Phosphorus, Inorganic & Nitrogen Flame Retardants Association

Your newsletter for non-halogen fire safety solutions n° 159 April 2024

PINFA IN ACTION

Historic fires show need for action

Webinar on 1963 Fitchville nursing home fire shows that fire safety improvements are slow and often inadequate. The webinar, by Eric Ebinger, author, historian and HR and EH&S manager, explained how 63 residents tragically died in the Golden Age Nursing Home fire, Fitchville, Ohio, in 1963 (of 84 residents in the home). Mr Ebinger identified six other US nursing home fires in the 1950's, including in Missouri 1957, 57 dead. The Golden Age was in a 1948 building, originally a toy factory, which had passed all inspections and was considered well run at the time. The fire started in mains electrical cables in the attic, which had not been replaced nor repaired despite previously having shown repeated overloading (fuses blowing). The fire then spread with dry dust and wood in the loft. The fire report concluded that, in addition to this known electrical danger, the following factors contributed to the fire tragedy: a lack of extinguishers, accumulated dry materials in the attic, the combustible tar roof, doorways too narrow for wheelchairs (this blocked escape), non-breakable sealed windows, inadequate staff on duty at the time. After the fire authorities took some actions including adding electrical safety to nursing home inspections, changes to the Building Code and staff ratio obligations, fire drill obligations (but these are maybe unrealistic). Automatic sprinklers however were only effectively introduced in 2013, when they were made a condition for Medicare funding.

"Still Not Safe: The Fire that Woke a Nation", pinfa-NA webinar with Eric Ebinger, presented 20th March 2024, watch here https://www.pinfa-na.org/firestillnotsafe

pinfa North America
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Save the date: EV materials webinar

pinfa-NA free webinar – EV battery enclosure screening fire tests, with K.R. Vessey, UL Solutions. Wed. 29th May, 11h30-12h30 EDT (17h30 -18h30 CEST). https://www.pinfa-na.org/

pinfa-NA at ANTEC® 2024

pinfa-NA members participated at ANTEC® 2024, Society of Plastics Engineers Annual Technical Conference, Saint Louis, Missouri, March 2024. With over 400 attendees, the event showcased the latest advances in industrial, laboratory, academic, and international work on plastics and polymers. Sessions included Industry 4.0 (digitalization), AI (Machine Learning applied to molecular design of polymers), Bio-paths to low carbon, safer and differentiated polyethylene products, up-cycling of polymers to increase recycled content, polymers additives, as well as a special symposium with Glenn Beall, a pioneer in the design of polymer based products.

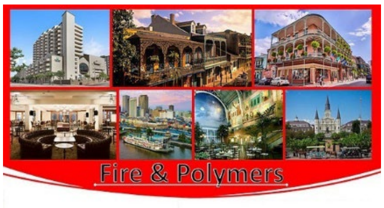
The additive related presentations emphasised replacement of PFAS with alternative technologies to improve processing and to prevent flaming-dripping (and so fire spread), in particular: Ingenia Polymers non-PFAS polymer processing aids including for film extrusion; Vertellus microencapsulation solutions for "hard to use", highly reactive or PCMs (phase change materials), including microencapsulation of Red Phosphorus; BP Polymers barrier resins as an alternative to PFAS in flexible packaging applications; Kaneka silicone core shell impact modifier to enhance PIN FR performance in electrical and electrical transportation applications.

Student poster sessions focused on the upcycling of recycle streams into a variety of industrial applications, e.g. sustainable composites, filtration media and insulation applications.

Summary by Maggie Baumann, with thanks.

ANTEC® 2024 proceedings
https://www.4spe.org/i4a/pages/index.cfm?pageid=8706

ANTEC® 2025 will be in Philadelphia, USA 3-5 March 2025
https://www.4spe.org/



pinfa-NA to present "value of FR materials"

Tim Reilly and Stephen Scherrer, pinfa-NA, will present on why and where flame retardants are needed at ACS Fire & Polymers, 12-15 May, New Orleans. pinfa-NA is developing a project on the "Value of flame retardant containing materials" to demonstrate that FRs are effective in saving lives and protecting property. The presentation will show why material fire performance standards are needed to ensure public safety, show cases where fire safety regulation has moved backwards over recent years, and discuss how the fire science community can contribute to better public and regulatory understanding of benefits of FRs.

