EXPERIMENTAL ASSESSMENT OF INHALATION AND DERMAL EXPOSURE TO CHEMICALS DURING INDUSTRIAL AND PROFESSIONAL ACTIVITIES

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BENAKI PHYTOPATHOLOGICAL INSTITUTE

INTRODUCTION

- No meaningful exposure data available for many specific work situations
  - Availability of reliable exposure models to predict exposure important for risk assessment.
  - Development and validations of exposure models hampered by scarcity of sound exposure data

- Validation studies performed to evaluate different parts of ECETOC TRA v3.1 model (ETEAM inhalation part, Cefic LRI B16 / Marquart et al. (2017) dermal part)
  - Results indicate that the model could be improved for certain PROCs, or that data lacked to evaluate certain PROCs
  - The model seemed less conservative for substances with high dustiness or volatility

OBJECTIVES

- Based on review, selection of scenarios and performing exposure measurements in experimental settings, taking into account both dermal and inhalation exposure, relevant exposure determinants used by ECETOC TRA (e.g. dustiness and volatility) and other contextual information.
- Compare these measurements with ECETOC TRA predictions
- Provide insight in areas where the model could be improved

EXPERIMENTAL DESIGN

PROC	Product	# volunteers	# repeats	# experiments	Dermal exposure	Inhalation exposure
PROC 4: Use in batch and other process (closed)	Solid	5	2	10	✓	
	Liquid	5	2	10	✓	✓
PROC 5: Mixing or blending in batch processes (partly closed)	Solid	5	2	10	✓	
	Liquid	5	2	10	✓	✓
PROC 10: Rolling	Liquid	5	2	10	✓	✓
PROC 13: Immersion	Liquid	5	2	10	✓	✓
PROC 19: Stirring	Solid	5	2	10	✓	

EXPERIMENTAL DESIGN (2)

- SOPs developed for each PROC describing:
  - Activity
  - Duration
  - Equipment used
  - Substance
  - Etc.
- Tested in pilot study

TEST LOCATION (BPI)

LRI The Long-range Research initiative

CHOICE OF SUBSTANCES

- For exposure scenarios containing solids:
  - Tinopal SWN (CAS 91-44-1, 7-diethylamino-4-methylcoumarin) Fluorescent compound

- For exposure scenarios with liquids:
  - Tinopal SWN dissolved in 1,2 Dichloroethane, Glycerol and MeOH
    - For dermal exposure, Tinopal SWN was measured
    - For inhalation exposure, 1,2 DCE was measured

MEASURING INHALATION EXPOSURE

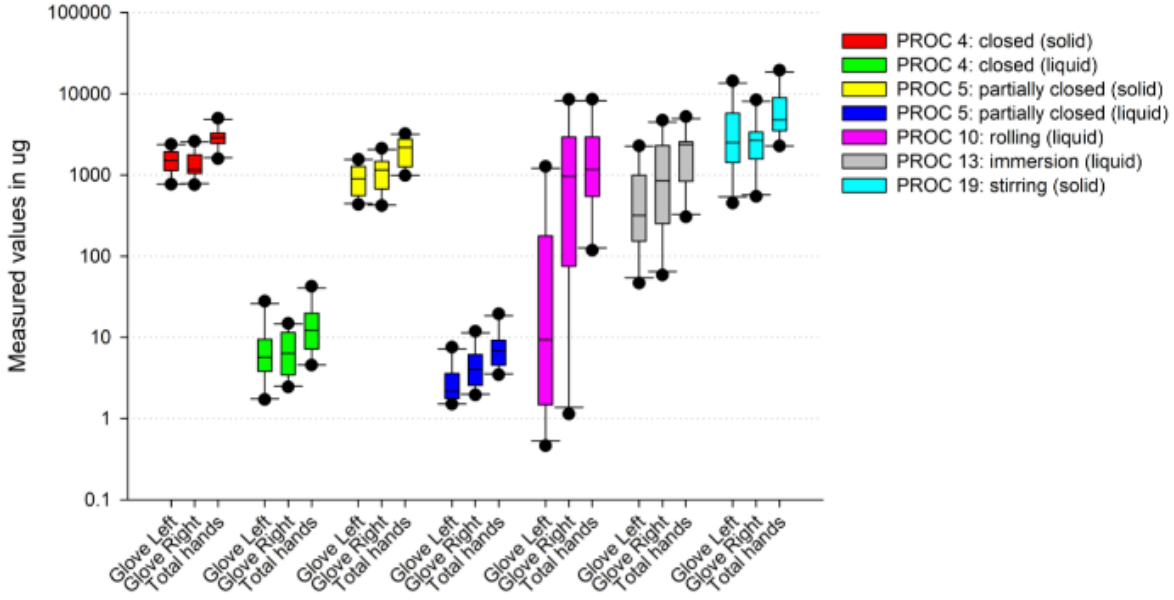
- Quantitative inhalation exposure:
  - Personal air-sampling pump, sampling head+matrix placed in breathing zone
  - Charcoal sorbent tubes
  - Chemical analysis: Shimadzu QP2010 Plus GCMS

