Public
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BS Flame Retardants
24-Apr-2008

The Ecological Footprint of Flame Retardants

Fire Retardants Technologies
Preston, UK, 23-Apr-2009

Clariant

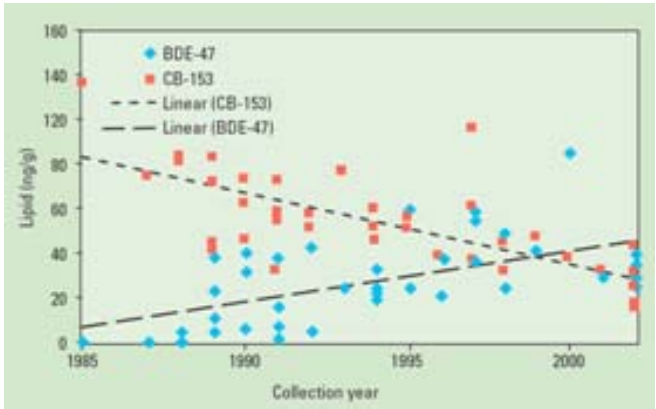
Exactly your chemistry.

Concerns about Flame Retardants

Clariant

Exactly your chemistry.

- Findings of brominated flame retardants in the environment, biota, humans; phosphate esters in indoor air
- Persistence, Bioaccumulation, Toxicity ?
- Endocrine disruption ?
- Official European Risk Assessments



Created for ES&T by Andreas Sjödin of the U.S. Centers for Disease Control, shows the levels of the most bioaccumulative PBDE congener, BDE-47, and the most bioaccumulative PCB congener, CB-153, in U.S. human blood samples. ES&T, 37, p. 384, 2003

Legislative Activities: RoHS, WEEE

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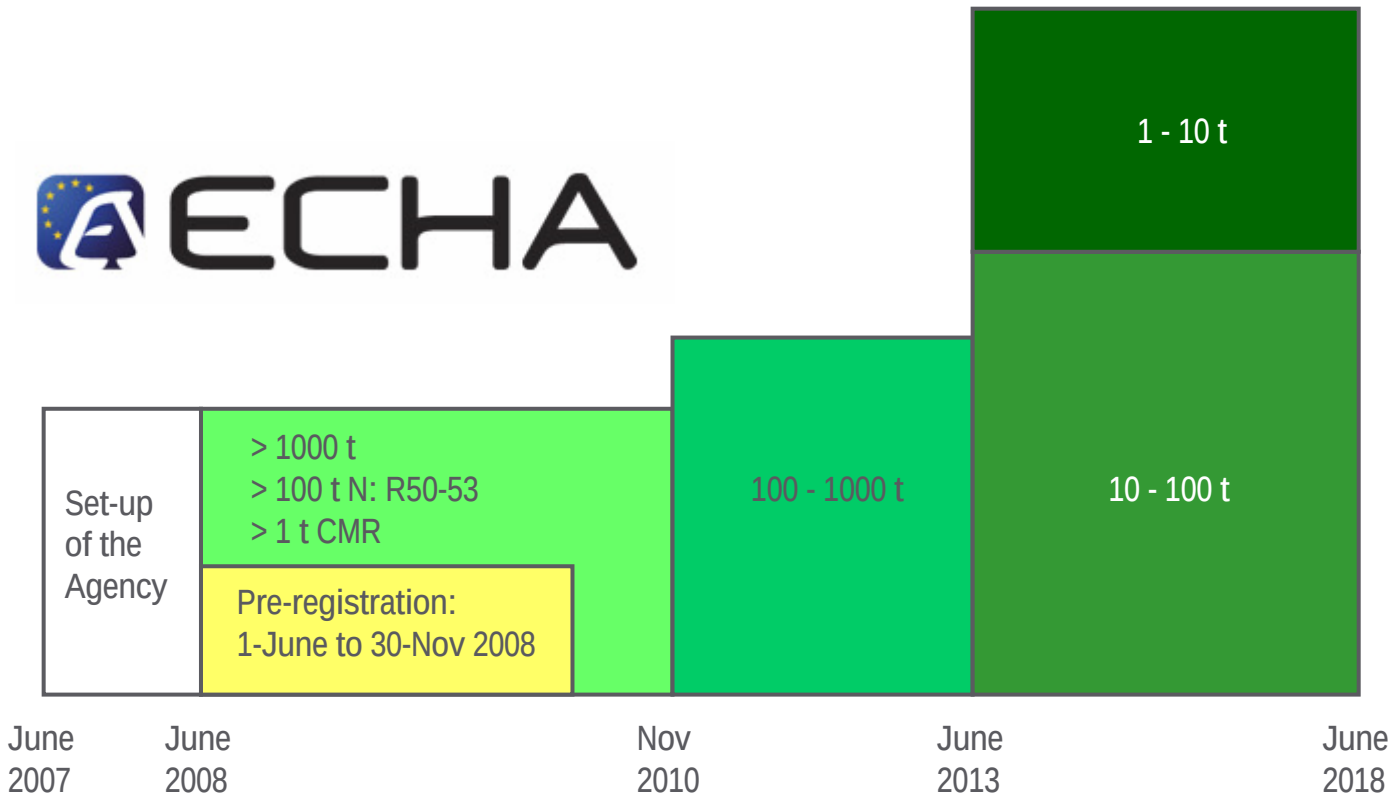
Exactly your chemistry.