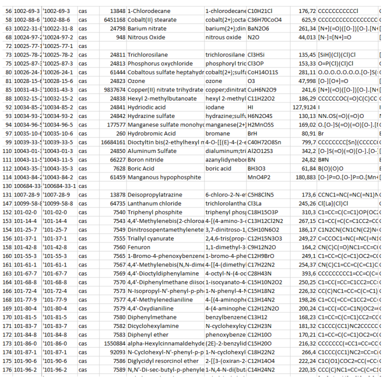
ACS Fire & Polymers Conference, 12-15 May, New Orleans
https://www.polyacs.net/24fipo

POLICY AND REGULATION

ECHA mandate for further work on FRs

The European Commission has clarified investigations ECHA should undertake in 2024 on flame retardants. This follows publication of the ECHA Regulatory Strategy for Flame Retardants (European Chemicals Agency, March 2023, see pinfa Newsletter n°147). The letter to ECHA, signed by DG GROW and DG Environment, requests a report by end 2024, to provide further information on FRs, in particular aromatic brominated FRs. This should include an assessment of whether these could fulfil PBT/vPvB criteria, in order to support a Commission decision of whether preparation of a restriction dossier is required and if so on its scope. ECHA shall also gather information on applications of these FRs and on alternative FRs or technologies which can be used for these applications. To support the Commission in determining other possible future regulatory action, ECHA is also asked to close information gaps on other flame retardants, to collect information on FRs not covered in the 2023 FR Strategy report (e.g. inorganic FRs), to collect data on emissions of FRs and on possibilities to differentiate waste streams containing polymeric or additive FRs. Following this mandate, ECHA made a public call for evidence and information on aromatic brominated FRs (closed 5th April, see pinfa Newsletter n°158). A second call for information on alternatives to aromatic brominated FRs is expected soon.

"Request to the European Chemicals Agency to prepare an investigation report to gather further information on flame retardants", Ref. Ares(2023)8848287 - 22/12/2023 *https://echa.europa.eu/documents/10162/17233/rest_flame_retardants_com_mandate_en.pdf/3e50850a-610d-385b-b5ed-b7dedb35cb46?t=1705476115426*



Global chemicals databases

A 2-year Norway – Switzerland research project is developing a database of chemicals used in plastics. Coordinated by Trondheim University and funded by the Norwegian Research Council, the "PlastChem" project intends to develop an overview of all plastics chemicals, identify and prioritise those which are considered safe (white list) and those of concern and provide guidance to policy making. The project has published an excel file listing more than 16 000 chemicals related to plastics (plastic additives, monomers, chemicals used in processing), by combining seven other data bases, including the UNEP report "Chemicals in Plastics" 2023 (see pinfa Newsletter n°150). PlastChem has sorted these 16 000 chemicals into white, orange, red, watch and grey lists. Over 3 600 chemicals are on the red list, considered by the authors as "of concern" (one or more of PBMT*) and not today internationally regulated. Only 160 chemicals are to date on the white list.

PlastChem has also identified 15 families of chemicals as priorities for action, including chlorinated paraffins but no other flame retardant groups (see PlastChem Report page 4). This database adds to other existing listings and has been developed independently of the ICCA (global chemical industry federation) initiative underway to develop a database of plastics chemicals (see pinfa Newsletter n°157).

PBMT: persistent, bio-accumulative, mobile, toxic

PlastChem project website: https://plastchem-project.org/

PlastChem report, March 2024, M. Wagner et al. http://dx.doi.org/10.5281/zenodo.10701706

Summary of launch webinar (14th march 2024) https://www.genevaenvironmentnetwork.org/events/launch-and-panel-discussion-state-of-the-science-on-plastic-chemicals-identifying-and-addressing-chemicals-and-polymers-of-concern/

Proposed modifications to IWUIC fire code

Revision of the (US) International Wildland Urban Interface Code shows wide discussion on materials fire resistance. The code defines requirements for land use and for buildings within wildland urban interface areas, with the aim of reducing impacts and dangers of wildland fires for buildings and preventing building fires spreading to wildland. Ongoing discussions concern whether wall or deck materials should have one hour fire resistance (to prevent fire penetration) or whether flame spread limitations are sufficient, definition of ignition resistant materials (to prevent buildings catching fire from e.g. burning embers), fire performance requirements for wood construction materials and wood roofings as for well as garage doors, fencing, etc.

