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

Jan Urbanus (Shell) for Concawe
ADN Safety Committee
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1. Project background
2. Theoretical considerations
3. Preliminary results from laboratory study
4. Planned field work
5. Timeline for project completion

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

- Boiling point [°C]
- %

Graph showing the boiling point distribution of HFO PA and HFO PB samples.
Set-up to generate and collect vapours from HFO

Laboratory oven

- Nitrogen
- Evaporator
- Peltier cooler 4°C
- HFO bulk
- Peristaltic pump
- Fume condensate collection flask
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 *vapour and mist in the same way as a person breathes in air*
Air sampler used for HFO vapour/mist collection

- Filter holder with 37 mm filter
- 3.2 g XAD2 cartridge
- 2.0 L/min critical orifice
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?