- European Directive on Waste Electric and Electronic Equipment
  - separation requirement for plastics containing brominated FRs
- European Directive on Restriction of certain hazardous Substances in E&E:
  - PBB and PBDE banned
- Both Directives currently under revision
- Activities in USA, China-RoHS, …

REACH is here – the Timeline

Clariant
Exactly your chemistry.



REACH – Chemical Safety Assessment

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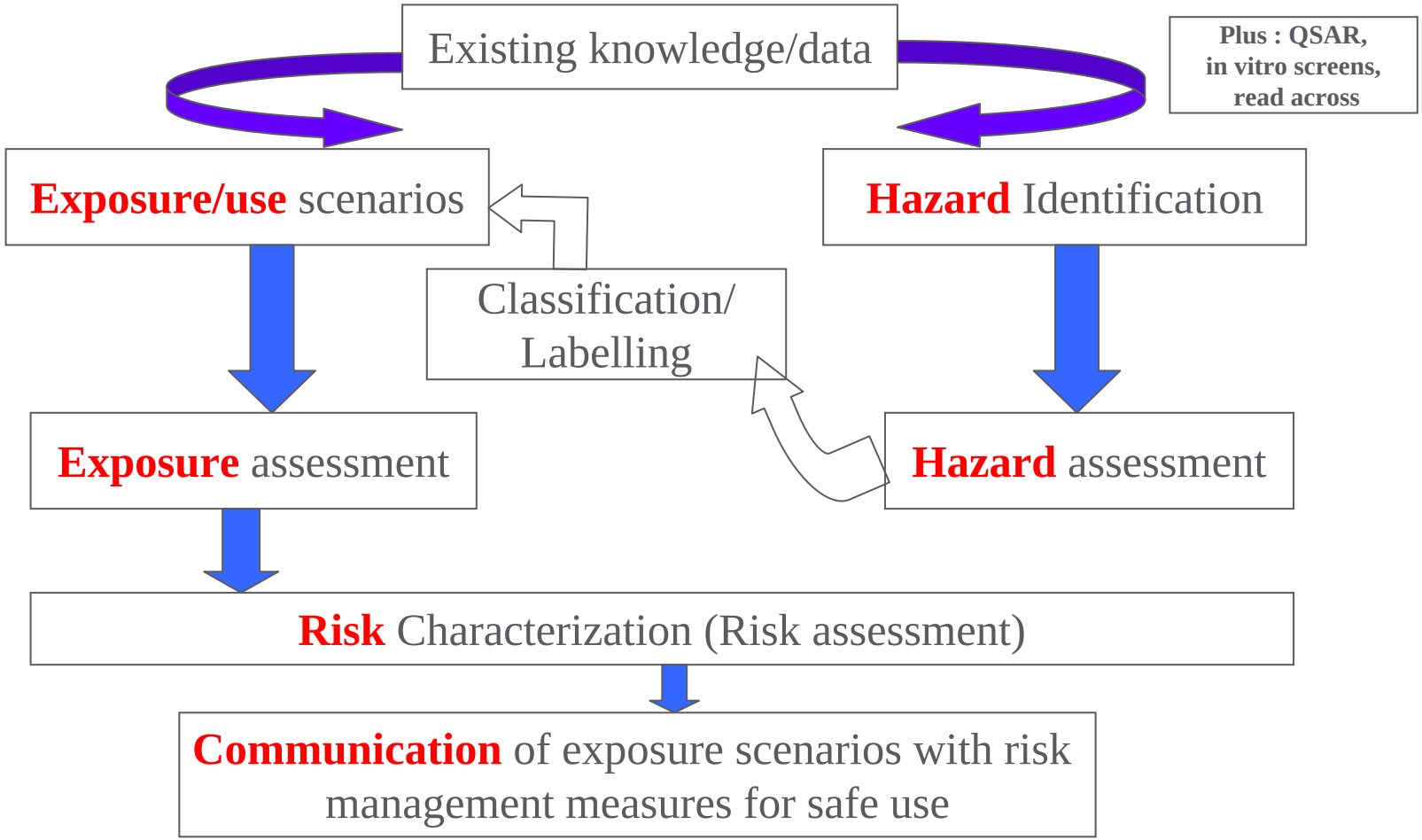
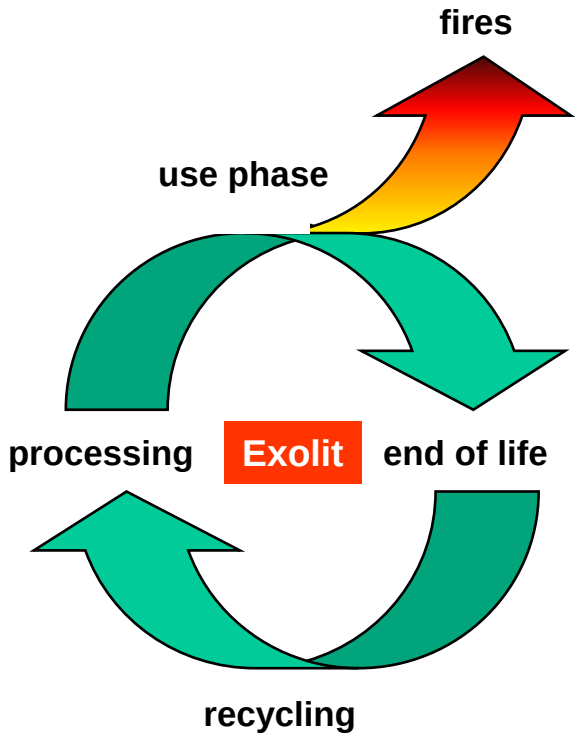
Exactly your chemistry.



