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Cross Sectional Study on Inhalation and Dermal Exposure to Solvent Cocktails in Printing Industry

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- **Industrial engineer biochemistry**
- **Occupational Hygienist**
- **Teamleader Occupational Hygiëne at Liantis**

Liantis

- **Organisation of 1700 employees**
- **All aspects of entrepreneurship**

Health and safety

- **Around 600 within health and safety**
- **Since 1966**

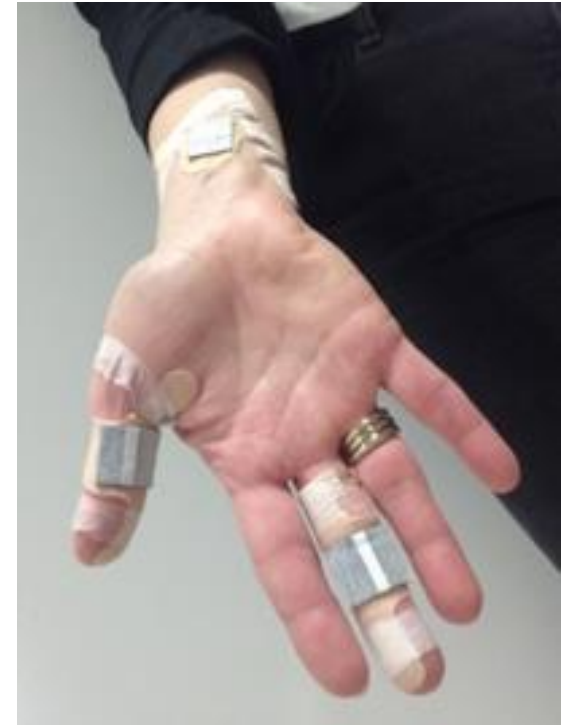
- 1. Introduction**
- 2. Method**
- 3. Result**
- 4. Conclusion**

Introduction

Course Occupational Hygiene (2017 - 2018) **Thesis study**

Subject?

- **Chemical risks**
- **Measurement possibilities**
- **Possibility to test new analysis method for dermal exposure**



Introduction

Measurements in association with university

<http://www.lamh.be/en>

LABORATORY FOR OCCUPATIONAL AND ENVIRONMENTAL HYGIENE

KU LEUVEN

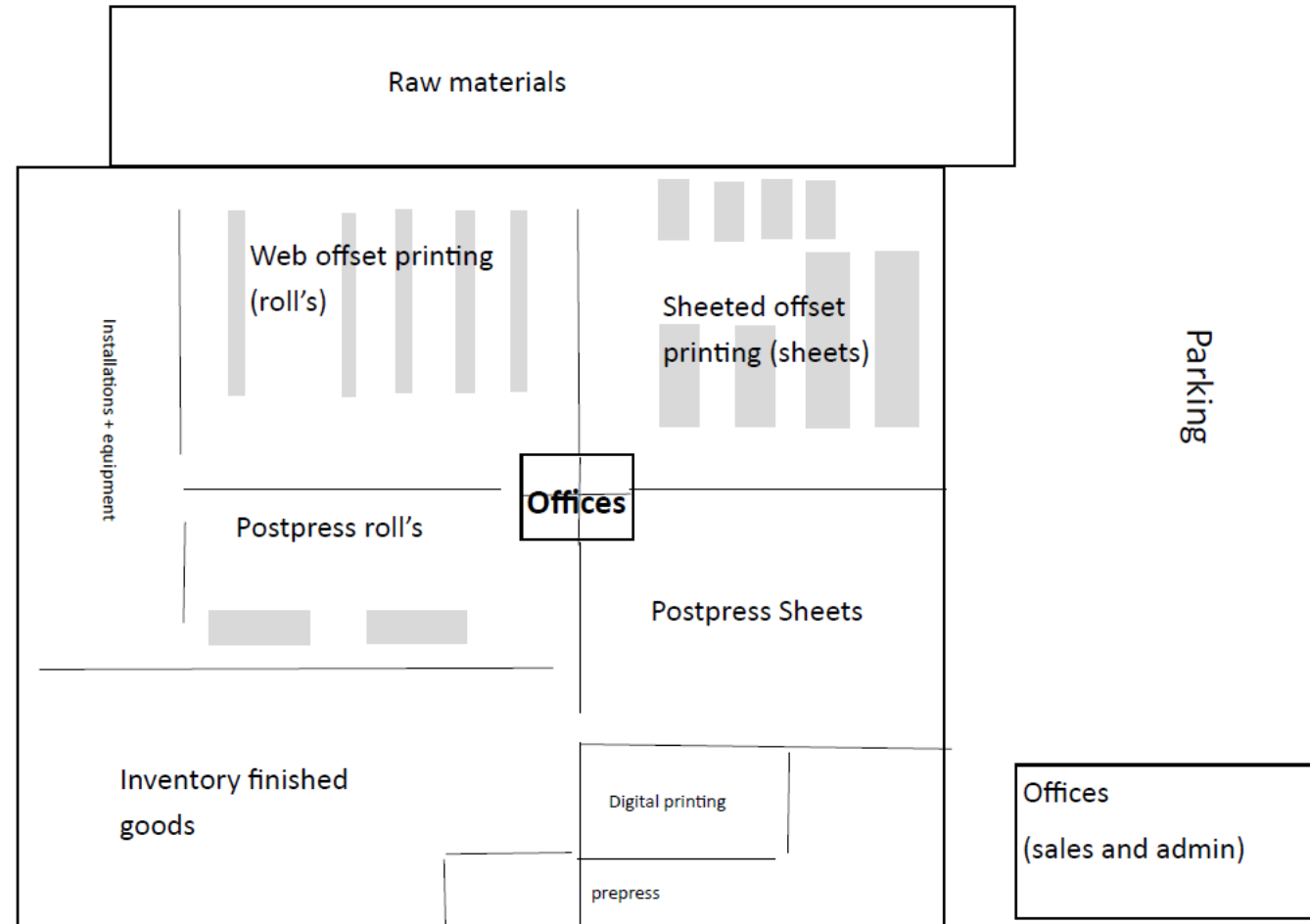
Introduction

- **Questions concerning the health impact of the printing proces to the employee of a client printer**
- **No Chemical Inventory**
- **No risk analysis**
- **No previous measurements**

