classified for human health effects as carcinogenic, mutagenic and toxic to reproduction
  - These effects have been observed in whole-product studies and are attributed mainly to 4-6 ring polycyclic aromatic compounds (PAC's)
- Vapours released from HFO and resulting worker inhalation exposures have not widely been studied
  - But are assumed to be low-level
  - And not to contain significant quantities of the key PAC's
- These assumptions are being tested in a 2013 project funded by CONCAWE and with results for discussion by the ADN Safety Committee

The nature of Heavy Fuel Oils (UN 3082)

- HFO's are substances produced in refineries and depots to a product specification such as viscosity
- Desired viscosity achieved by a combination of components and storage/handling temperature (typically 70-90 °C)
  - Typical loading temperature up to 80 °C.
- Product constituents boil at different temperatures:
  - Typical 'boiling point distribution': 5% of product boils off at 265 °C (carbon number C_{14}), 90% boils off at 715 °C (carbon number C_{98}) – data from Concawe report 12/7 (2012)
- Emissions to air, and worker inhalation exposure, are determined by vapour pressure of product
  - Varies between products mainly due to presence of lighter ('gas oil-like') components used as cutter stocks
  - Some of the vapour emitted at elevated temperature during loading will condense to mist in ambient air

Theoretical considerations

Commissioned a desk top study from an environmental consultant

- Using models recommended by Concawe; UK Environment Agency; and US Environmental Protection Agency
- Calculated 10-20 grams/tonne loaded product at 80 °C
- Equates to 130-260 kg of emission when loading a large 13,000 tons barge over 10 hours
  - Although typical barges hold 3,000 – 6,000 tons