Fraunhofer IUSE study

- Evaluate environmental profile of alternatives to halogenated flame retardants



- Dr. Thomas Marzi
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  thomas.marzi@umsicht.fraunhofer.de

Processing: Extrusion

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- No emission of phosphine (PH_3):
  - measurement directly at the outlet of the extruder by Draeger tubes and gas sensor
  - all mesured values below detection limit (< 0.01 ppm PH_3)

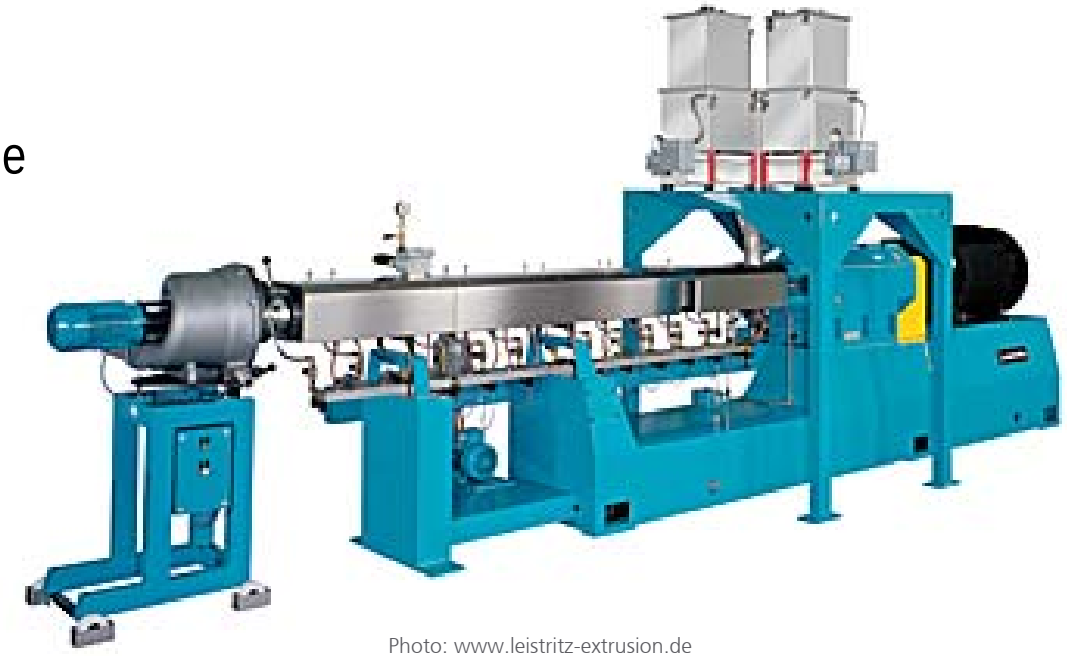
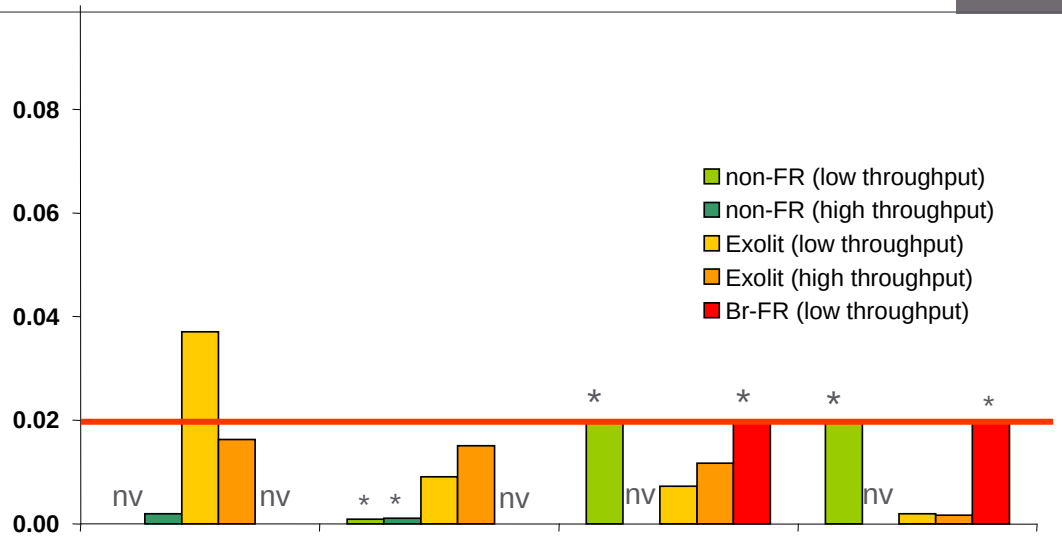


