pinfa
Phosphorus, Inorganic & Nitrogen Flame Retardants Association

Your newsletter for non-halogen fire safety solutions n° 148 April 2023

PINFA ACTIONS

Webinar on fire risks, fire tests, FRs

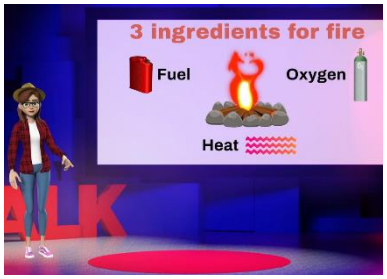
pinfa-na webinar with Alex Morgan on links between fire tests, materials fire safety, fire safety engineering and FR solutions. Dr. Morgan (University of Dayton Research Institute, Center for Flame Retardant Material Science) is a leading global expert on materials fire safety and assists governments, companies and researchers in addressing fire safety and flame retardancy challenges.

Fire risk scenarios, fire tests and flame retardants. Free webinar, May 17th 11h30-12h30 EST (17h-18h CEST) https://www.pinfa-na.org/fireriskwebinar

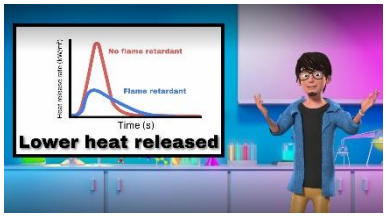
pinfa-NA explainer video series

pinfa-NA launches series of short (2-3 minute) educational videos on the use of flame retardants for fire protection. The short learning videos aim to inform the public on public fire safety, flame retardant technology and human & environmental health topics. A dozen further videos are planned by pinfa-NA.

Timothy Reilly, Vice-Chairman of pinfa-NA: "flame retardant-containing materials play an important behind-the-scenes role in protecting human life and property. While society routinely learns from the media about the destructive fire that did happen, we rarely hear about the fire that did not happen thanks to specially designed materials which properly performed. pinfa-NA's planned multi-part video series will demonstrate the important role these materials play in public fire safety."



The first video explains how flame retardant materials prevent fires and save lives. Zoé and Ethan, using animated infographics, start by showing that fire needs fuel, heat and air, and explain that flame retardants can prevent the fire starting (ignition), slow its



development and reduce heat release, so increasing time for building occupants to escape safely. The video ends with the message that “Flame retardant materials play an important part in protecting life and property”. A dozen further explainer videos are now planned by pinfa-NA

The second video shows how flame retardants contribute to passive fire safety, keeping us safe the whole time. With a building fire every minute every day in the USA (NFPA data), both active and passive fire safety are needed. Applications of flame retardant materials in passive fire safety are summarised: buildings, furnishings, transport, electrical installations, electronics. A comparative burn test of flame retardant and non-flame retardant material is shown.

The third video discusses fire regulations, codes & standards, and how these correspond to real fire risk scenarios, from technical specifications through to legal requirements. The example of mattress flammability standards is given, where NIST estimates that these requirements save 65 lives per year in the USA. The need for differing standards for the same type of product, depending on fire risk and escape possibilities are explained: a fire in seating on a ship or airplane is likely to have worse consequences than in a building.

www.pinfa-na.org/learnfrmaterials

EU PUBLIC CONSULTATIONS

EU Taxonomy consultation

Draft green finance criteria. pinfa input that the significant environmental impacts of fire safety should be considered. pinfa emphasised that fire has not only human and economic costs, but also important environmental consequences, both local (smoke and soot, polluted extinction waters, etc.) and global (impacts of response, replacement of damaged buildings and contents, site remediation, etc.), see pinfa Newsletter n°141. Fires also reduce the service life of installations and buildings, which is contrary to the Taxonomy’s Circular Economy objectives. The proposed criteria for electrical and electronics manufacturing (Annex II 1.2) exclude (with exceptions) halogenated materials in the finished product. pinfa underlines that PIN (phosphorus, inorganic and nitrogen based) flame retardant solutions are available to ensure fire safety in modern performance materials. A number of PIN flame retardants have been validated as low-risk and preferable for use by independent assessments (Denmark EPA Lous 2016, ENFIRO 2013, LIFE-FLAREX 2018, GreenScreen, Öko-Tex, TCO …) and are compatible with end-of-life recycling (see www.pinfa.eu/media-events/pinfa-academy).