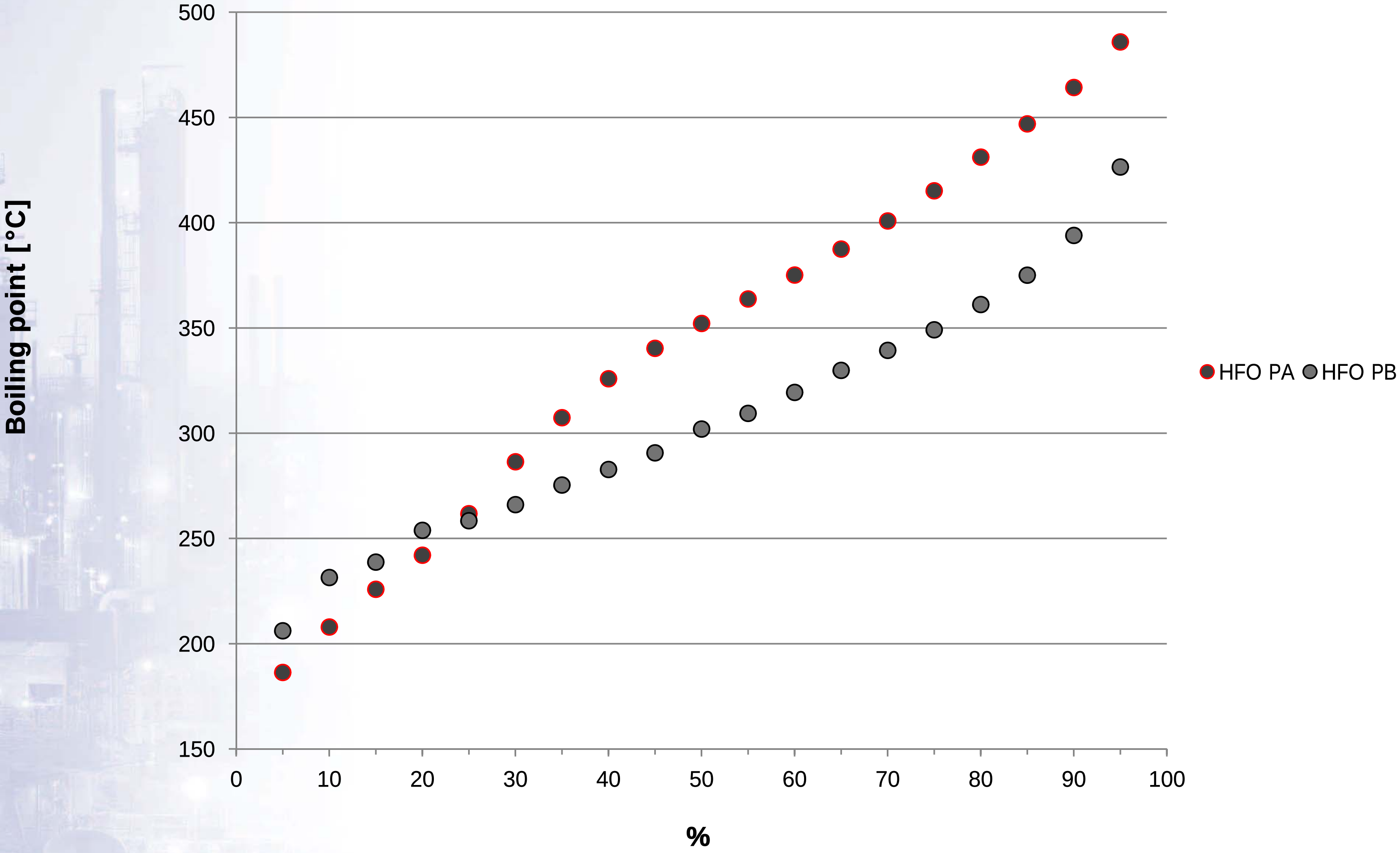
Preliminary results laboratory study

Concawe contracted the Fraunhofer Institute for Toxicology and Environmental Medicine (Prof. Wolfgang Koch) to:

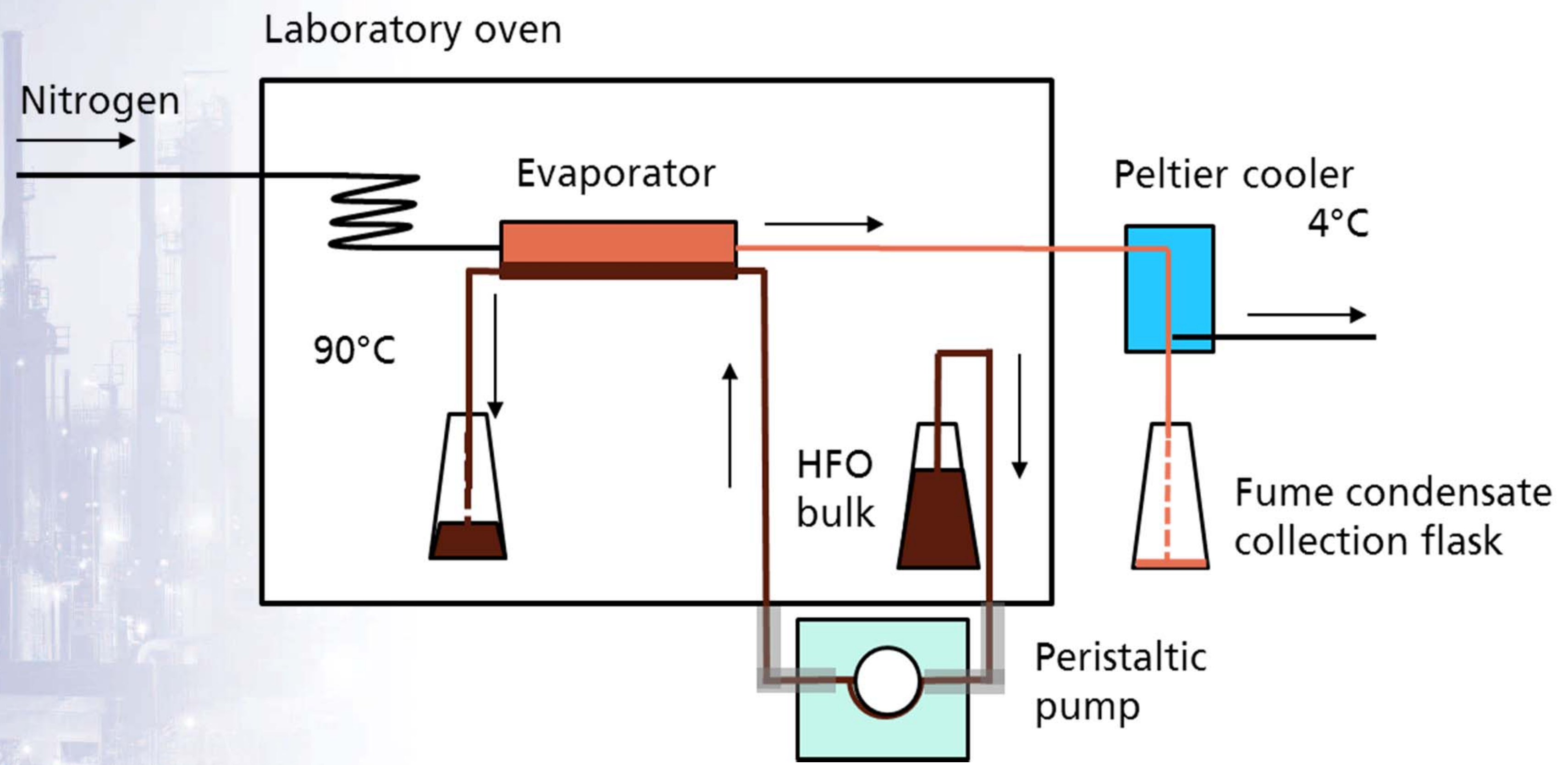
- Set up a laboratory system to simulate vapour emission from the surface of heated HFO in bunkers during barge loading (using a real product at its standard operational temperature)
- Collect the vapour (by condensation) to study composition and biological activity
- Support Concawe member companies in field studies of emissions and worker exposures