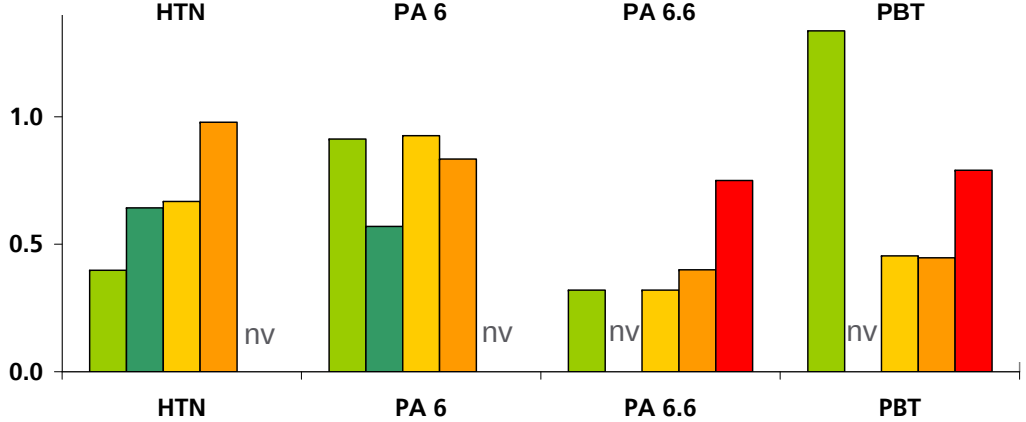
Photo: www.leistritz-extrusion.de

Extrusion – emissions to gas phase

Phosphorus, total
mg / kg compound



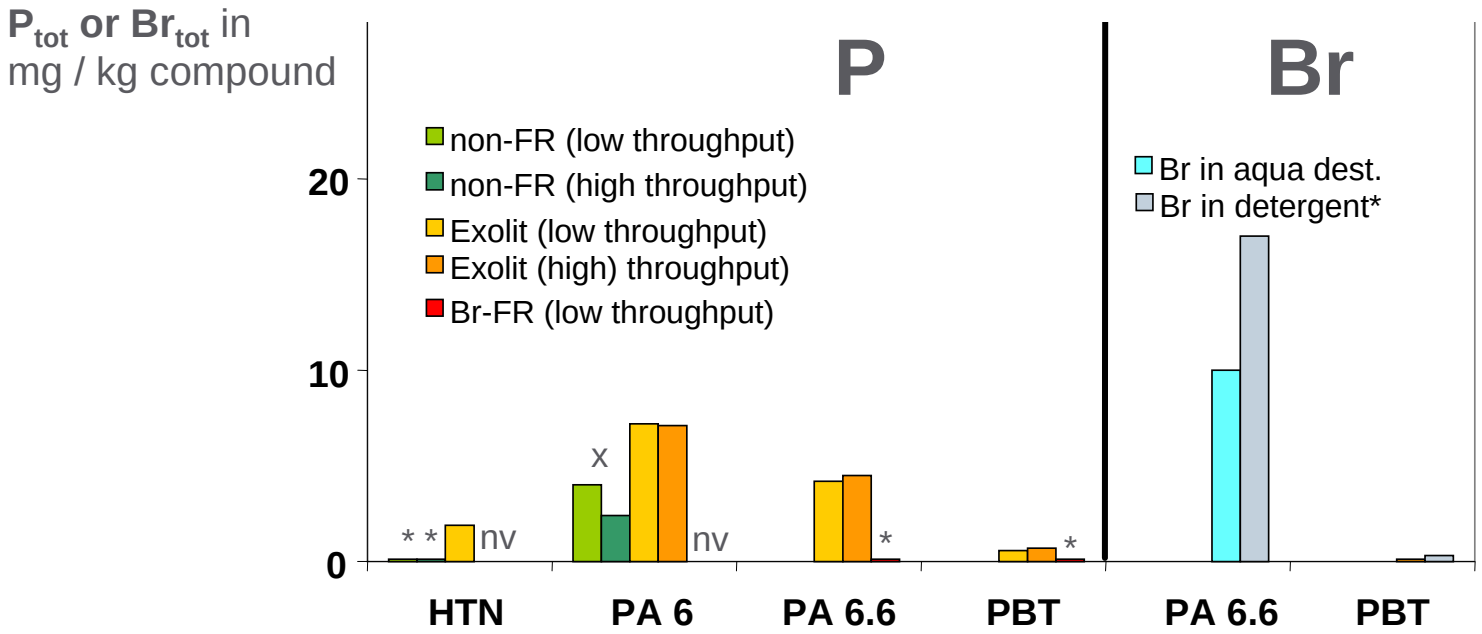
Total Organic Carbon (FID-C)
mg / kg compound



* = limit of detection for this sample
nv = no value, not measured

Migration into Water – Phosphorus and Bromine

Clariant
Exactly your chemistry.



* = limit of detection for this sample
nv = no value, not measured