introduction

Description print company

- **145 employers**
- **Industrial print processes**
- **All types of paper and printwork**



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Introduction

Determination of subject:

- **Typical products in printing: Solvents**
- **Air evaluations possible**
- **Dermal evaluations possible**
- **Known to affect skin (dry skin, skin permeation?)**

Goal :

- **Global evaluation (air and dermal)**
- **Air measurements according to standard NBN EN 689:2019**

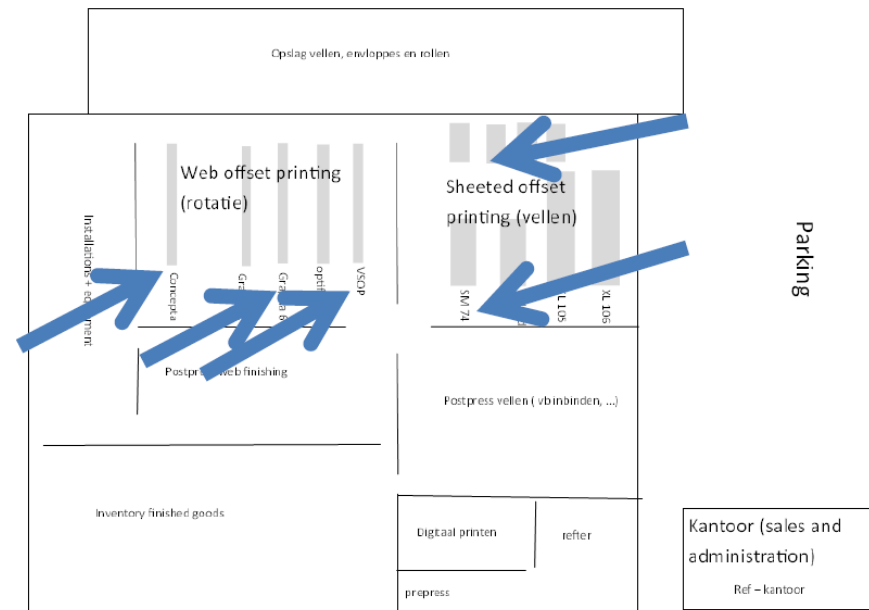
Estimations of usage of chemical products

- Focus on 2 big printing sites (roll's and sheet's)
- Proces type: Offset printing
- Most used solvent : Isopropanol
- Expectation :Isopropanol in relatively high concentrations in air

Methods

1. Screening

- Geneal solvent screening
- Sheets and roll's (different exposures expected)
- Different measurements per exposure
- •5 measurements
- •October 2017