QUANTITATIVE DERMAL EXPOSURE HANDS

- Measurements of potential dermal exposure
- Active substance: Tinopal SWN (fluorophore compound)
- Use cotton gloves
- Existing validated HPLC-FD method for powders and liquids

RESULTS MEASUREMENTS DERMAL

- Liquid: concentration Tinopal SWN 0.5%
- Solid: concentration Tinopal SWN 100% (pure Tinopal)

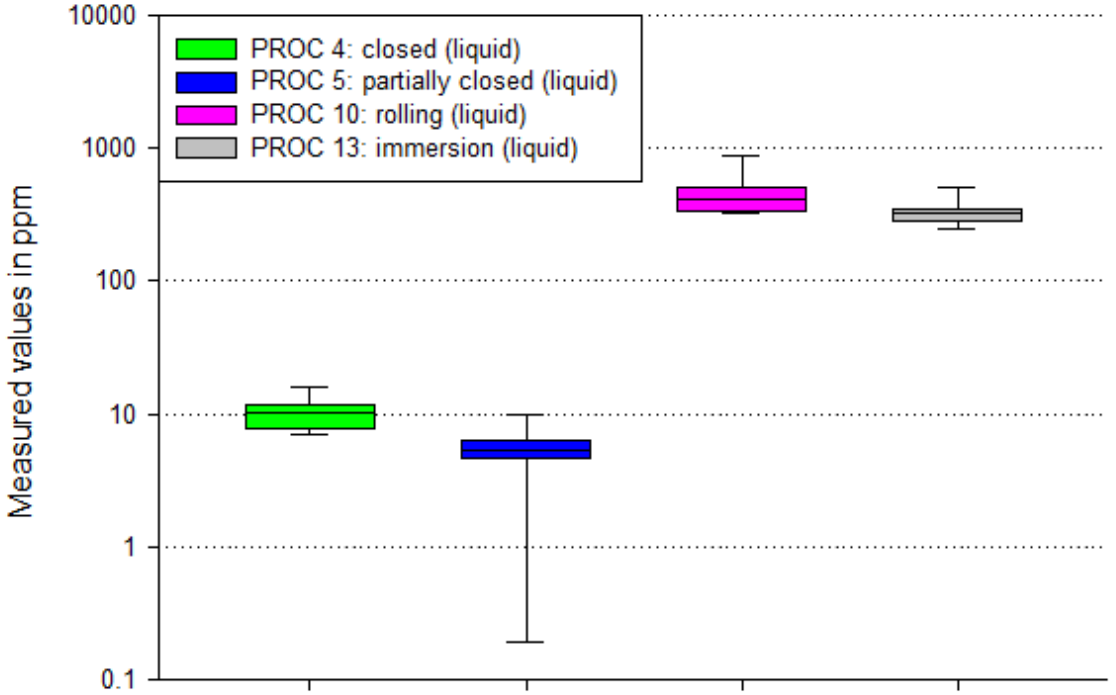


PROC 4 SOLIDS

PROC 10 LIQUID

RESULTS MEASUREMENTS INHALATION

- Liquid: concentration 1,2-dichloroethane (semi-volatile) 64.5 %



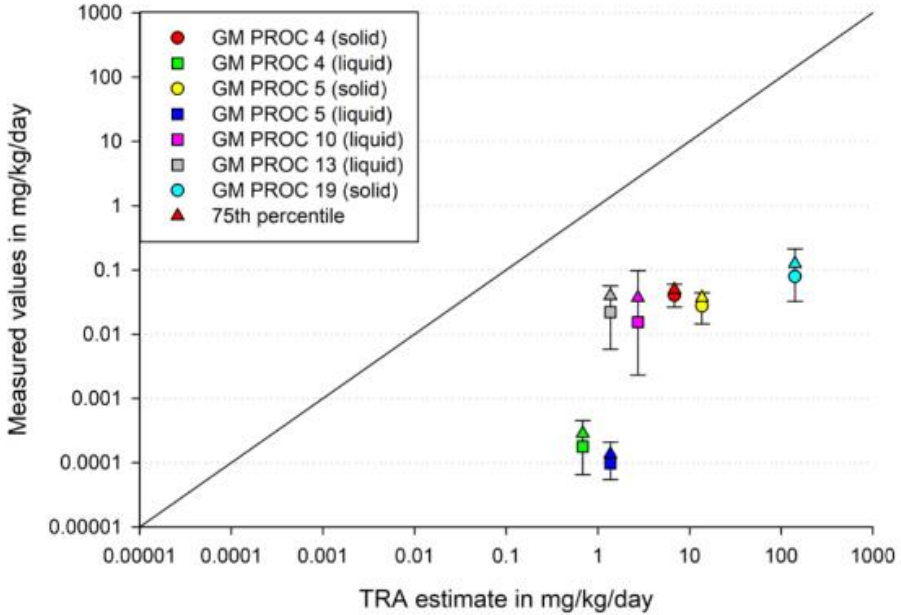
MODEL INPUTS PER PROC

- Both dermal and inhalation
  - No LEV
  - Professional use
- Dermal
  - No gloves
- Inhalation
  - Enhanced general ventilation