x = PA6 contained a phosphorus based stabilizer

*with a detergent (0,1 % Triton X 100) to simulate landfill leachate

Use Phase: accidental fires

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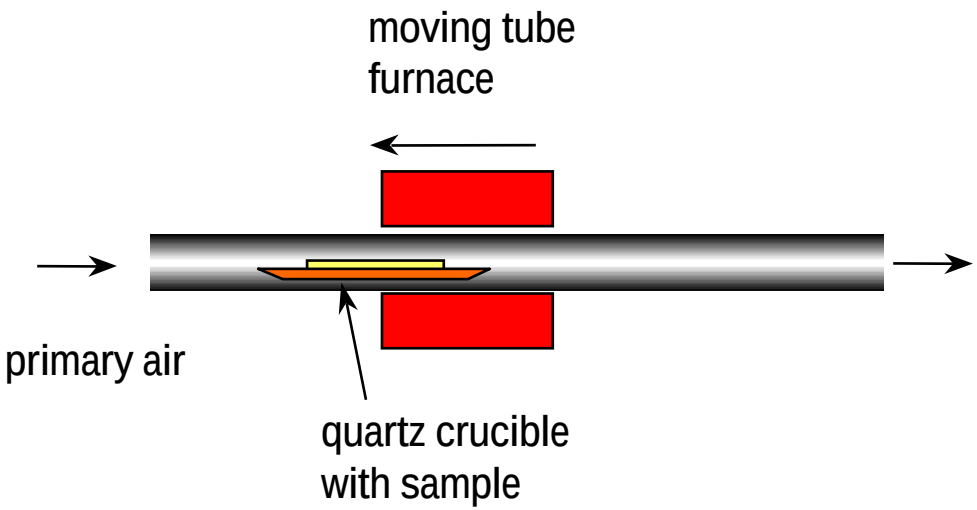
Combustion experiments according to DIN 53436



Gas-analysis by gas chromato-graphy + mass spectrometry (GC-MS), wash bottles for inorganic species, gas analyzer (Testo 360)

Test conditions chosen to simulate a well ventilated, developed fire:

- sample weight: 5 g
- air supply: 200 L / h
- temperature of sample: 700 °C

Combustion products with acute toxicity

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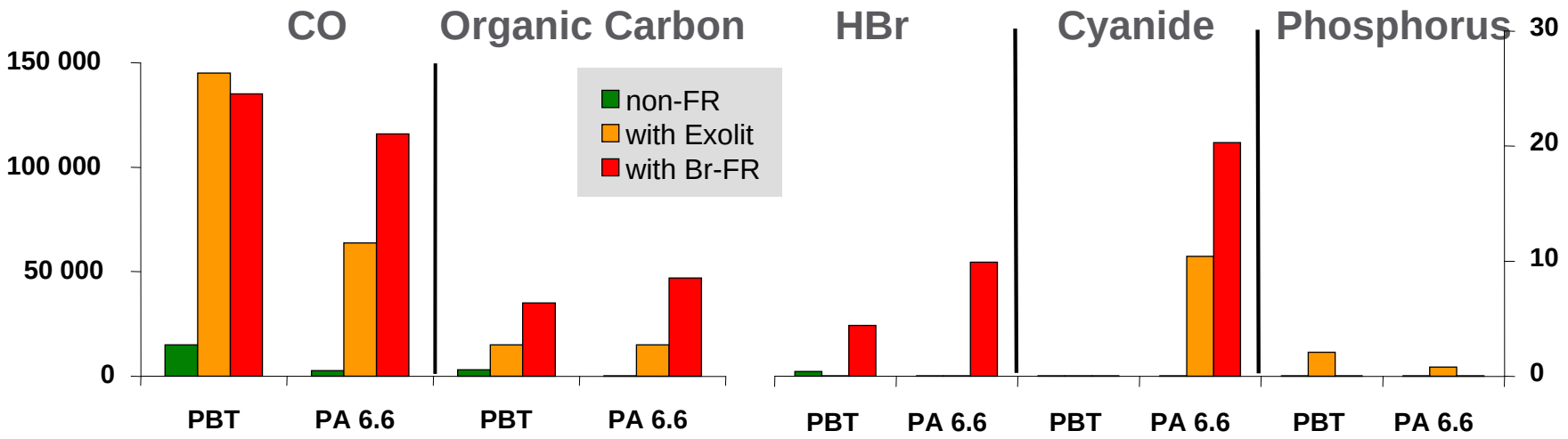
yields in mg / kg sample



Combustion products with potential long-term effects

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Toxicity of condensates from combustion flue gasses

Mutagenicity:
Ames test with Salmonella typhimurium TA 98;
Cytotox: Cell culture of TK6-cells and larynx cancer cell line (to mimmick human respiratory effects);
- no effect
(-) ambiguous negative results
(+) weak positive effects
\+ clearly positive effects

Toxicity testing done by Institute for Toxicology at the University of Würzburg

		Mutagenicity		Cytotox	
		ST 98	+activation	Proliferation	Cell death
PA 6,6	no FR	-	-	-	-
	P	(+)	(+)	-	-
	Br	(+)	+	+	+
PBT	no FR	-	-	-	-
	P	-	-	-	(-)
	Br	-	-	+	+

Mechanical Recycling of FR Polymers

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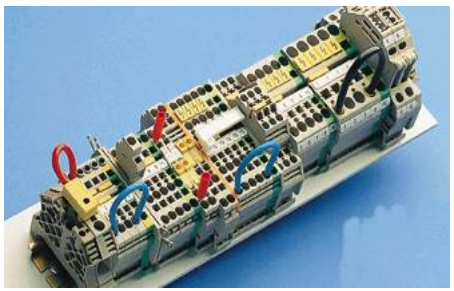
Exactly your chemistry.

- Example: Exolit OP (phosphinate) and brominated polystyrene in Polyamide 66,
- glass fiber reinforced
- Test procedure
  - Injection molding of compounds (1. pass)
  - Grinding of the test bars
  - Mix 50% of grinded material with 50 % of neat compound
  - Injection molding
  - etc.
- Comparison of 1st , 3rd and 6th pass