Results

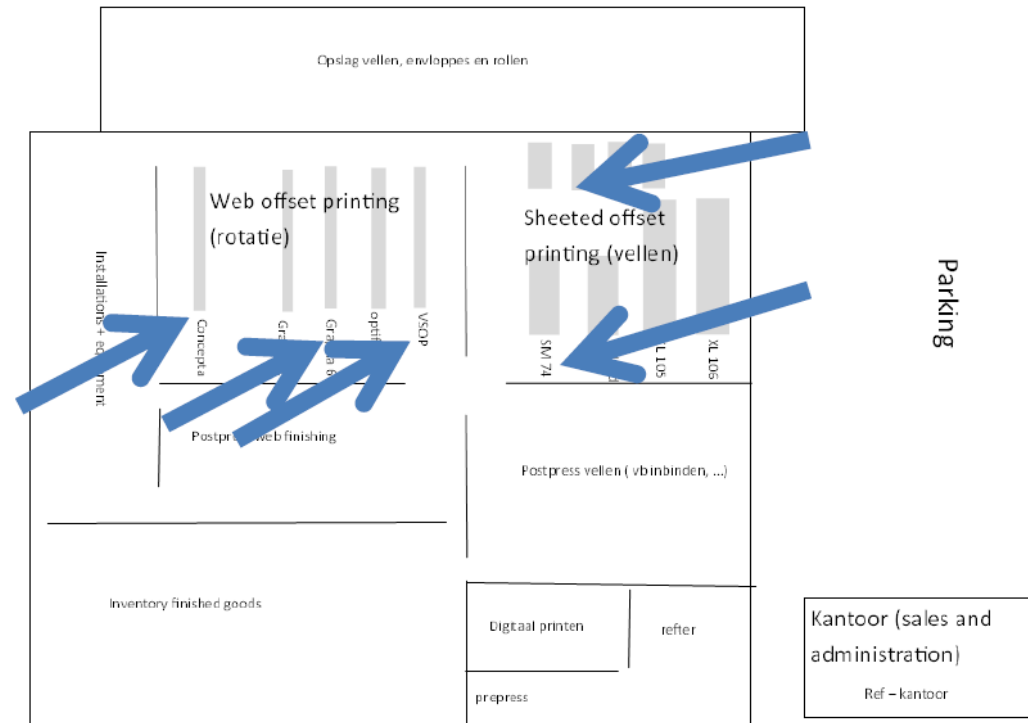
Screenings measurement

Confirmation of isopropanol in the air

Component	Cas nummer	TLV (µg/m³)	VSOP (rotatie)		Concepta (rotatie)		Grapha 6 (ro		enveloppes		SM 74	
			L3206_15		L3209_18		L3208_17		L3207_16		L3205_14	
			concentratie (µg/m³)	relatieve conc (%)	concentratie (µg/m³)	relatieve conc (%)	concentratie (µg/m³)	relatieve conc (%)	concentratie (µg/m³)	relatieve conc (%)	concentratie (µg/m³)	relatieve conc (%)
Isopropanol	67-83-0	500.000	31.836	6,37%	22.725	4,55%	15.040	3,01%	69.709	13,94%	103.880	20,78%
11-undecaan	1120-21-4		344		517		198		1.403		1.113	
Butoxyethanol	111-76-2	98.000	282	0,29%				0,00%	588	0,60%	633	0,65%
n-heptaan	142-82-5	1.664.000	113	0,01%	67	0,00%		0,00%	1.354	0,08%	566	0,03%
n-dodecaan	112-40-3		210		260		113		611		541	
methylcyclohexaan	108-87-2	1.633.000	84	0,01%	51	0,00%			1.037	0,06%	517	0,03%
Aceton	67-64-1	1.210.000									487	0,04%
1-methoxy-2-propanol	107-98-2	375.000	700	0,19%							372	0,10%
3-methylhexaan	589-34-4		57		37				693		314	
n-butylacetaat	123-86-4	723.000									295	0,04%
n-decaan	124-18-5				232		92		377		288	
2-methylhexaan	591-76-4								420		193	
Ethanol	64-17-5	1.907.000									113	0,01%
2,3 di-methylpentaan	565-59-3								167		79	
n-tridecaan	629-05-5		58		72				53		44	
n-pentaan	109-66-0	1.800.000	38	0,00%	35	0,00%					34	
n-nonaan	111-84-2	1.065.000	61	0,01%								
Cyclohexaan	110-82-7	350.000							86	0,02%		
Cummulative blootstelling				7%		5%		3%		15%		22%

Methods

2. Measurement campagne



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Methods

2. Measurement campagne

- active air sampling
- passive air sampling
- Dermal measurement
 - Thumb
 - Middle finger
 - Fore arm
 - nek
- Sheet / rolls departments + reference measurements



March and April 2018
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Methods

Analysis on Patches

**patch with activated charcoal layer
(diffusion + absorption)**

**analysis with dillution of CS₂ and GC-MS
(cnfr air samplings)**



Methods

3 day's

- •Monday 12/03/2018
- •Monday 09/04/2018
- •Friday 13/04/2018

•divided over different workers and jobtypes

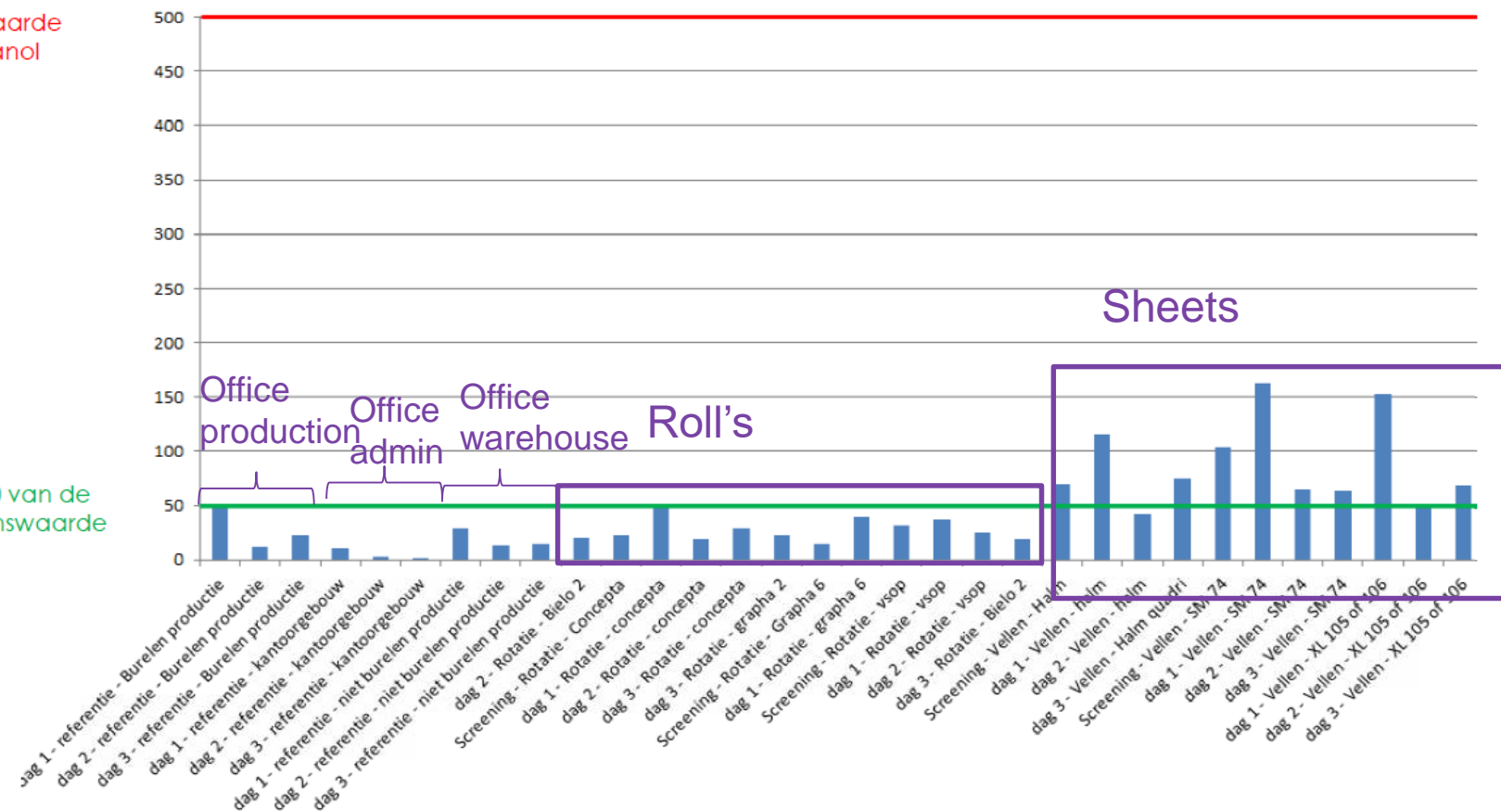
- 3 machines in sheets
- 3 machines in rolls
- The office in production
- The office in de storage
- The adminisatrative office

