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The Flame Retardants Controversy: Fire Safety and Environmental Protection

Composites in Fire
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1

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Abstract

- Whereas flame retardants provide the necessary level of fire safety for many common polymers in various applications, flame retardants are also perceived as potential environmental pollutants by environmental pressure groups and authorities. The author will give you an update on the latest scientific studies on environmental and health aspects of flame retardants like e.g. life cycle assessments including the effects of fires. In addition, the presentation will give an overview of current regulatory issues around flame retardants like the European Directive on Waste Electrical and Electronic Equipment (WEEE) which is due for national implementation in 2004 and the EU risk assessments of flame retardants. How flame retardants are dealt with in the various ecolabel schemes will also be discussed.

2

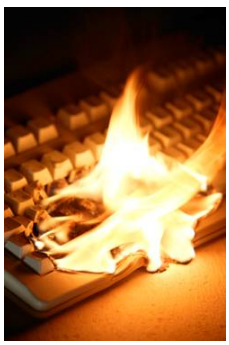
Outline

- Why are flame retardants used?
- Trends in fire safety requirements
- Issues and concerns about flame retardants
- Activities
  - laws and regulations
  - standards
  - ecolabels
- Conclusions

3

Fire Casualties and Damage (Europe 25)

- about 15 casualties in Europe per day
  - ~ 75 % of victims in private homes
  - intoxication by smoke is main cause of death
- costs of 30 billion EUR per annum
  - ~ 0.3 % of gross domestic product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Effects of Combustion Products and Smoke

- heat
- dense smoke can make orientation impossible
- acutely toxic:
  - narcotic: CO, HCN - deadly within minutes; CO_2, O_2-deficiency
  - irritants for eyes and breathing: HCl, SO_2, NOx, aldehydes
- compounds with long term effects:
  - polycyclic aromatic hydrocarbons (PAHs)
  - halogenated dioxins + furans (PCDD/F)
  - mostly adsorbed to soot

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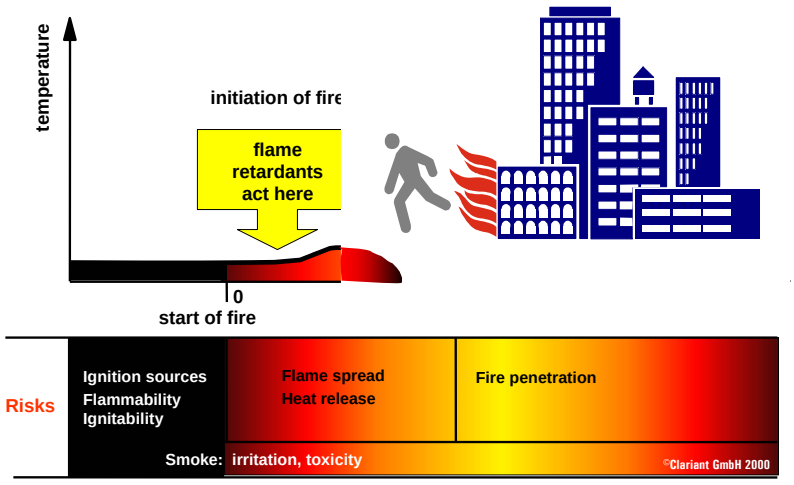
Development of a Fire



6

Plastics Pyramid

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heat stability, resistance to chemicals and fire

high performance plastics
5 ... 20 (100) EUR / kg

engineering plastics
2.50 ... 3.50 EUR / kg

commodity plastics
1.00 ... 2.00 EUR / kg

World Tonnage (2000)

PI PEEK PES FP PTFE LCP — **250 kt < 1 %**

COC PA 4.6 PC PBT/PET PPO POM PA 6/6.6 — **5.700 kt 4 %**

ABS PUR PPV PS PP PVC PE-HD PE-LD — **131.000 kt 96 %**

data from: Kunststoffe, 8/2001, p. 46 ff

7

Catastrophic fires started by easily ignitable materials

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2002-02-20 Rhode Island Club, USA
2001-01-01 Volendam, NL
2000-11-11 Kitzsteinhorn, A
1996-04-11 Dusseldorf Airport, D