Mechanical Recycling PA

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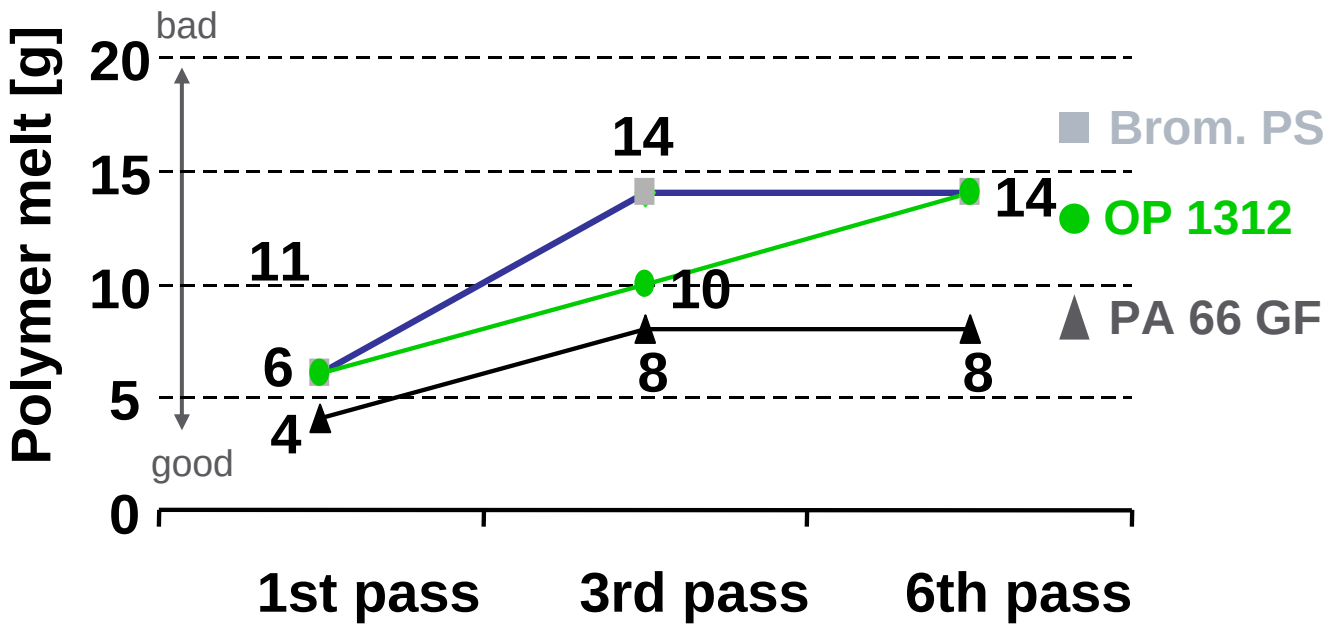
- Stability of Polymer melt during injection molding (Internal test)
  - g of Polymer melt flowing out of the die
  - retention of FR level (UL 94 V0)



Thermal transformation - example of waste incineration

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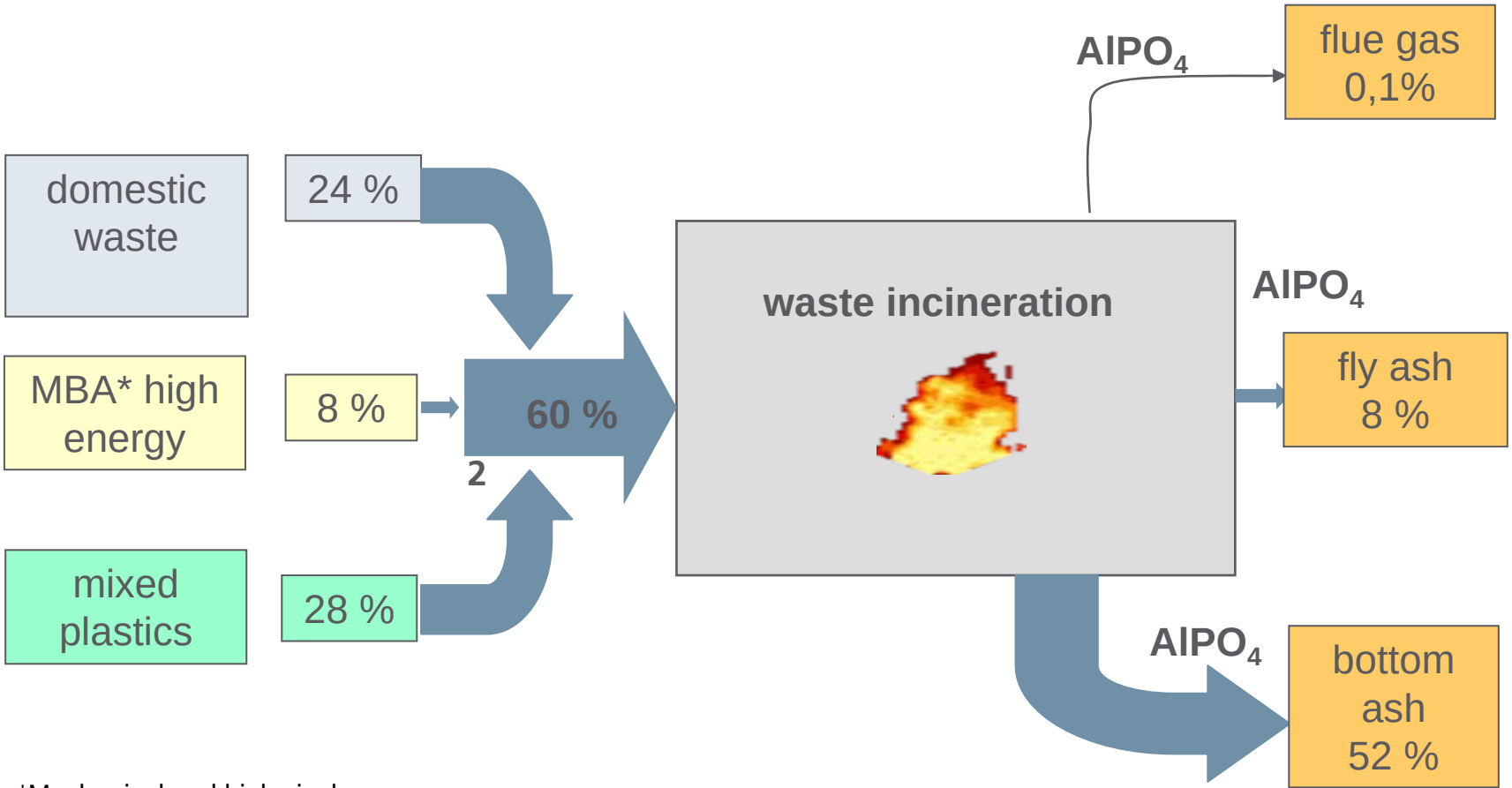