Results

Air exposure

Grenswaarde
isopropanol

1/10 van de
grenswaarde



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Results

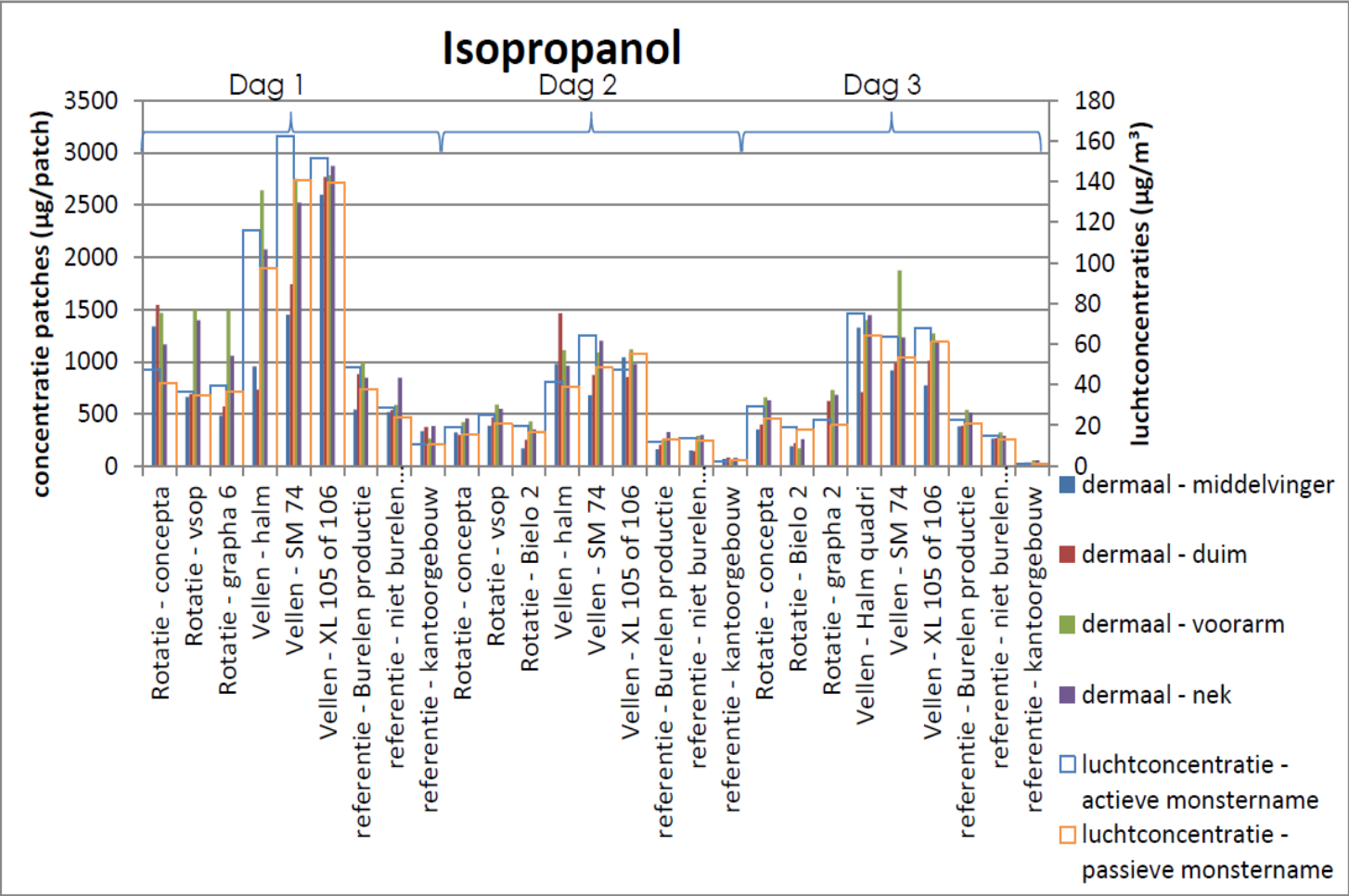
Air exposure

- **Office admin significantly lower**
- **Office in production / warehouse simular exposure as roll's**
- **Relative low exposure at roll's (due to type of proces : UV hardning => low emission + ventilation with filters)**
- **Highest concentration at sheets**