Revision of the (US) International Wildland Urban Interface Code (preparation of 2027 edition): https://www.iccsafe.org/products-and-services/i-codes/code-development-process/2024-2026-group-a/

See summary in Fire Safety & Technology Bulletin (FS&TB) March 2024 (vol. 18, n°3) https://www.gbhint.com/firesafety-and-technology-bulletin/

FIRE SAFETY

Batteries, technologies and fire safety

Fire fighter suggests to anticipate fire safety in new materials, rather than trying to deal with consequences. Lithium ion batteries, lightweight timber and steel construction, new polymers: these all bring new fire risks for society and challenges for fire fighters. Dr Burton Clark, with fifty years of firefighting and expert experience, says that to date, society's approach has been to roll out new technologies and materials and then let fire fighters deal with the consequences. He cites as an example a claimed breakthrough in polymers producing 2-dimensional polymer materials "lightweight and stronger than steel … could be used as a building material for bridges or other structures". But who is thinking about the possible consequences if the material burns?

A second article summarises electrical vehicle fires, based on a 60 page review (HERE), noting that they occur statistically less often than for internal combustion engine vehicle but pose specific fire hazards and extinction challenges. Safety is a key objective in EV and battery development, with physical battery protection, electronic battery control and monitoring and new battery technologies (LFP lithium iron phosphate, as already widely used, and possibly in the future solid-state batteries).

"Electric Vehicle Fires: An Overview and Analysis", Fire & Risk Analysis, read on LinkedIn https://www.linkedin.com/posts/jessica-gallo-a743952aa_electric-vehicle-fires-an-overview-and-analysis-activity-7155584230209597440-mD61

"Lithium's looming legacy", B. Clark, and "The dynamics of EV fires", J. Gallo, in International Fire Safety Journal (IFSJ), vol. 03, issue n°34, March 2024 https://internationalfireandsafetyjournal.com/magazine/

Cost of fire in England: 12 billion UK£/year

Government estimates total fire costs at 12 bn UK£/y, of which a 1/4 is impacts of fire, and 3/4 fire prevention and mitigation. The report covers only fires attended by fire services, for the year ending March 2020 and covers only England (population 56.5 million, 2021, so total cost = c. UK£ 210/person/year). The "marginal" costs of fires (consequences of fires which would be reduced if the number of fires was reduced) is estimated at 4.6 bn UK£/y, of which around 2 bn is from property damage, 0.3 bn from road vehicle damage and 0.4 bn from physical and emotional harm to people. Fire consequence costs also include lost output from property damage or victims lost work time, health service costs, environmental costs, administration of fire insurance claims and (marginal) costs of fire service interventions. The 8.8 bn UK£/y "anticipation" costs comes mainly from 4.6 bn fire defence spending in buildings, 2 bn fire defence in consumer goods and 1.4 bn fire and rescue service (fixed) costs.

UK Government Home Office "Research and analysis. Economic and social cost of fire" 29th June 2023 https://www.gov.uk/government/publications/economic-and-social-cost-of-fire/economic-and-social-cost-of-fire#introduction

Lessons from Japan Airlines Airbus fire

All 379 people escaped the A350, with its carbon-composite fuselage, when it caught fire after a crash on landing. The, Japan Airlines flight crashed during landing into a small aircraft which was stationary on the runway at Haneda Airport, Japan, 1st January 2024 (see pinfa Newsletter n°156). Everyone on board escaped. Experts say this was thanks to the aircraft crew's exemplary action, but also because the carbon-fibre – polymer resin composite of the fuselage and the flame-retardant seats and other fittings provided effective protection of passengers from fire. Experts do however express concern that the carbon composite fuselage caused the aircraft to burn for longer, posing dangers to firefighters. Airbus indicate that composites make up 53% of the A350-900 model concerned. Carbon-fibre composites are 20% lighter than aluminium, meaning significant fuel economies.