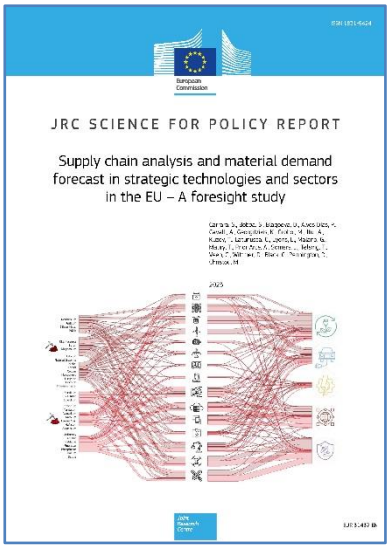
pinfa regrets that fire safety is not specified in the proposed EU Taxonomy criteria for manufacture of electrical and electronic

equipment (Annex II 1.2), for buildings (Annex II 3.1 + 3.2), for plastic packaging (Annex II 1.1, for e.g. pallets and films for transport and construction sites) and for spare parts (Annex II 5.2).

pinfa input 3rd May 2023 , on EU "Have Your Say" website: HERE

"Sustainable investment – EU environmental taxonomy", EU public consultation (closed 3rd May 2023) and draft Delegated Regulation establishing further Technical Screening Criteria for the EU 'Taxonomy' Regulation 2020/852 HERE.

See also: European Commission taxonomy and sustainable finance web page HERE and EU Taxonomy Navigator online tool HERE.



Strategic Raw Materials (SRM) consultation

EU public consultation now extended to 30th June: phosphorus not in proposed SRM list despite being critical for fire safety. The proposed EU Critical Raw Materials Regulation retains "Phosphorus" and "Phosphate Rock" on the list of Critical Raw Materials, but not on the list of "Strategic Raw Materials", eligible for EU funding, joint projects and other policy tools. The essential role of elemental phosphorus P_4 (termed "Phosphorus") for fire safety (necessary for many P-based flame retardants) is mentioned only for data centres, but ignored for batteries, renewable energy, other electronics applications, aerospace ..

Further detail in pinfa Newsletter n°147.

You can input to the public consultation until 30th June here: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13597-European-Critical-Raw-Materials-Act_en

PINFA NORTH AMERICA NEW MEMBER

Performance Polymers and Additives LLC

PPA was formed in 2015 to commercially develop and distribute flame retardants, functional polymers and additives in North America. PPA today has three staff and works with a network of experts including GH Associates, Avakian Polychem Consulting and Robert Eller and Associates. PPA distributes FRX Polymers polyphosphonates, JLS Chemicals additives and masterbatches, and Paxymer acrylate copolymer, as well as customised masterbatches and compounds including Polyvision graft modified and recycled PET based compounds and masterbatches. PPA services include industrial market research and commercial development, including product introductions and distribution services. Focus is currently on the growing and dynamic area of non-halogenated flame retardants and synergists and other functional additives with excellent EHS profiles. PPA has become an Associate Member of pinf-NA. Maggie Baumann, President of PPA, has been active in pinfa-NA since 2012.

www.performancepa.com

POLICY AND REGULATION

Position for building renovation fire safety

pinfa supports joint position to include safety, including fire safety, in the EU Energy Performance of Buildings Directive (EPBD revision). The position signed by 12 organisations asks the European Council (member states) to follow the amendments voted by the European Parliament to include safety in new construction and renovation, in solar energy installations, in roofed car parks, in inspections, in tenant information and in the "Renovation Passport" which will ensure traceable information on building works. The fire risks of increasing electrification and renewable energies and of new materials and insulation are underlined. A holistic safety approach to construction, including fire, electrical, gas and carbon monoxide safety, is needed to enable building energy renovation and green building without increasing risks of tragic accidents which could lead to resistance to decarbonisation solutions.