Results

Dermal exposure Isopropanol

Correlation Dermal concentration vs air concentration



Results

Relative good correlations dermal vs air concentrations

No systematic differences between different dermal concentrations

- **Direct contact : Thumb, middlefinger**
- **Splashes : fore arm**
- **Reference due to passive absorption: neck**

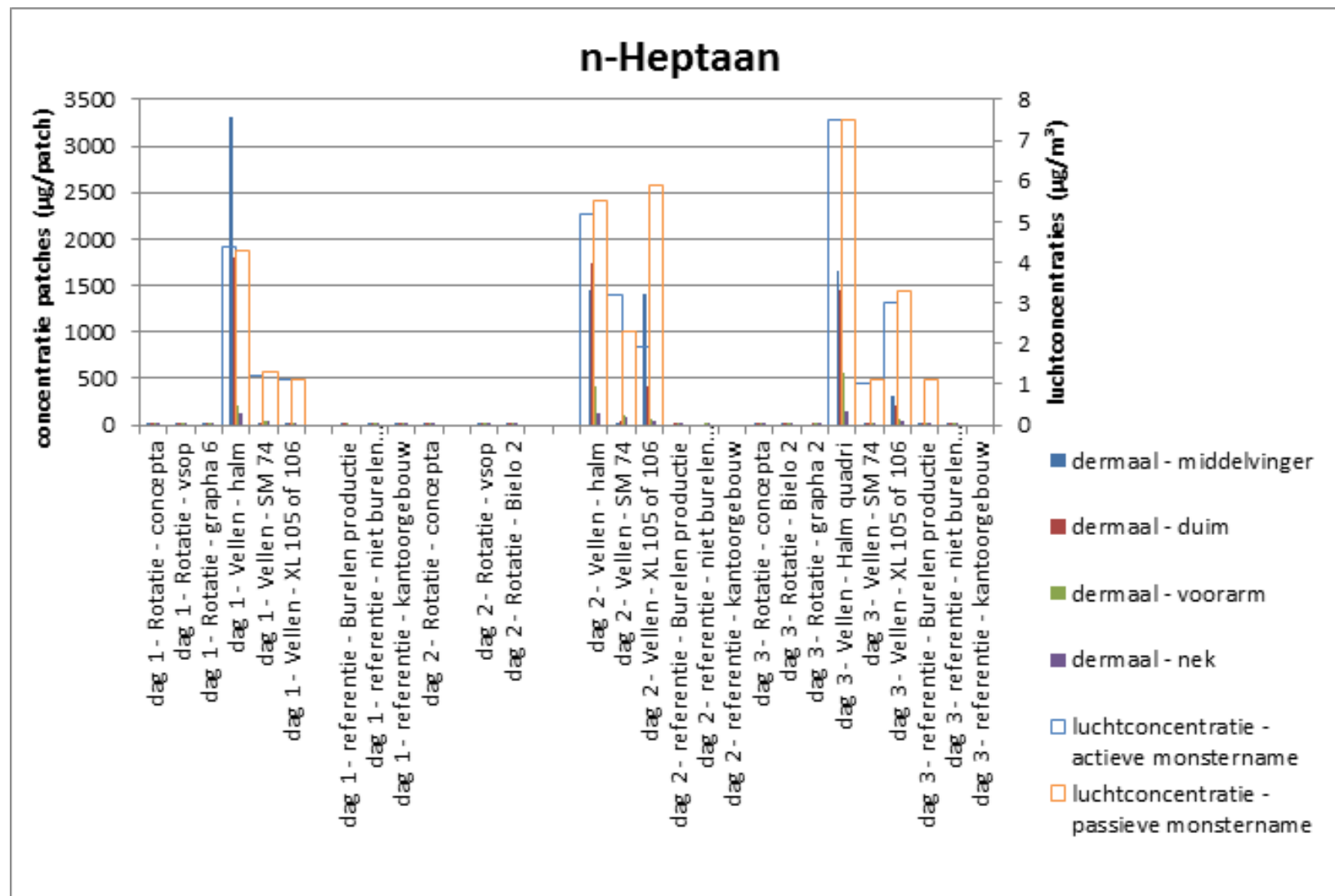
Results

Results manually transferred to data sheet

Some results seemed at least remarkable

**Isopropanol in air allways in high excess present (factor 100 higher) –
other componant in same range dermal exposure
=> relative contribution changed**

Results



Results

Question

- **Are traditional evaluation methods sufficient for dermal exposure?**
High volumes in dermal exposure but not present in air?

Visualisation: correlation air versus dermal exposure.

