

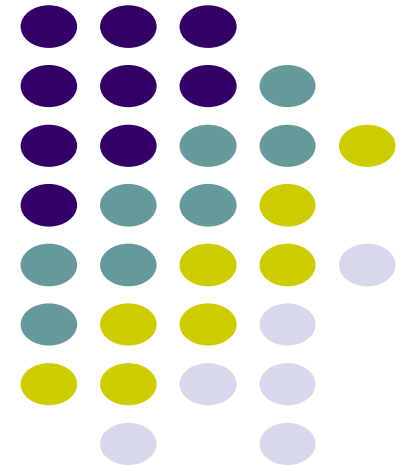


“Low & no VOC paints” & their composition



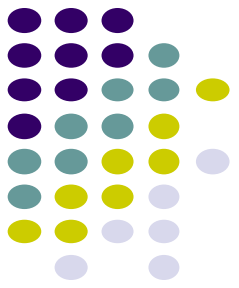
Tim Robinson

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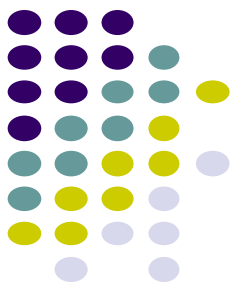


Preview

- What are the concerns with VOCs
- Definition of VOCs:
 - According to the EPA
 - According to the WHO
- Typical components of paint
- Regulations governing VOC composition in paints
- Case study:
 - Monitoring VOCs being emitted by a low VOC paint over a period of two months
- Summary of main conclusions