8

Trends in fire safety requirements

- International standards (ISO, IEC, CEN)
- Sophisticated methods
  - from fail / pass towards numerical data: RHR, FIGRA, MAHRE, ...
  - example: EN 45545 railway rolling stock
- Audio-/Video Equipment: External ignition
- Europe: enhanced producer liability and de-regulation
  - Harmonized Standards – „New Approach“
  - General Product Safety Directive
  - Construction Products Directive
  - Low Voltage Directive

9

Television sets

8 min after ignition with a small flame:

- flame retarded
- not flame retarded

www.acfse.org

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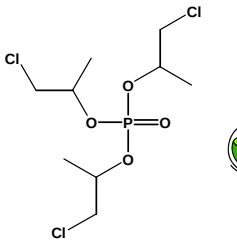
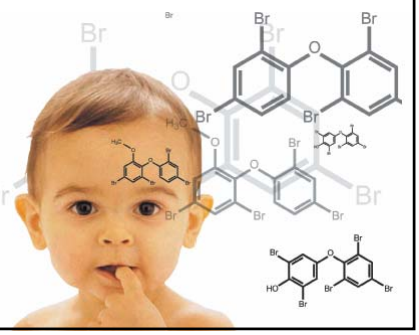
Concerns against flame retardants

- Concerns voiced in Europe on environmental impact, fate and toxicology of certain flame retardants
- Studies and publications on FRs presented in Germany, Sweden, Denmark, the UK and Switzerland
- Topics: Persistence, Bioaccumulation, Toxicity (PBT)
- Indoor air: phosphate esters



TCPP



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Pressure on halogenated FRs

- »grey«/»black« lists of additives
  - e.g. car manufacturers: Global Automotive Declarable Substance List (GADSL), http://www.gadsl.org/
- brominated biphenyls and diphenylethers
  - voluntary commitment of the German chemical and plastics industry to discontinue their use (1986)
  - Sweden + Denmark are striving for EU wide ban (since 1999)
  - EU risk assessment of penta-, octa- and decabromo-diphenylethers: A ban on penta and octa-BDE as of August 2004
- Electro/electronics industries in Germany:
  - statements on how to avoid FRs and use of alternative approaches for fire safety
  - trend towards non-halogenated casings / circuit boards

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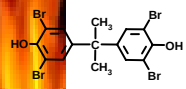
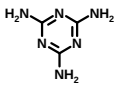
The Variety of Flame Retardants

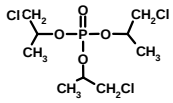
- diversity in terms of physical / chemical properties, environmental fate, toxicology, and regulatory status

^{35}Cl ^{31}P ^{27}Al

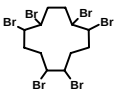




^{80}Br



^{14}N



$Al(OH)_3$ ^{11}B ^{24}Mg

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Upholstered Furniture LCA Project

- Life Cycle Analysis
  - different flame retardants: P and Br based
  - in comparison with non flame retardant components
  - combined with fire statistics
- The project was contracted by EFRA to SP & IVL (Swedish Environmental Research Institute)