Purpose determination of the slopes

Slope = indication

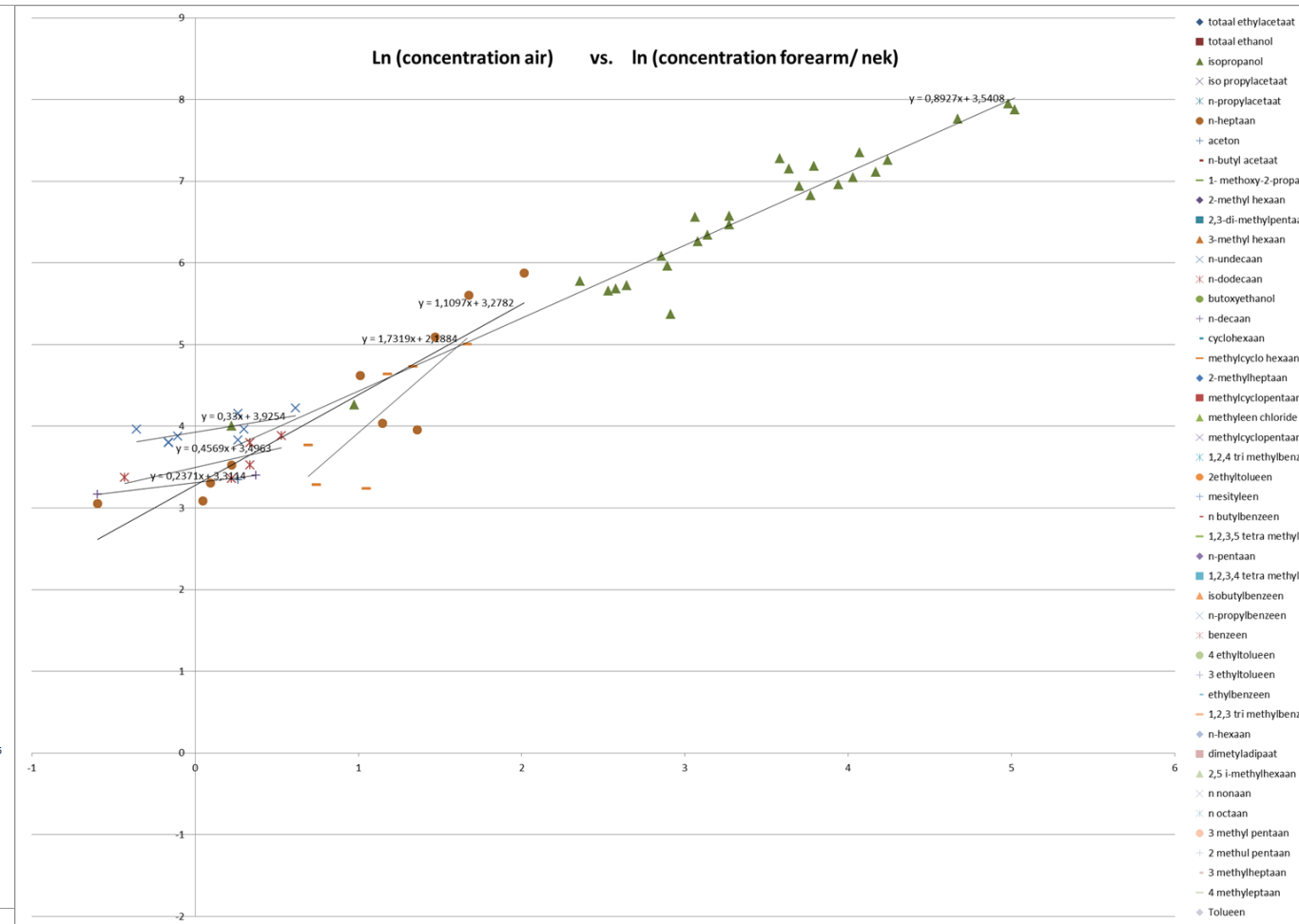
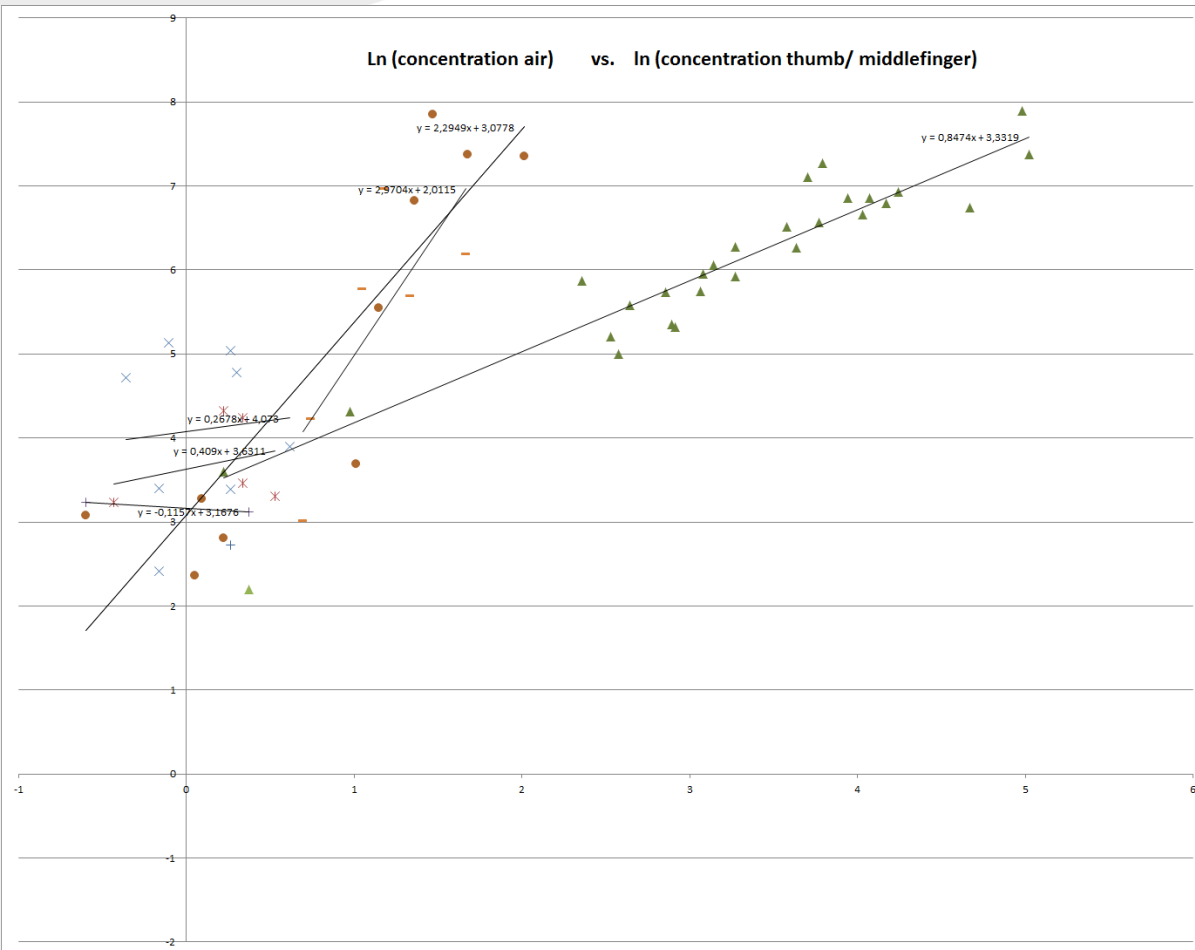
Way to make the graph