General concerns with VOCs

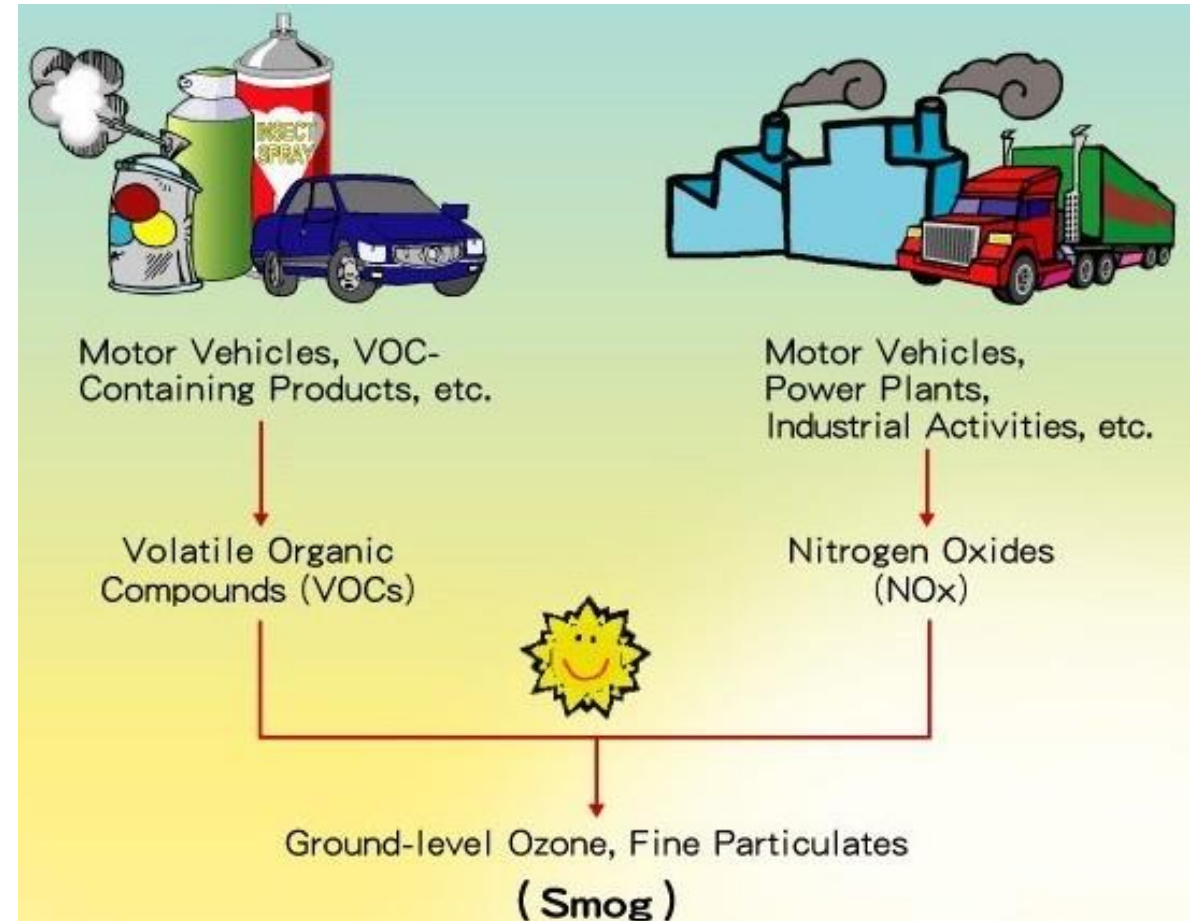


Environmental

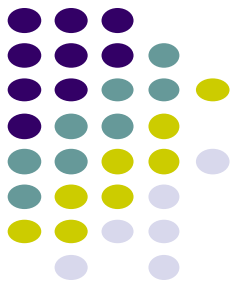
- Certain VOCs react to form ground level ozone & fine particulates (Smog)
- Produce greenhouse gases on combustion

VOCs in indoor air

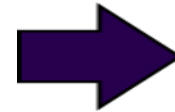
- Health effects:
 - Depends on VOC, level & length of exposure & sensitivity of individual
 - Symptoms may include:
 - Eye, nose & throat irritation
 - Headache, loss of coordination & nausea
 - Damage to liver, kidneys & central nervous system
 - Certain VOCs are carcinogenic
- Paint odour



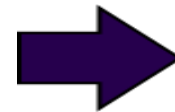
Definition of VOCs according to the EPA



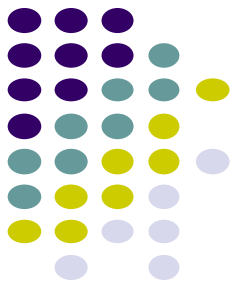
- Former VOC definition intended for outdoor regulation to prevent the formation of ground level ozone & smog – focus on photochemical reactivity
- Created confusion amongst manufacturers of building materials & products – assumed only regulated compounds were classed as VOCs
- More general definition – consistent with the definition used for indoor air quality (IAQ)



" Volatile organic compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions, **except those designated by the EPA as having negligible photochemical reactivity**"



" Volatile organic compounds or VOCs are organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure."



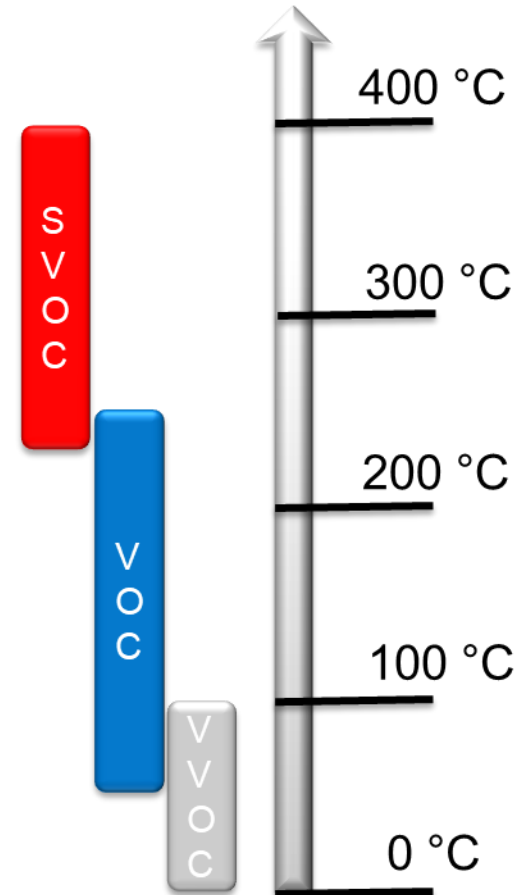
Definition of VOCs according to the WHO

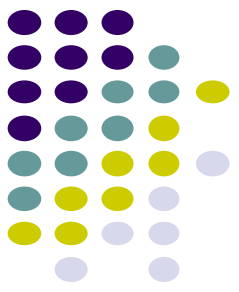
Non-Volatile Organic Compounds – Particle-Bound Organic Matter