14

Upholstered Furniture LCA - Results

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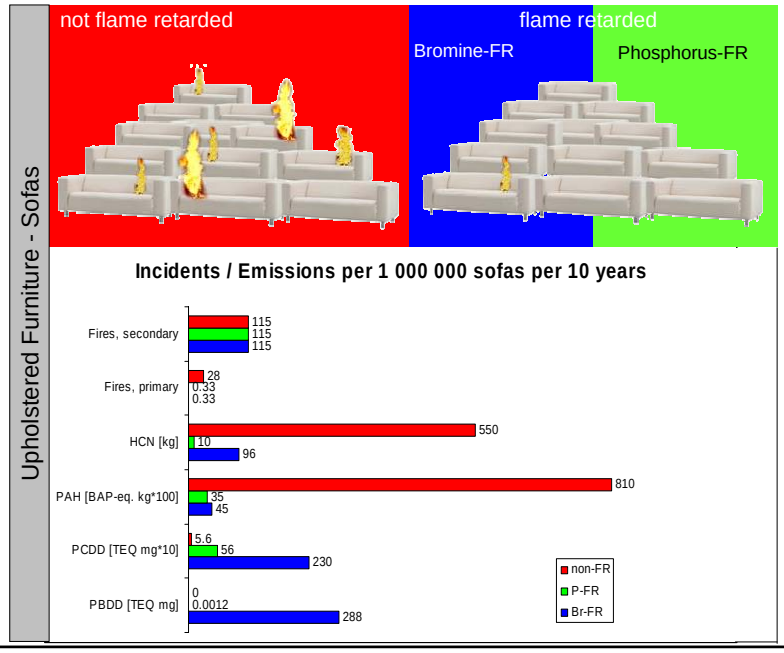

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Upholstered Furniture LCA - Results

- flame retarded sofas produced more chlorinated / brominated dioxins and furans
- non-flame retarded sofas produce markedly higher emissions of HCN and PAHs
  - due to much higher number of fires
  - therefore, non-flame redarded sofas have a more negative impact on the environment

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EU Risik Assessments

Substance		Rapporteur	Priority List no. (year)	Status
Antimony trioxide	ATO	Sweden	4 (2000)	Under way
Short-chain Chlorinated Paraffins	SCCP	UK	1 (1994)	Published
Medium-chain Chlorinated Paraffins	MCCP	UK	3 (1997)	Draft circulated
Pentabromodiphenyl ether	PBDE	UK	2 (1995)	Published
Octabromodiphenyl ether	OBDE	UK/France	1 (1994)	Published
Decabromodiphenyl ether	DBDE	UK/France	1 (1994)	Published
Hexabromocyclododecane	HBCD	Sweden	2 (1995)	Draft circulated
Tris(2-chloroethyl) phosphate	TCEP	Germany	2 (1995)	Draft circulated
Tetrabromobisphenol A	TBBPA	UK	4 (2000)	Under way
Tris(2-chloroisopropyl) phosphate	TCPP	Eire/UK	4 (2000)	Under way
Tris(1,3-dichloroisopropyl)phosphate	TDCPP	Eire/UK	4 (2000)	Under way
2,2-bis(chloromethyl)trimethylene bis(bis(2-chloroethyl)phosphate)	V6	Eire/UK	4 (2000)	Under way

- PEC = Predicted Environmental Concentration
- PNEC = Predicted No Effect Concentration
- MOS = Margin of Safety
- http://ecb.jrc.it/existing-chemicals/

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WEEE + RoHS Directives

- European Directives on
  - waste electric and electronic equipment (2002/96/EC)
  - restriction of hazardous substances in E&E (2002/95/EC)
  - published Feb-2003
- ban of polybrominated biphenyls and penta-BDE and octa-BDE as of August 2004 (2003/11/EC)
- deca-BDE is included in ban of PBDEs as of 2006 in RoHS, can still be revised
  - stakeholder consultation in July-2004
- separation requirement of plastics containing brominated flame retardants

18

Ecolabels and Green procurement

- various national schemes
  - since the late 1970ies, e.g.
- Blue Angel in Germany:
  - restricts halogenated FRs in a number of products, some exceptions for parts < 25 g and recycling
- EU Flower
  - uses risk phrases from classification of chemicals
  - only few FRs are explicitly blacklisted (e.g. PBDEs)
- TCO Development
  - wide-spread acceptance in the business electronics sector
  - restricts halogenated FRs
  - manufacturers have to submit environmental and tox data

EG-Umweltzeichen

19

New Flame Retardants ?

- new flame retardants are being developed:
  - safety standards will improve and become more and more international
  - low emission / migration, reactive, environmentally friendly, low toxicity, provide adequate fire safety standards
  - improved flame retardants have to be developed in close co-operation of manufacturers, processors and users of the target materials / products

BUT

- registration and toxicity testing costs – REACH ?!