Ln concentrations => exposures are mostly logarithmical functions

Dermal exposure in 2 groups : direct en indirect contact

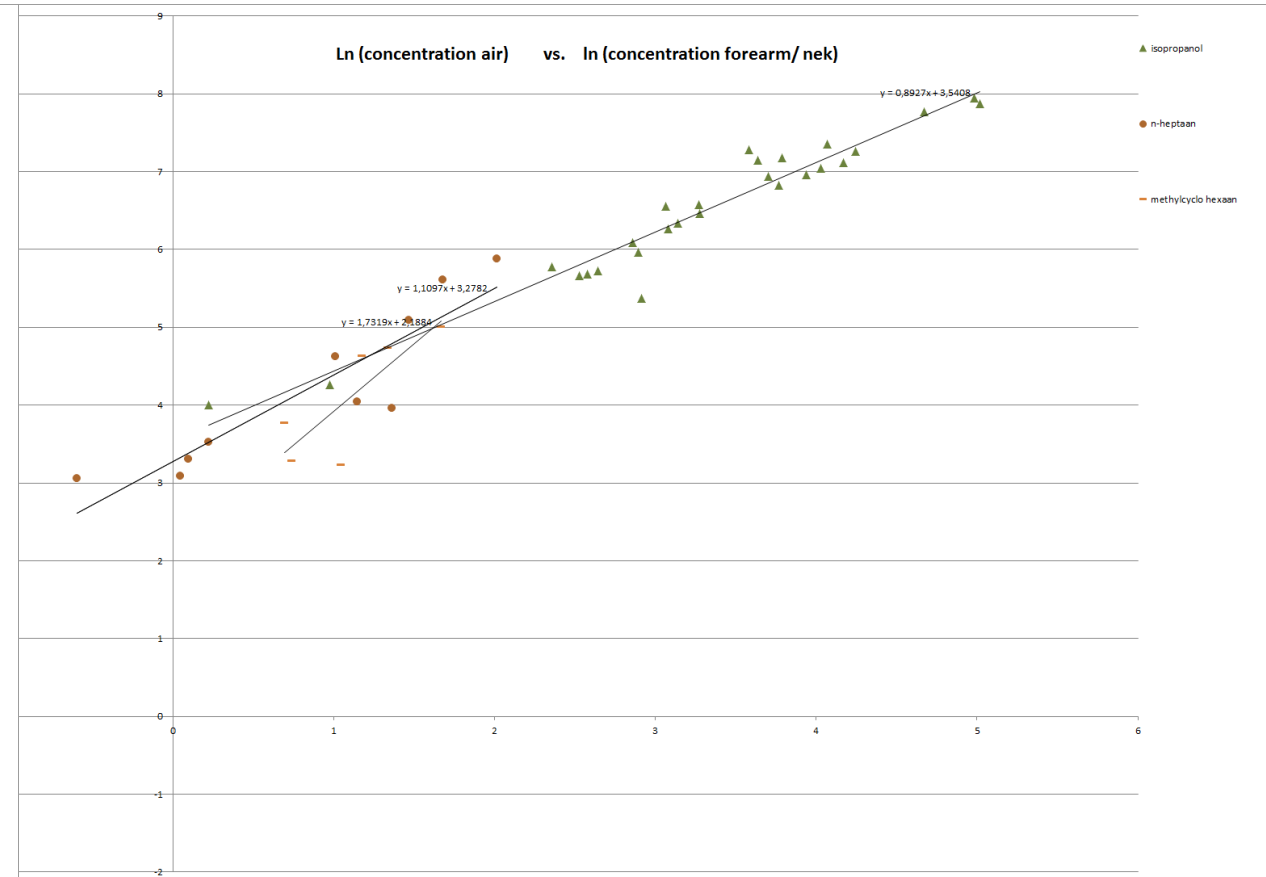
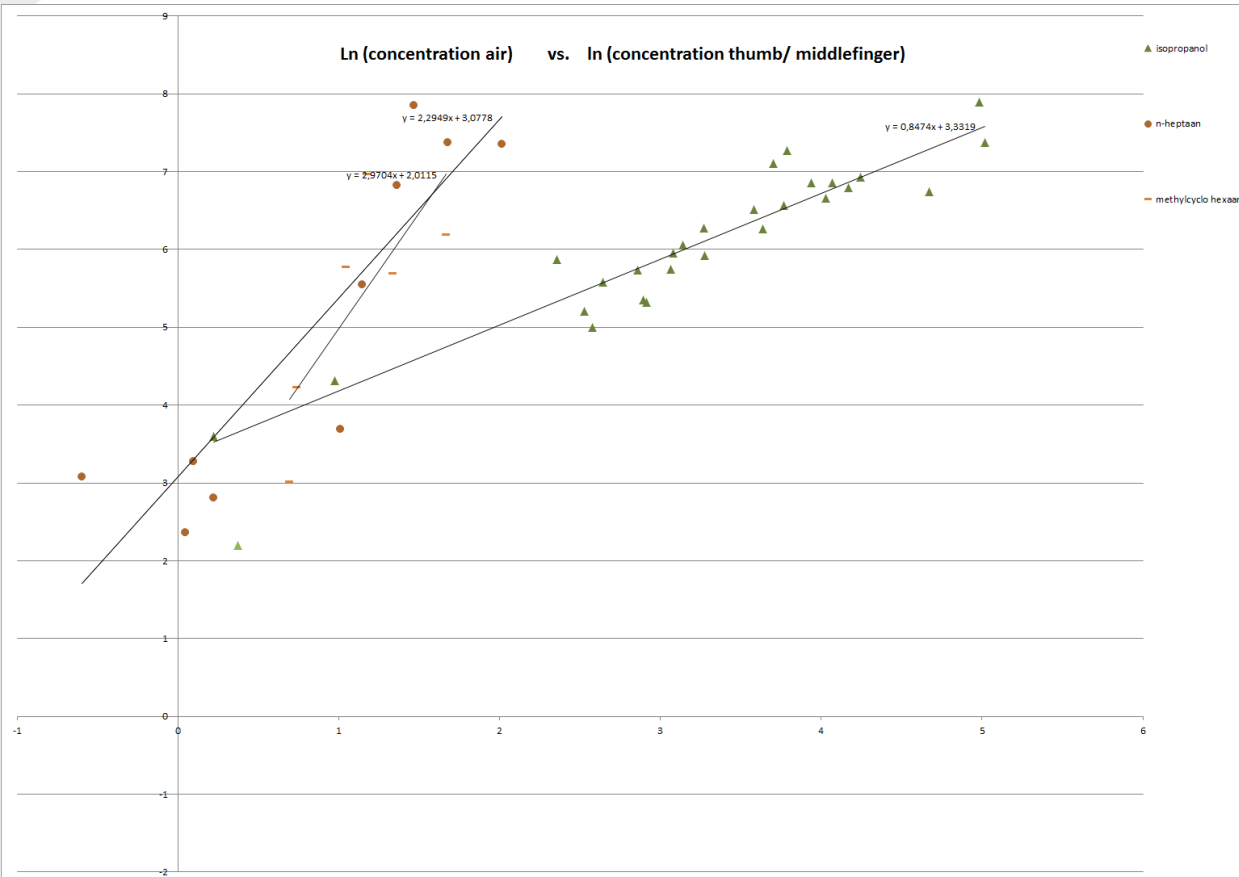
- Direct contact : thumb + middlefinger
- Indirect contact / reference : fore arm + nek