"The Japan Airlines A350's fuselage gave passengers and crew time to escape and did not burn through for some time", FireRescue https://www.firerescue1.com/safety-experts-eye-carbon-composite-fiber-fuselage-in-japan-airliner-fire

"Japan Airlines fire to give insights into latest manufacturing materials", Financial Times https://www.ft.com/content/f0903192-dc12-4c13-a04c-2136833b773b

RECYCLING

Perspectives on FR polymer recycling

Detailed review of technologies, implementation and perspectives for recycling of flame retardant polymers. Based on over 230 references, of which nearly 30 are summarised in a table, this review covers recycling of different polymers with PIN and with halogenated FRs, including thermosets, thermoplastics and new solutions such as vitrimers and covalent adaptable networks. A key challenge is considered to be the sorting and separation of plastics containing brominated FRs, as required by legislation because certain BrFRs are banned (total bromine < 0.2%). The authors noted that recovered WEEE plastics often remain contaminated by these, and that around half of EU WEEE waste is not being properly sorted. For PIN FR thermoplastics, mechanical recycling is the best option, for sustainability and cost, but with challenges to maintain mechanical and fire performance. The polymer matrix and the specific FRs strongly impact recycling and mixed waste streams are difficult to reprocess. Thermoplastics can be mechanically recycled by shredding to flakes which can be used as fillers in new polymer compounds. Solvent, thermochemical and pyrolysis recycling routes pose questions of energy efficiency, emissions and costs. The authors identify as highlights: development of energy efficient recycling routes, importance of sorting of halogenated FR containing wastes, avoid halogenated releases in processing, need for more sustainable recycling processes for thermosets and need to ensure that future polymer compounds are designed for recycling.

"Recycling of flame retardant polymers: Current technologies and future perspectives", A. Bifulco et al., J. Materials Science & Technology 2024, https://doi.org/10.1016/j.jmst.2024.02.039

Mechanical recycling of PET with P FRs

Recycling of PET fibres with different phosphorus PIN FRs showed that combinations can achieve excellent stability. PET (polyethylene terephthalate) was mechanically recycled with three reprocessing cycles @ 275 – 305 °C (extrude, quench, melt-spin) neat and with two different commercial PIN phosphorus flame retardants: a DOPO derivate DOPO-PEPA @ 5% loading and a phosphonate compound @ 3% loading. The phosphonate FR hindered recycling by causing cross-linking/chain-branching, making the recycled compound too brittle to melt-spin, but this was resolved when combined with the DOPO-PEPA. The two PIN FRs together enabled stable viscosity during reprocessing, efficient fire protection of the recycled compound and maintained mechanical properties (tensile strength). This confirms similar results with this PIN FR DOPO derivative in polyester (Bascucci 2022 in pinfa Newsletter n°136).

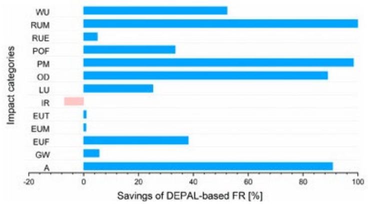
"Mechanical recycling of PET containing mixtures of phosphorus flame retardants", J. Chen et al., J. Science & Technology, 2024, https://doi.org/10.1016/j.jmst.2024.01.035 See also J. Chen poster at FRPM 2023 in pinfa Newsletter n°151.

RESEARCH AND INNOVATION

PIN FR 3-D printing for rigid performance

BASF Forward AM non-halogenated FR resin offers high throughput production of rigid technical parts to UL 94 V-0. The photopolymer resin is compatible with a range of 3D printers, offers low viscosity (350 mPa at 30 ºC) and easy to print process. The resin offers high heat deflection temperature (HDT 0.45 MPa >255°C) and mechanical performance (Young's modulus 3900 MPa, tensile strength 78 MPa, elongation at break 3%). It is self-extinguishing (see video) and can achieve UL 94 V-0 (2 mm). Applications include electronics cable holders, connectors, battery housings, high-voltage electrical components, aerospace, custom parts, automotive and aerospace.