*Mechanical and biological pre-treatment

US-EPA: Alternatives Assessment

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Exactly your chemistry.

- Evaluation of environmental and health properties of alternatives to TBBPA
- Hazard focused approach
- No black and white picture:
  - Alternatives have chemical hazards, too, however,
  - Need to check relevance
  - No surprises because of data gaps
- www.epa.gov/dfe
- The Green Screen
  - http://www.cleanproduction.org/

Market Drivers: NGOs, Ecolabels, Green Public Procurement

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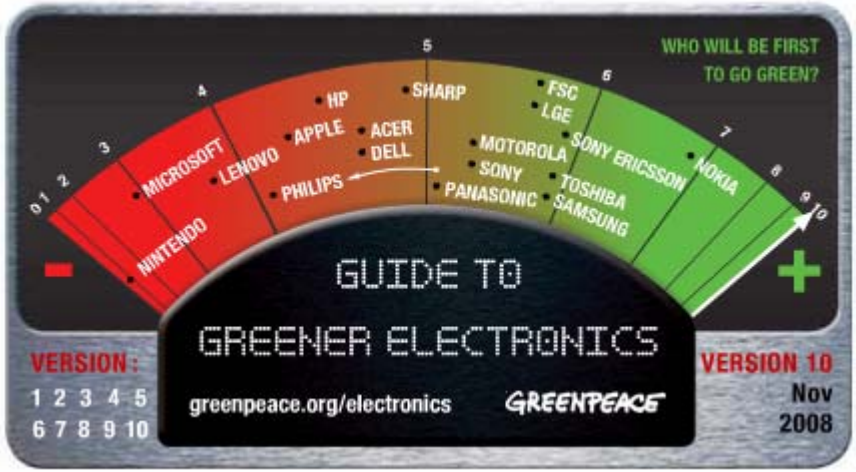

Umweltzeichen

weil .....

EG-Umweltzeichen

TCO Development

GPP

OEM Commitments and Roadmaps

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Exactly your chemistry.

- Examples of Original Equipment Manufacturers (OEMs) who have made commitments or defined roadmaps for eliminating halogenated flame retardants (some with exemptions)

HDP USER GROUP INTERNATIONAL, INC.®

Project Report
Halogen-free Guideline

- www.hdpug.org
  released 2008-09

Conclusion

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Exactly your chemistry.

- The environmental behaviour of flame retardants has been studied for more than 20 years
- Over the last 10 years the public debate has led to some regulatory restrictions (e.g. RoHS and WEEE directives in Europe)
- All these activities have led to large pool of data on the environmental profile of (some) flame retardants
- REACH will require even more information on substance properties and uses
- There is a strong trend towards more environmentally compatible FRs, driven by NGOs, OEMs and legislation like RoHS, REACH