Results



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Results



Results

Isopropanol

- **Slope of direct contact (thumb + middlefinger) and indirect contact (forearm + nek) simular – same inclination**
 - The contribution of isopropanol to dermal exposure is simular for direct and indirect contact, thus due to **general diffusions**
 - Skin permeation factor : 0,00089 cm/h

Results

N-heptane + methylcyclohexane

- **Slope of direct contact (thumb + middlefinger) and indirect contact (forearm + nek) clearly different – very different inclinations**
 - The contribution to dermal exposure is different for direct and indirect contact, thus **direct contacts** to products give an **increase in dermal exposure**
 - **Skin permeation factor : 0,95 cm/h**

Results

How much is to high?

No OELV for dermal exposures

- **Calculations possible based on echa DNELS?**

- Not found on ECHA for isopropanol and n-heptane
- Alternative source: 'chemiekaarten'

$$\text{mg/kg bw/day} = \frac{\begin{array}{c} \text{Dermal patch} \uparrow \\ \mu\text{g/cm}^2/\text{hr} \times 2000\text{cm}^2 \times 8\text{hr} \end{array}}{\begin{array}{c} \text{Hands+forearms} \uparrow \\ 75\text{kg} \times 1000 \\ \text{Body weight} \downarrow \end{array}}$$

Isopropanol DNEL 888 mg/kg/day – n-heptane: DNEL 300 mg/kg/day



Conclusions

•Air concentrations

- Highest concentration in department sheets
 - Re-evaluation necessary within 2,5 years (NBN EN 689:2018)
 - Less product but no air ventilation
 - Thermal drying of the inks
- Other locations (department rolls and offices)
 - Exposure under control
 - No further evaluation necessary as long as situation remains the same

Conclusion

Dermal concentrations

- No dermal uptake of isopropanol, but possibly due to other solvents, usage of gloves with a chequed frequency of renewal necessary
- Slope $\ln(\text{air})$ vs $\ln(\text{hand})$ and $\ln(\text{air})$ vs $\ln(\text{ref})$ possible indication of products which have a dermal uptake
- Classical methods of evaluation seem irrelevant. Also products in smaller volumes of usages could have a relative significant dermal exposure

Conclusion

Lack of data for evaluation of dermal exposures

- No exposure limits
- No dose – effect descriptions
- No safe values (or calculated from air values)
- Very few possibilities for measurements
- Few information known

⇒ Very theoretical approach of dermal exposure

⇒ No information of the industry

Conclusion

Human exposure routes

- **Inhalation**
 - Measurements, OELV's, DNEL, exposure modeling,
- **Dermal**
 - ?
- **Ingestion**
 - Good hygiene + no consumption

**Vragen of
opmerkingen?**