PAHs (~370-500°C) **Semi-Volatile Organic Compounds**
Pesticides (~100-450°C) – BP 240-260 to 380-400 °C
Phthalates (~280-380°C) – BP 240-260 to 380-400 °C
Flame Retardants (~220°C) – Primarily semisolid/solid state

Limonene (176°C) **Volatile Organic Compounds**
Benzene (80°C) – BP 50-100 to 240-260 °C
MEK (80°C) – BP 50-100 to 240-260 °C
Hexane (68°C) – Both gas and liquid/solid state
Acetone (56°C) – Both gas and liquid/solid state

Formaldehyde (-19°C) **Very Volatile Organic Compounds**
CFCs (~ -40-50°C) – BP < 50 to 100 °C
Ethane (-89°C) – Permanent gases
Methane (-151°C) – Permanent gases



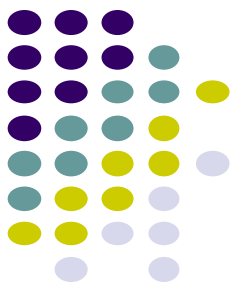


Typical components of paint

- Pigments:
 - Provide colour, “hide” & bulk
- Binders:
 - Bind pigment together in paint film
 - Provide paint “performance”
 - Latex binders used in water-based paints
- *Solvents (liquids):
 - Enable pigment and binders to reach painted surface
- *Additives:
 - Provide additional paint property enhancements – thickening agents, biocides, defoamers, coalescing agents etc.



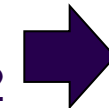
*VOCs typically found in solvents & additives



VOC composition in paints

UK / European regulations

- VOC controls governed by two sets of legislation:
- Europe:
 - The Paint Product Directive (2004/42/CE)
 - The Industrial Emissions Directive (2010/75/EU)
- UK:
 - The Volatile Organic Compounds in Paints, Varnishes and Vehicle Refinishing Products Regulations SI 2012 No 1715
 - Environmental Permitting (England and Wales) Regulations 2010 SI 675



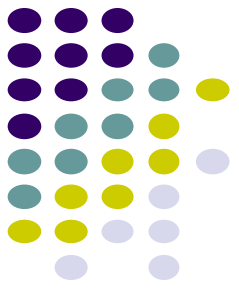
USA definition (EPA)

- Low VOC paint <50 g/l
- Zero / no VOC paint <5 g/l

A Maximum VOC content limit values for paints and varnishes			
	Product subcategory	Type	VOC (g/l)
a	Interior matt walls and ceilings (Gloss ≤25@60°)	WB	30
		SB	30
b	Interior glossy walls and ceilings (Gloss >25@60°)	WB	100
		SB	100
c	Exterior walls of mineral substrate	WB	40
		SB	430
d	Interior/exterior trim and cladding paints for wood and metal	WB	130
		SB	300
e	Interior/exterior trim varnishes and woodstains, including opaque woodstains	WB	130
		SB	400
f	Interior and exterior minimal build woodstains	WB	130
		SB	700
g	Primers	WB	30
		SB	350
h	Binding primers	WB	30
		SB	750
i	One-pack performance coatings	WB	140
		SB	500
j	Two-pack reactive performance coatings for specific end use such as floors	WB	140
		SB	500
k	Multi-coloured coatings	WB	100
		SB	100
l	Decorative effect coatings	WB	200
		SB	200