"BASF Ultracur3D RG 9400 B FR" https://forward-am.com/material-portfolio/ultracur3d-photopolymers/rigid-line/ultracur3d-rg-9400-b-fr/ and https://filament2print.com/gb/engineering/2421-basf-ultracur3d-rg-9400-b-fr.html and https://electronics360.globalspec.com/article/20413/nexa3d-unveils-new-ultrafast-desktop-post-processing-and-new-resin-materials



Phosphorus FR Life Cycle Assessment

LCA comparison concludes that DEPAL* (PIN FR) has slightly lower carbon footprint and lower environmental impacts than brominated FR+ATO** in glass-fibre reinforced polyamide 6-6 for electric vehicles and electronics applications, where fire safety is required. Differences were particularly marked for consumption of mineral resources, ozone depletion, particulate emissions and acidification. The authors note that energy consumption needed to produce P_4, essential for DEPAL synthesis, is significant, and the carbon footprint calculation assumed 42% renewable energy (hydro). The DEPAL carbon footprint could be improved by higher use of renewable energy in P_4 production. Both carbon footprint and certain environmental impacts (in particular mineral resources) for the BrFR-ATO case were largely due to the ATO. Overall, using recommended normalisation factors (excluding toxicity, for which the DEPAL case also showed lower impact), the aggregated environmental footprint of the DEPAL fire-protected reinforced polymer is 0.72/FU, whereas that for the BrFR-ATO case is 250.

** DEPAL = aluminium diethyl phosphinate.*

*** Comparison was to brominated polystyrene plus ATO (antimony trioxide).*

"Toward Sustainable Fire Safety: Life Cycle Assessment of Phosphinate-Based and Brominated Flame Retardants in E-Mobility and Electronic Devices", D. Maga, V. Aryan, A. Beard, ACS Sustainable Chem. Eng. 2024, 12, 3652−3658, https://doi.org/10.1021/acssuschemeng.3c07096

Study carried out by Fraunhofer UMSICHT research institute, Germany, funded by pinfa member Clariant.

Fire spread in cable tray

Tests show faster flame spread in cables when they are pre-heated. Tested HFFR cables performed better than PVC cables. All the cables were IEC 60332-1-2 fire rated and the HFFR (halogen-free flame retardant (PEVA/PE based) cable was additionally IEC 60332-3-23 fire rated. Several cables were placed on a metal grid cable tray, total 3.4 m long (CISCCO test rig). Flame spread was faster in the PVC cables (up to 5.5 m/s) than in the HFFR cables (up to 1.5 mm/s), with flame spread rate increasing significantly in the PVC cables from around 170-250°C after pre-heating, but only from around 280-370°C with the HFFR cables. Fire growth rate was also related to pre-heating temperature, and was linearly correlated to flame spread rate.

"Flame Spread Experiments on a Horizontal Preheated Cable Layer", PL Zavaleta et al., Fire Technology, 60, 641–667, 2024 https://doi.org/10.1007/s10694-023-01521-5.

Review of FRs for polyurea elastomers

Polyurea elastomers are widely used in industrial coatings. Review shows development of PIN FRs, especially additive, and expects "a gradual abandonment of the use of halogen compounds". Polyurea coatings are used for waterproofing in construction, roofings, tank linings for water, fuels and chemicals, membranes, fillers as well as in vehicle parts. The global market is growing at > 10%/year and is expected to reach 1.5 billion US$ by 2025. Various non-halogenated flame retardant and smoke-suppression solutions are presented, including phosphorus-based PIN FRs, inorganic PIN FRs and organic clays. Because polyurea formulations and applications are very diverse, a range of different PIN FR and synergist combinations are needed.

"Flame Retardant Additives Used for Polyurea-Based Elastomers—A Review", W. Dukarski et al., Fire 2024, 7, 50, *https://doi.org/10.20944/preprints202401.0384.v1*.

PUBLISHER INFORMATION

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