Note: the principles applied are based on similar studies on bitumen conducted by Fraunhofer ITEM which were published in the scientific literature

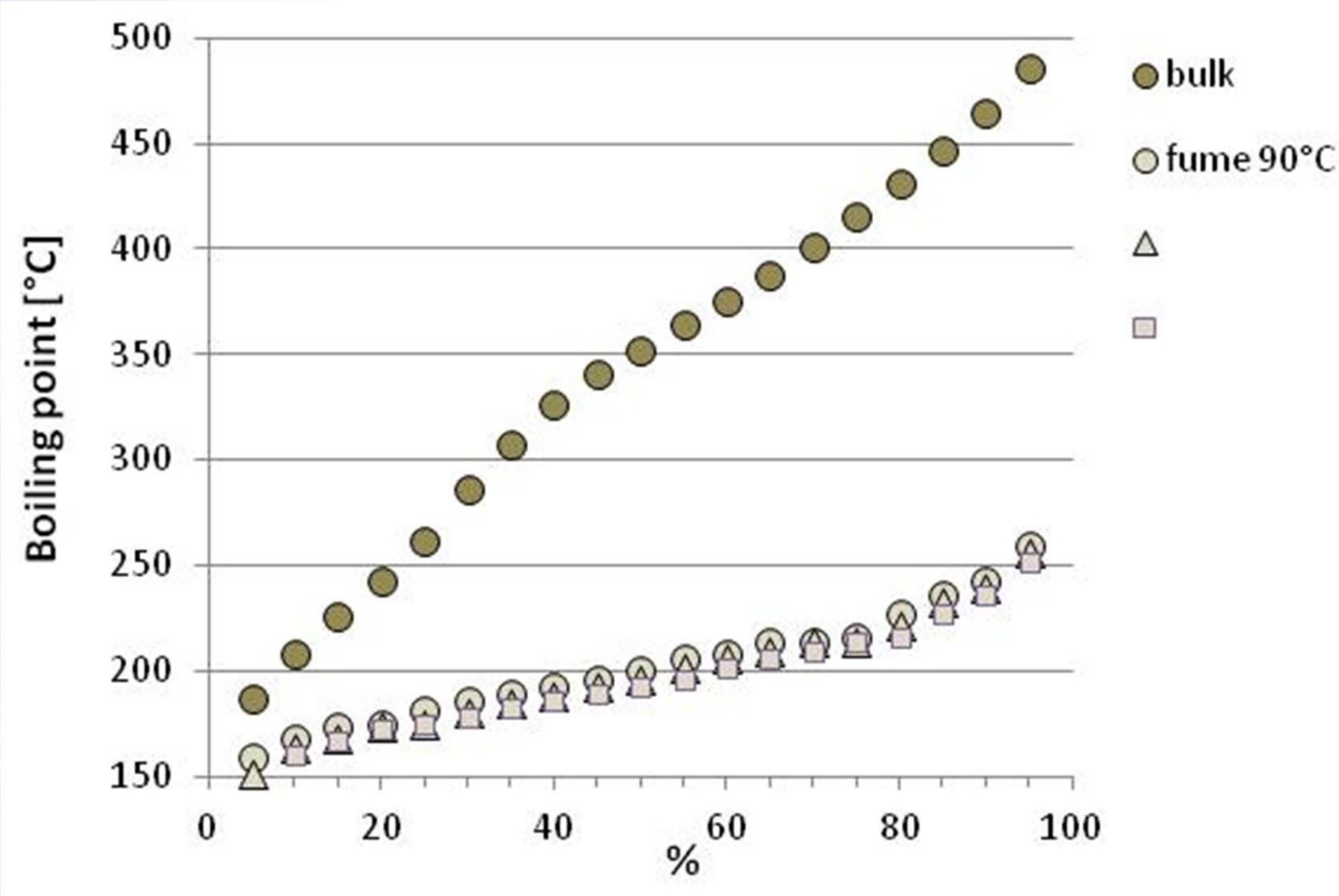
Boiling point distribution of 2 HFO bulk samples



Set-up to generate and collect vapours from HFO



Boiling point distributions of HFO bulk and vapour (3 tests)