Case study – Low VOC paint off-gassing

VOCs emitted by a “Low VOC” paint over time



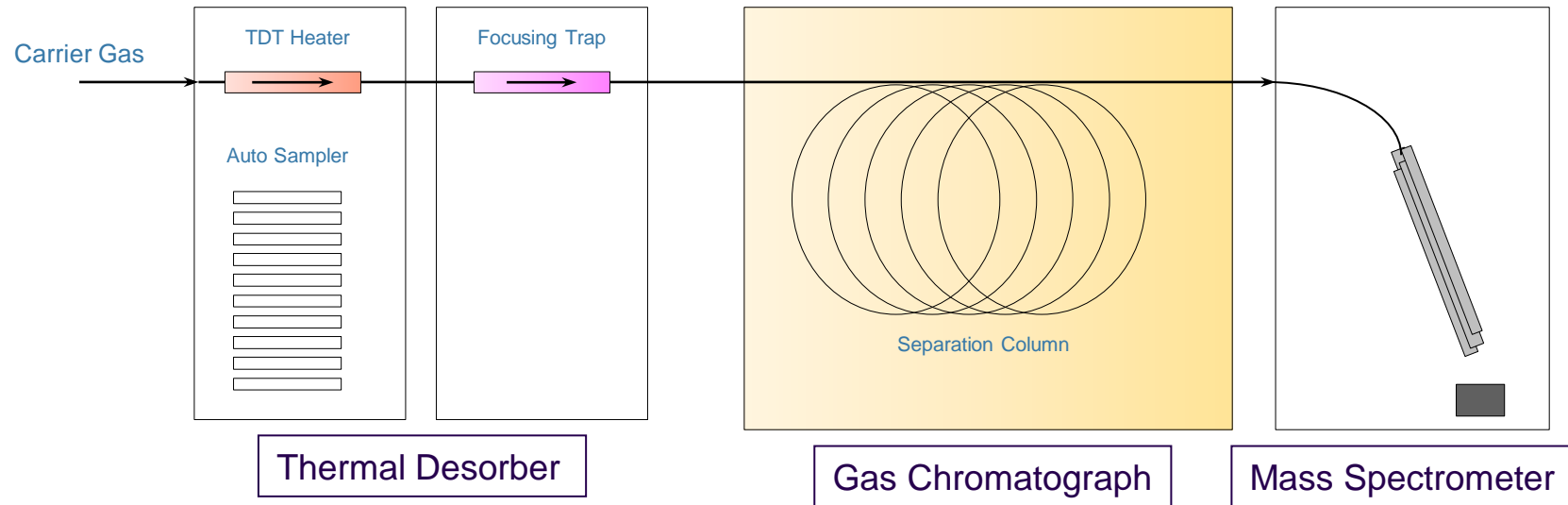
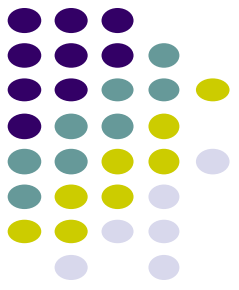
- Living room & dining room painted with “Low VOC”, water-based paint
- Airborne VOC samples collected onto thermal desorption tubes (TDTs):
 - Before painting
 - During painting
 - One day after painting
 - Two weeks after painting
 - Two months after painting
- Ten paint-related VOCs identified & tracked over time
- House ventilated during the day & closed at night – daytime temp. 21-27°C



