Verifying the efficiency of solvent RMMs

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Project Background

- ECETOC TRA used for solvent CSAs
- Basis = generic exposure scenarios developed by ESIG/ESVOC
- However, RMMs within TRA not sufficient / realistic for solvent scenarios

➡ RMMs / phrases identified by ESIG on basis of CONCAWE report 11/12

  - Various levels of containment in combination with ventilation
  - Use of drum pumps for filling procedures
  - Draining and flushing procedures for maintenance operations

- Lack of experimental data on efficiency

➡ Search and/or generate experimental data

Phrase Description	Phrase Codes	Reduction (estimated %)	Boundary of Application
Minimise exposure by extracted **full enclosure** for the operation or equipment	E61	90 (prof) 95 (ind)	All PROCs
Minimise exposure by **partial enclosure** of the operation or equipment and provide extract **ventilation** at openings	E60	80 (prof) 90 (ind)	All PROCs except 7 and 11 (spray operations)
Restrict **area of openings** to equipment	E68	80 (all uses)	All PROCs except 7 and 11 (spray operations)
Drain down and **flush** system prior to equipment break-in or maintenance	E55	90 (ind)	Only maintenance activities (essentially PROC 8a) in industrial settings
Drain down system prior to equipment break-in or maintenance or **Drain or remove** substance from equipment prior to break-in or maintenance	E65 or E81	80 (all uses)	Only maintenance activities (essentially PROC 8a)
Use **drum pumps**	E53	80 (all uses)	Only material transfer activities for liquid substances (essentially PROCs 3, 4, 8a and 8b). Moderate volumes (drums, IBCs).

Available literature + further information

- Literature research (WebOfScience, SciFinder, Scopus) on efficiencies:
  - Hardly solvent specific information (dust, mwf, …)
- Industry (drum pump manufacturers, formulators, adhesives association, …): Mostly qualitative information

➡ No good database for solvent related scenarios and RMMs
➡ Experimental studies

Development of experiments

- All evaluated phrases should be covered with a minimum of experiments
- Tasks should be compatible with the corresponding phrases
- Tasks should be representative for the solvent sector

- Transfer activities (e.g. PROC8a, 8b) = representative task for most phrases (**containment** and **drum pump** phrases)
- "Worst case" task (large surface, spilling possible)
- **Flushing and draining:** drum = surrogate for generic parts of equipment (flushed vs. just drained)

→ Evaluation of several RMMs with a small number of experiments and a standardised and pragmatic set-up.

Development of experiments

- Discussion of scenario setup + several iterations of refinement
- Experimental pilot study: establishment of experimental set-up, data acquisitions / sampling and evaluation

Main equipment:

- Reservoir and collection containers (120 and 60 L) with removable lids; two openings
- Drum pump set “Solvents”
- Portable IR-Spectrometer
- Antistatica Kit
- Fume hood
- bioethanol

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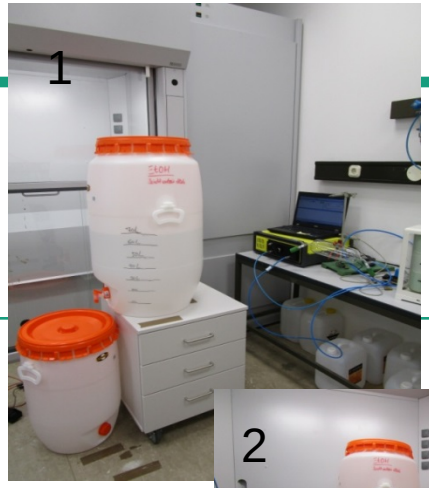
Scenarios

#	Scenario
1	Baseline – Gravity transfer from an open container into another open container with no exhaust and ventilation system in place
Gravity Transfer (splash loading)	
2	Open gravity transfer with partial enclosure (inside open fume cupboard) into a container. Room ventilation and fume cupboard switched on.
3	Open gravity transfer with full enclosure (inside closed fume cupboard) into a container. Room ventilation and fume cupboard switched on.
4	Gravity transfer from an open container into another open container – application of a local exhaust system (LEV, elephant trunk) and no enclosure (outside fume cupboard). Room ventilation switched on.