Study						TRA inputs		
PROC	**Product**	**Duration**	**Route of exposure**	**Dustiness / vapor pressure**	**Concentration**	**Duration**	**Dustiness / vapor pressure**	**Concentration**
4	Solid	17-18 min.	Dermal	10976 – 16663 mg/kg	100 %	> 4 hours	High	>25%
	Liquid	17-18 min.	Inhalation	8.7 kPa	64 %	> 4 hours	500 to 10000 Pa	>25%
			Dermal	Low volatile	0.5 %		< 0.01 Pa	<1 %
5	Solid	16-17 min.	Dermal	10976 – 16663 mg/kg	100 %	> 4 hours	High	>25%
	Liquid	16-17 min.	Inhalation	8.7 kPa	64 %	> 4 hours	500 to 10000 Pa	>25%
			Dermal	Low volatile	0.5 %		< 0.01 Pa	<1 %
10	Liquid	25 min.	Inhalation	8.7 kPa	64 %	> 4 hours	500 to 10000 Pa	>25%
			Dermal	Low volatile	0.5 %		< 0.01 Pa	<1 %
13	Liquid	6-8 min.	Inhalation	8.7 kPa	64 %	> 4 hours	500 to 10000 Pa	>25%
			Dermal	Low volatile	0.5 %		< 0.01 Pa	<1 %
19	Solid	15 min.	Dermal	10976 – 16663 mg/kg	100 %	> 4 hours	High	>25%

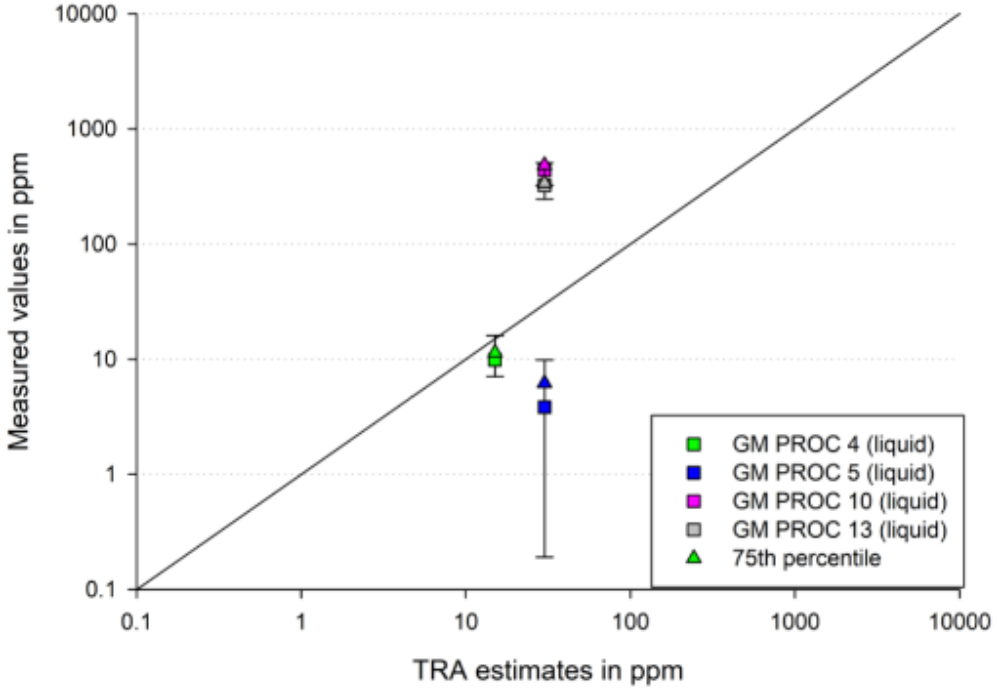
MODEL COMPARISON DERMAL (MG/KG/DAY)

- General observations
  - TRA estimates conservative for all situations
  - Too conservative?
  - For PROC 4 measured exposure values are slightly higher compared to PROC 5
- Measured values were converted to mg/kg/day (total hands (in µg) / 1000 µg / 70 kg)



MODEL COMPARISON INHALATION (PPM)

- General observations
  - TRA predicts well for PROC 5, but underestimates the other PROCs
  - PROC 5, 10, 13 all have the same initial estimate.



CONCLUSIONS AND RECOMMENDATIONS

- ECETOC TRA dermal module is conservative for all PROCs measured
- ECETOC TRA inhalation module is not conservative for PROC 10 and 13 medium volatile substances
  - Advised to:
    - adjust the base exposure predictions for these PROCS
    - to investigate conservatism over different model parameters
  - Fluorescence photographs are useful to investigate:
    - body exposure visually
    - exposure patterns on body and hands


THANK YOU FOR YOUR ATTENTION
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