Air sampling pump with Thermal Desorption Tube

Case study – Low VOC paint off-gassing

Analysis of VOC samples in the lab using GC-MS



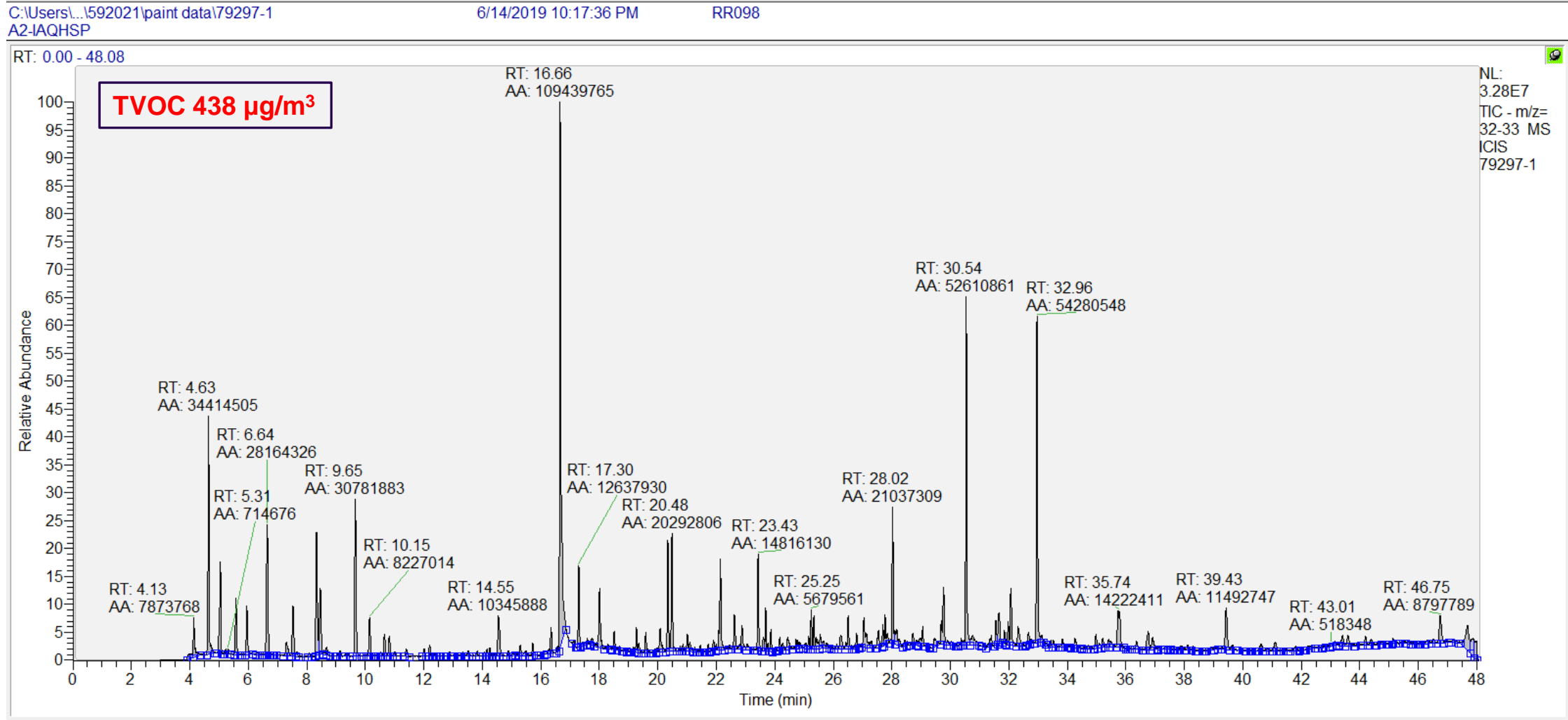
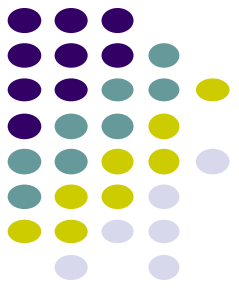
- Sample tube heated to drive off captured VOCs
- Gas Chromatograph separates VOCs by volatility and chemical class
- Mass Spectrometer identifies individual VOCs by breaking molecules into characteristic fragments
- Method compliant with **ISO 16000-6** for the analysis of VOCs in indoor air using active sampling