Some initial HFO vapour data from the laboratory

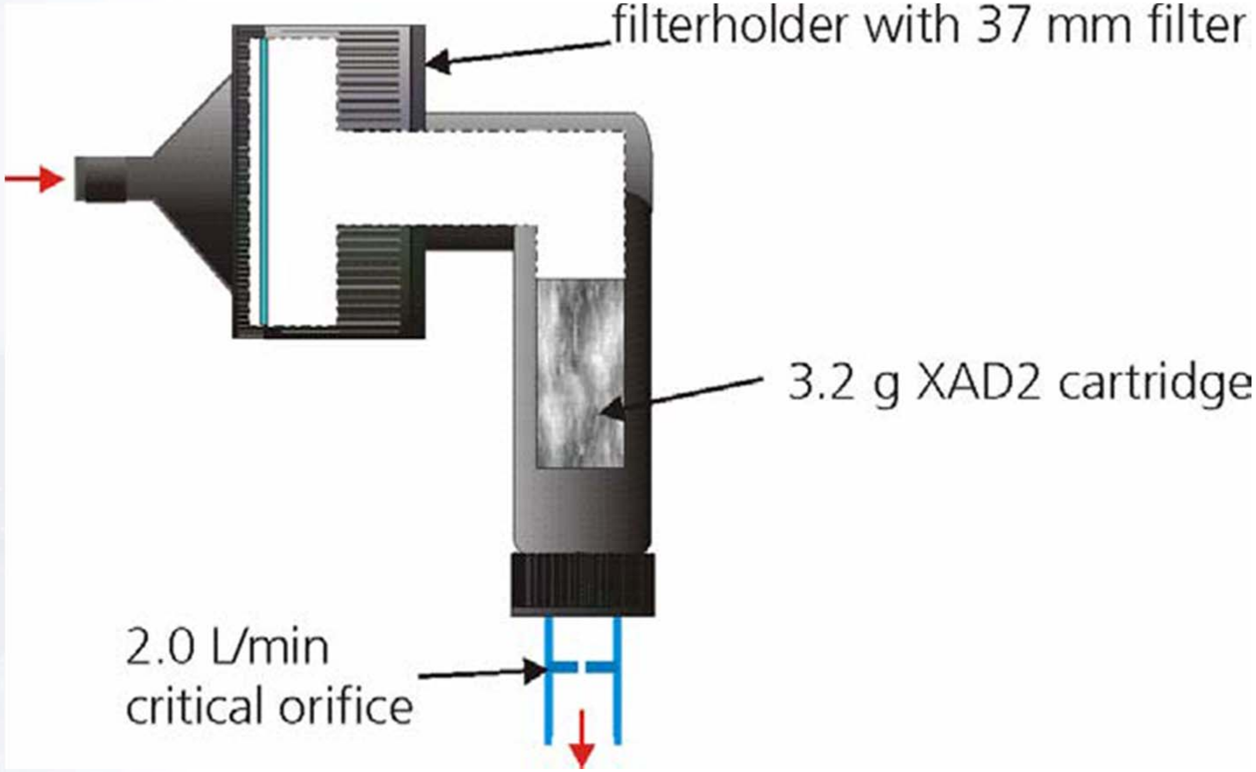
Sample HFO PA, held at 90 °C (worst case):

- Boiling point range (5-95%): 150 – 260 °C
  - For comparison, kerosine boils over 90 – 320 °C; diesel fuel boils over 140 – 500 °C
- Tested fluorescence at 415 nm calibrated against Diphenyl anthracene
  - Indicative of overall PAC content
  - Vapour sample 1600 times less fluorescence than bulk sample
- Further HFO samples from other sources will be studied
  - Fluorescence
  - Chemical composition
  - Modified Ames test to characterise mutagenicity (and carcinogenicity potential)

Planned field studies at HFO barge loading jetties

- Static air sampling near central vent on barge
- Personal sampling on crew member who monitors loading
- Personal sampling of jetty operator during loading (connection/disconnection of hose), product sampling, jetty supervision
- Analytical strategy aimed at comparing field data with lab generated vapour – based on same products and temperature in lab and in field
- Air Sampler designed to collect <u>vapour and mist in the same way as a person breathes in air</u>

Air sampler used for HFO vapour / mist collection



Timeline to complete study

- Field work scheduled for July – October
  - Attempts in July/August in Rotterdam and Hamburg areas not successful due to last-minute barge loading changes
  - Next survey scheduled for Vlissingen (NL), w/c 29th August
- Laboratory work was started in April, to continue until November
- Data interpretation, report writing in Q4/2013
- Next presentation to ADN Safety Committee in January 2014

Thank you for your attention!

Questions?