Drum Pump Transfer (submerged loading)	
5	Drum pump transfer (lids on containers) with no exhaust and no room ventilation
6	Drum pump transfer (lids on containers) with partial enclosure (inside open fume cupboard). Room ventilation and fume cupboard switched on.
7	Drum pump transfer (lids on containers), room ventilation and a local exhaust ventilation system in place (elephant trunk)

Drain and Flush	
8	Base configuration for scenario 9: Drained container without flushing with no exhaust and ventilation system in place
9	Flushed container with no exhaust and no room ventilation system in place

Phrase (experimental aspect represented by comparison)	**% exp.**	**% estimated**
Gravity transfer		
E60: Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings (open fume cupboard, switched on, room ventilation)	98.8	80/90
E61: Minimise exposure by extracted full enclosure for the operation or equipment (closed fume cupboard, switched on, room ventilation)	(>99)	90/95
E54: Provide extract ventilation to points where emissions occur**; or E66:** Ensure material transfers are under containment or extract ventilation (LEV + room ventilation)	97.1	(75-95 LEV, 30/70 GV, ECETOC TRA)
Drum pump transfer		
E53: Use drum pumps; **(E68:** Restrict area of openings to equipment) (drum pump (with closed container lids))	93.5	80 (E53/ E68)
E53 (E68) and E66 (drum pump (with closed container lids) + open fume cupboard, switched on, room ventilation)	99.5	-
E53 (E68), and E54 or E66 and room ventilation (drum pump (with closed container lids) + LEV + room ventilation)	98.9	-
Draining and flushing		
E55: Drain down and flush system prior to equipment break-in or maintenance (working on flushed equipment)	95.2	90

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Summary + conclusion

- Selected RMMs / phrases were evaluted: ventilation, enclosure, drum pumps
- Limited information available in literature → experimental studies
- Assessed situation and all exposure parameters have to be considered in order to ensure that the expected exposure reductions will be met.
- Efficiency results for the evaluted RMMs are only valid for the specific process of solvent transfer (not removal of drum pump etc.)
- New experimental data seem to support ESIG suggestions (all comparisons with worst case baseline result in >90%)
- Even higher efficiencies may be reached when the task is undertaken in a well-controlled setting
- Ventilated containment (fume cupboard) and drum pump can both give high efficiency for transfer activities → suitable alternatives for LEV

Lessons learnt during this project

- Careful design of experimental setup:
  - Clear definitions and assignments of phrases
  - Technical details
- Choice of baseline scenario:
  - Realistic and relevant worst case
- Data evaluation and sampling:
  - Personal sampling vs static sampling
  - Peak concentration, average …

Thank you very much for your attention!

Acknowledgements:

ESIG - European Solvents Industry Group

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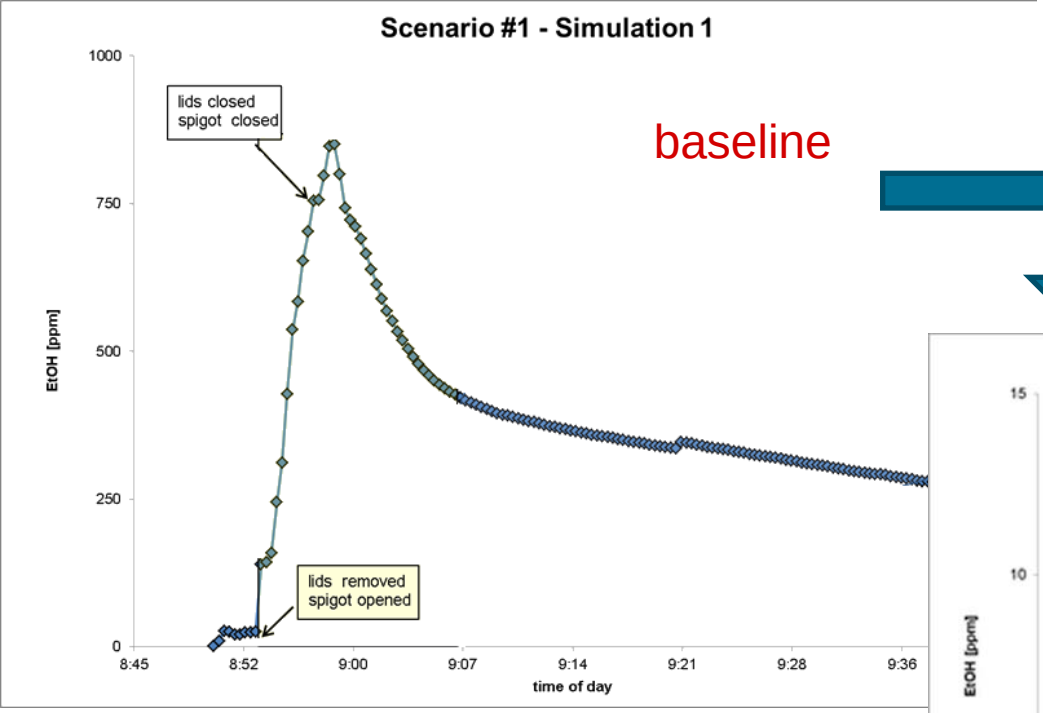
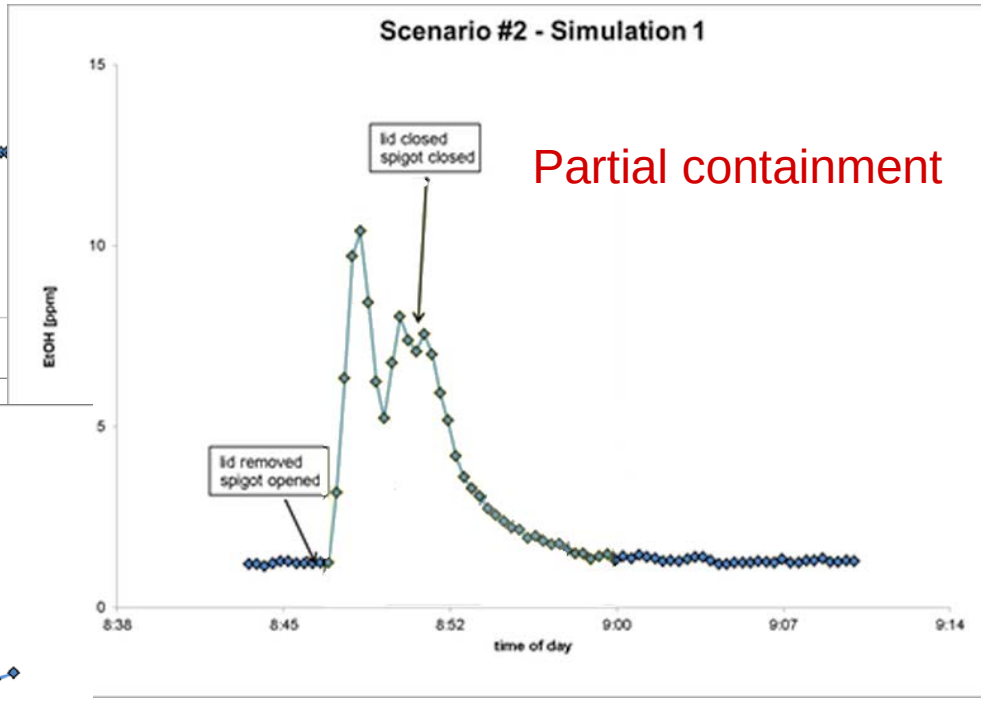
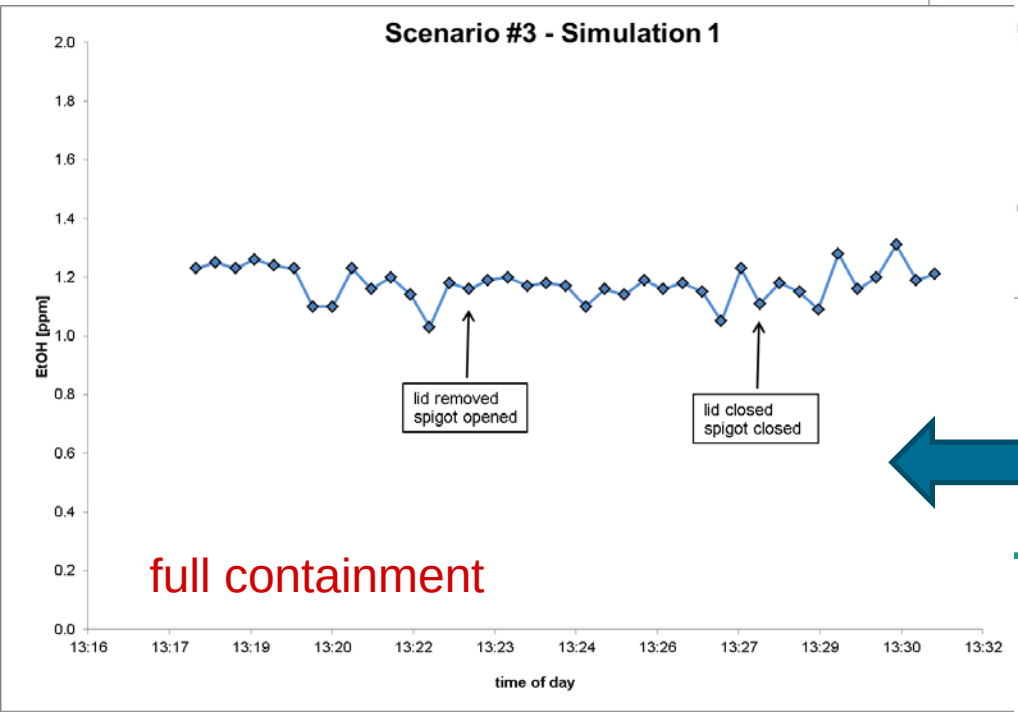
Examples