GC-MS

Case study – Low VOC paint off-gassing

Before painting



Case study – Low VOC paint off-gassing

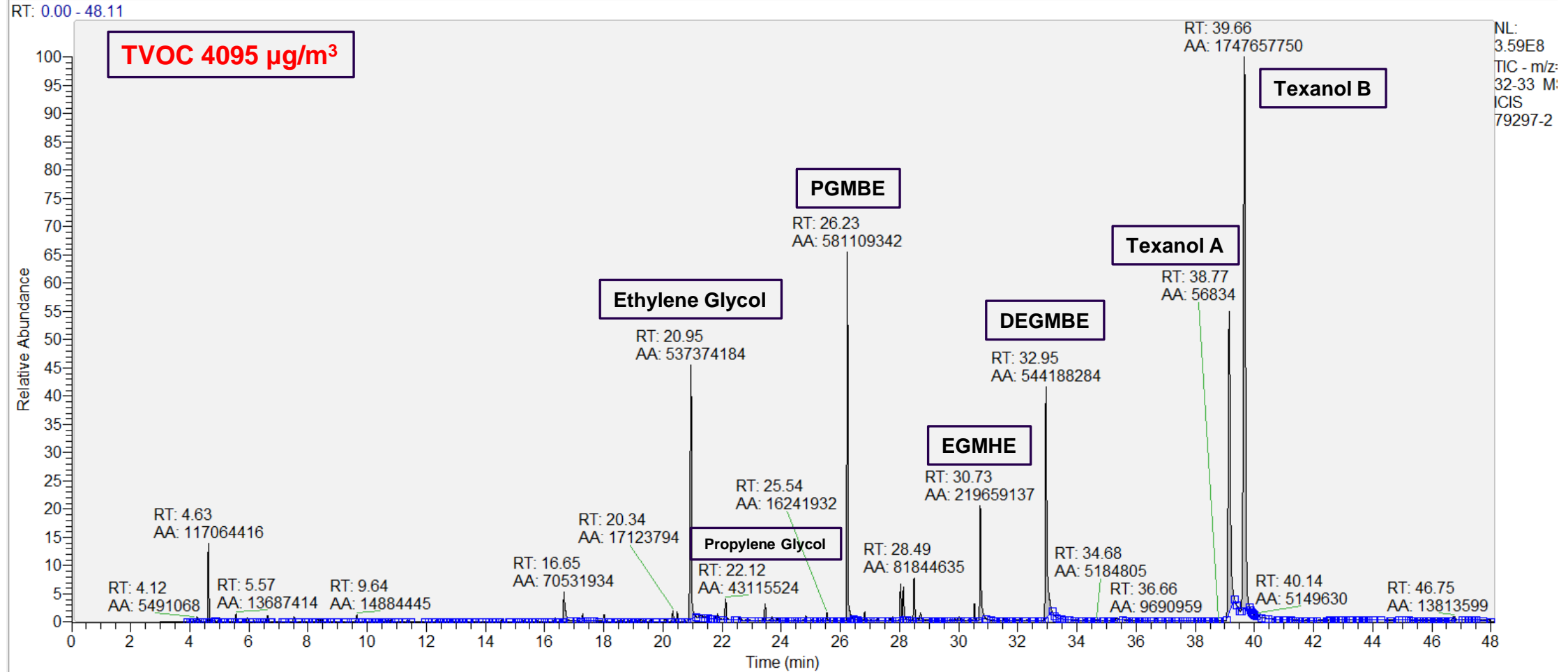
During painting



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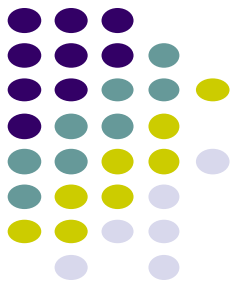
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Case study – Low VOC paint off-gassing