20

The Ecological Footprint of an FR

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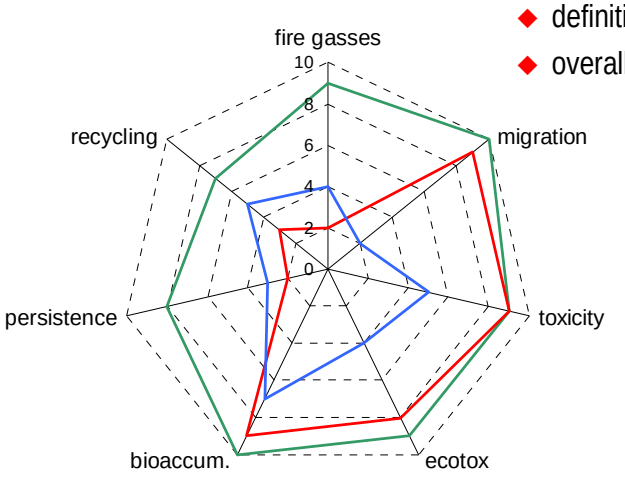
- definition of scales?
- overall ranking?



21

Flame Retardants in Product Life Cylces

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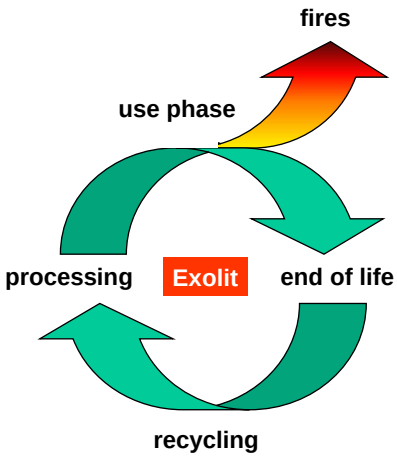
- Emissons?
- Toxic degradation / combustion products?
- Compare to background levels (blank polymer) and established technologies



22

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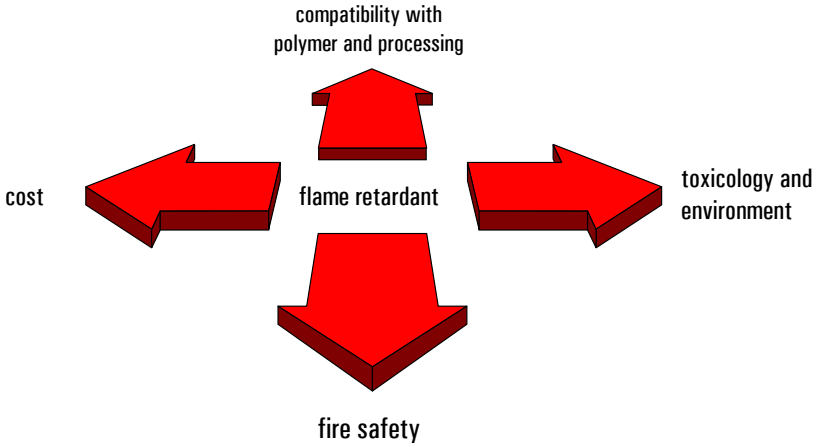
Requirements for Flame Retardants



23

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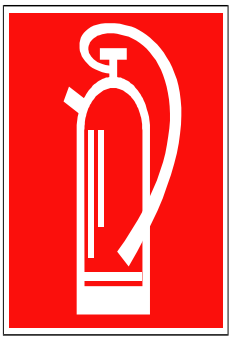
Conclusion

- Flame retardants minimise the risk of fire and protect lives and property – this has been shown in many case studies and statistical exercises
- When used properly, the undesirable „side effects“ of flame retardants are very small compared to their benefits
- Due to flame retardants, a great variety of plastics can be safely used in our homes, workplaces and transport environments



24

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More information….

- www.flameretardants-online.com
- www.exolit.com
- www.cefic-efra.com

25