baseline



Partial containment



full containment

- Stationary sampling
- Min. 3 simulations per scenario

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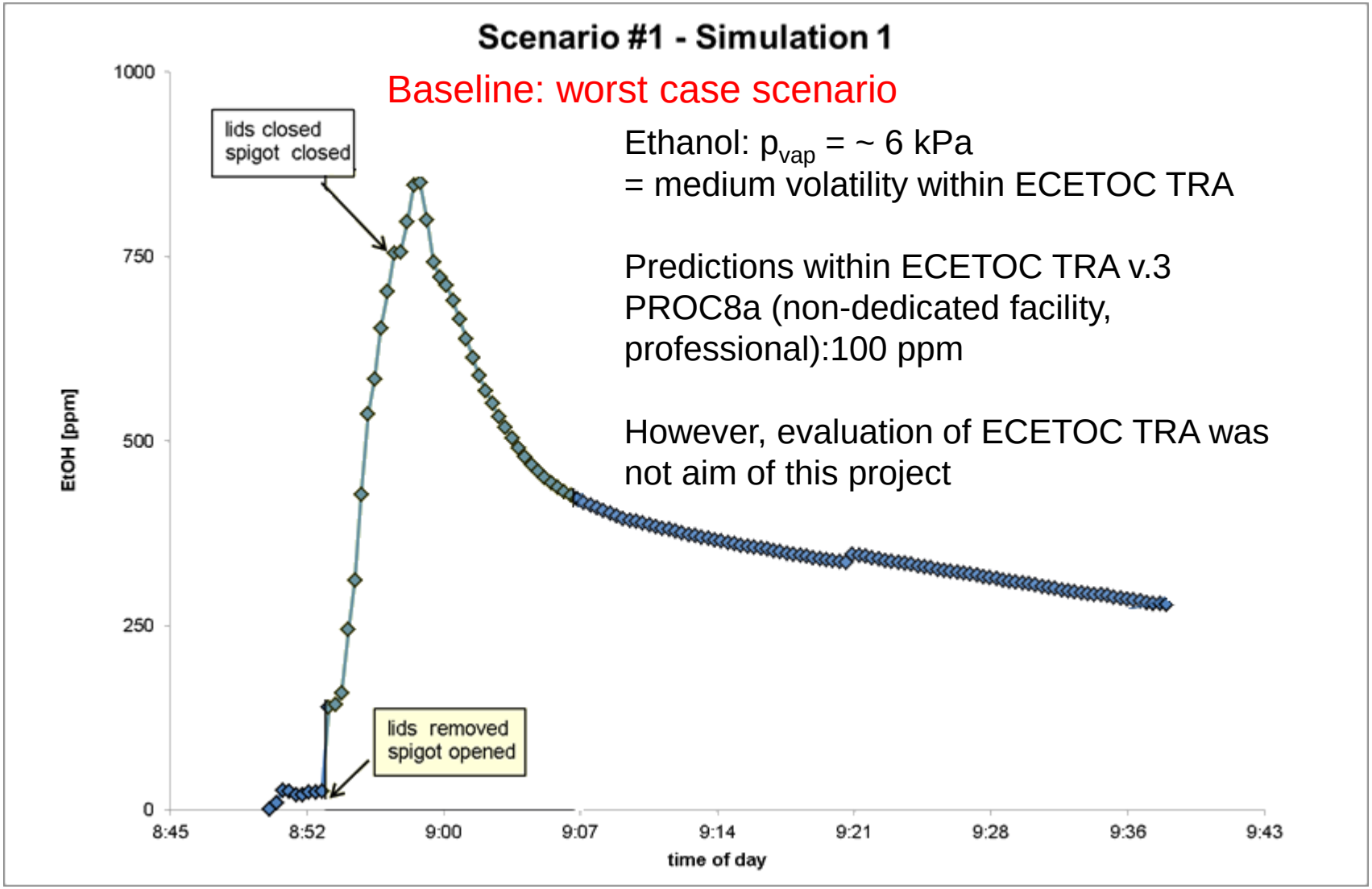

Ethanol: p_{vap} = ~ 6 kPa
= medium volatility within ECETOC TRA

Predictions within ECETOC TRA v.3
PROC8a (non-dedicated facility, professional):100 ppm

However, evaluation of ECETOC TRA was not aim of this project