One day after painting

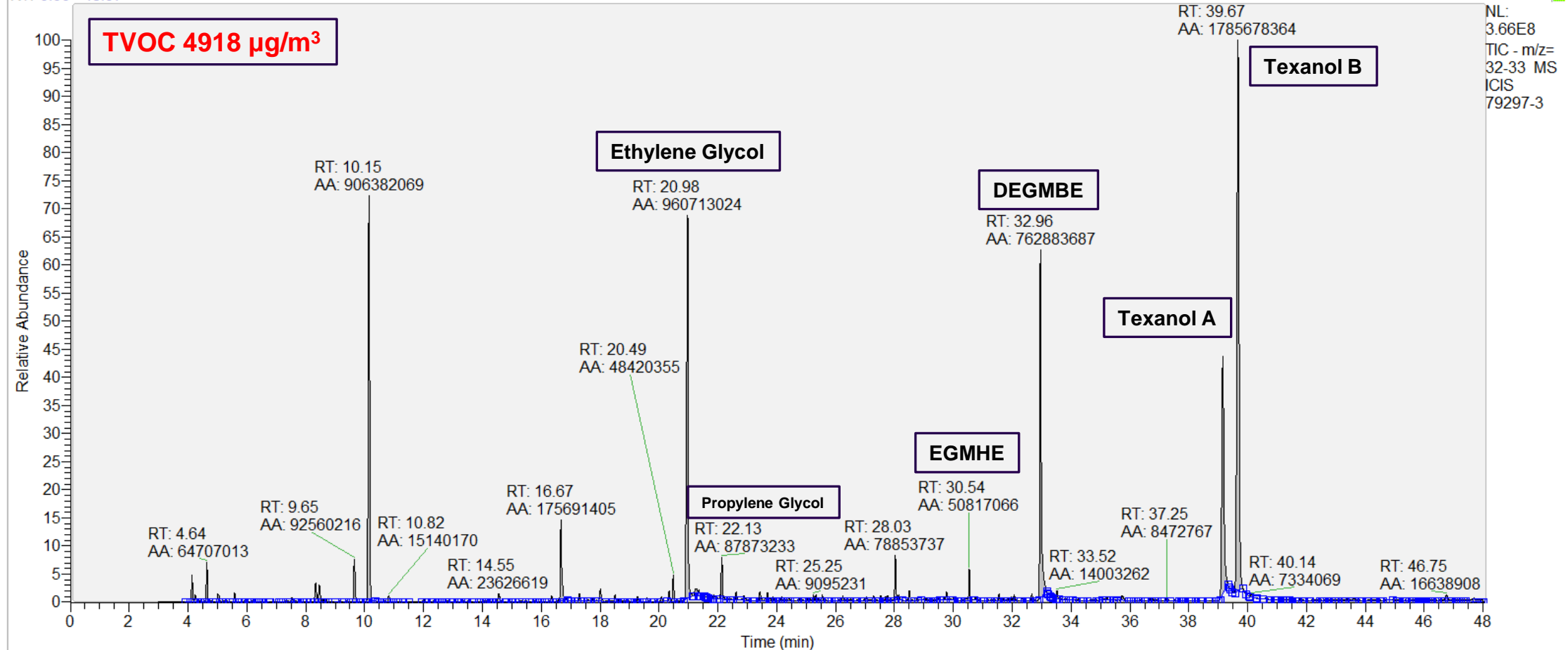


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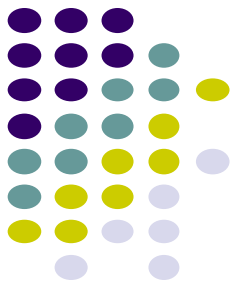
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RT: 0.00 - 48.07



Case study – Low VOC paint off-gassing

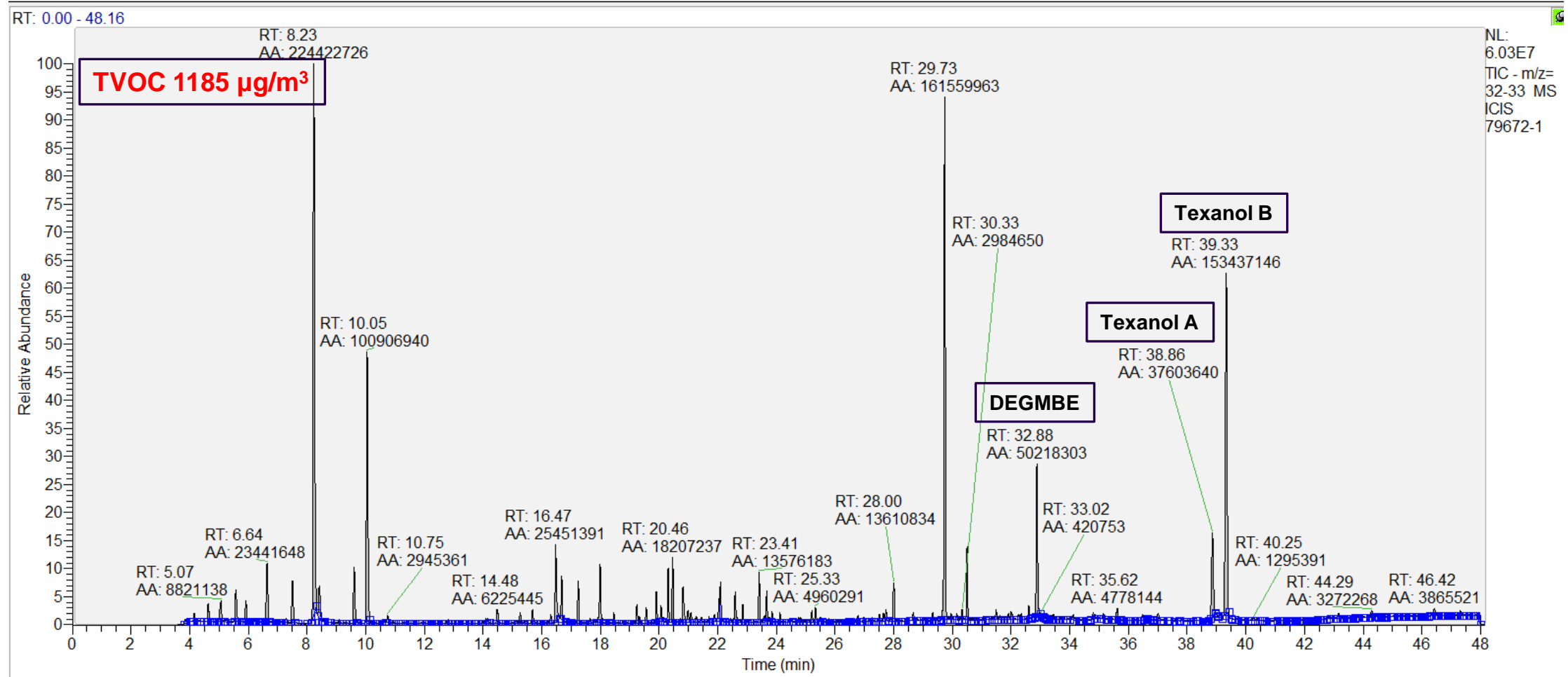
Two weeks after painting



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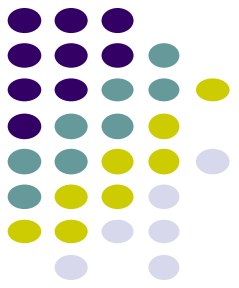
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Case study – Low VOC paint off-gassing

Summary table with results after two months



List of paint VOCs	GC RT (mins)	Before painting ($\mu\text{g}/\text{m}^3$)	During painting ($\mu\text{g}/\text{m}^3$)	One day after ($\mu\text{g}/\text{m}^3$)	Two weeks after ($\mu\text{g}/\text{m}^3$)	Two months after Loc A ($\mu\text{g}/\text{m}^3$)	Two months after Loc B ($\mu\text{g}/\text{m}^3$)
Ethylene glycol	20.95	0	313	559	6	-	-
Propylene glycol	22.12	0	24	48	3	-	-
n-Butyl ether	23.46	0	13	3	0	-	-
1-Butoxy-2-propanol (PGMBE)	26.23	0	319	4	0	-	-
DPGME (3 isomers)	28.04	0	112	18	0	-	-
2-Ethyl-1-hexanol	28.71	31	7	0	1	-	-
n-Hexylcellosolve (EGMHE)	30.73	0	121	3	0	-	-
Butoxyethoxyethanol (DEGMBE)	32.95	0	299	419	29	-	-
Texanol A	39.15	0	529	434	21	-	-
Texanol B	39.66	0	958	979	85	13	19
TVOC ($\mu\text{g}/\text{m}^3$)		438	4095	4918	1185	610	520
Sum of 10 paint VOCs ($\mu\text{g}/\text{m}^3$)		31	2695	2467	145		
Paint VOCs as % of TVOC		7.08	65.81	50.16	12.24		

Summary



Conclusions

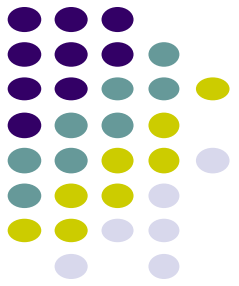
- “Low VOC”, water-based paints account for 84% of decorative paints sold*
- Despite their reduced VOC content, emissions from these paints can have an impact on IAQ for weeks and months following their use
- Heavier, less volatile compounds off-gas for longer than lighter VOCs, which deplete fairly quickly with ventilation
- “Zero & No VOC” paint content claims can be misleading and require further investigation

Acknowledgements

- Thanks to ASBP for inviting me to speak
- Thanks to the Enthalpy Analytical laboratory for the paint analysis and data



* Source – British Coatings Federation



Thank you!

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