"EPBD Revision: European Parliament's fire safety considerations need to be supported", Joint statement of fire, electrical, gas and CO safety organisations, 23rd March 2023, published on the EFSA (European Fire Safety Alliance) website HERE.

Opinion on wildfire retardant application

US federal Department of the Interior Opinion suggests wildfire chemicals have limited impacts on ecosystems and species. The revised opinion, based on extensive consultation, updates previous documents and specifically considers a significant number of threated plant, animal and insect species. The wildfire fire retardant chemicals used for some fifty years now are nearly all phosphorus- or phosphorus and ammonium- based, with some magnesium and chloride salts. The Opinion concludes that, as used to fight wildfires, these chemicals are not likely to jeopardise survival of the species considered nor adversely modify the critical habitats considered. Action will continue to limit applications susceptible to impact protected species or habitats and to monitor impacts in the field. Wildfire retardant chemicals are subject to specific approval protocols, for example France CEREN CCTP2010, Spain UNE 23.530 (both accepted in several Mediterranean countries), US Forest Service Specification FS 5100-304d (valid also in Australia, New Zealand).

"2023 Revised Final Biological Opinion for the U.S. Forest Service Programmatic Nationwide Aerial Application of Fire Retardant on National Forest System Land", United States Department of the Interior, Fish and Wildlife Service, 13 February 2023
https://www.fs.usda.gov/sites/default/files/2023-02/Fire-Retardant-FWS-Biological-Op.pdf

Fire safety engineering only partly in place

European Commission JRC survey concludes that fire safety engineering (FSE) is only partially implemented across Europe and that more work is needed to enable performance-based methods for fire design, to develop supporting standardisation, design scenarios and criteria. Responses from 32 European countries indicate that although FSE methods are in most cases available and authorised, prescriptive methods (criteria for different materials) are more generally applied, rather than a holistic FSE approach looking at the whole building system, despite wide recognition that an FSE approach is necessary to enable innovative building design and new construction techniques and materials. Prediction of fire, smoke and evacuation depend mainly on international standards and national regulations. Qualifications required for FSE practitioners and reviewers are very variable.

"The status and needs for implementation of Fire Safety Engineering approach in Europe. Support to policies and standards for sustainable construction", A. Athanasopoulou et al., European Commission JRC, 2023, ISBN 978-92-76-61624-5, https://dx.doi.org/10.2760/031591

ECHA publishes PFAS Restriction proposal

The EU has published a proposal to Restrict some 10 000 polyfluoroalkyl substances (PFAS), including PTFE. This was announced with the EU Chemicals Strategy for Sustainability in 2020 (SWD(2020)249). The proposal specifies per- and polyfluoroalkyl substances (PFAS) proposed for restriction as: "Any substance that contains at least one fully fluorinated methyl (CF3-) or methylene (-CF2-) carbon atom (without any H/Cl/Br/I attached to it)" except if it contains certain structural elements (*). The most widely used fluoropolymer is PTFE (polytetrafluorethylene, Teflon™), and one of its quantitatively small uses is as an anti-drip synergist with flame retardants, to prevent propagation of fire by burning drips of molten plastic. The restriction proposal offers two options: RO1 = a full ban after 18 months, or RO2 = a ban after 18 months with some derogations plus tolerance at ppm/ppb levels in mixtures, articles or as constituents of other substances. The Restriction proposals will now enter a consultation and scientific and regulatory evaluation process which may take several years.

** PFAS containing the following structural elements are NOT concerned by the proposed Restriction: CF3-X or X-CF2-X', where X = -OR or -NRR' and X' = methyl (-CH3), methylene (-CH2), an aromatic group, a carbonyl group (-C(O)-), -OR'', -SR'' or –NR''R''', and where R/R'/R''/R''' is a hydrogen (-H), methyl (-CH3), methylene (-CH2-), an aromatic group or a carbonyl group (-C(O)-).*

"ECHA publishes PFAS restriction proposal", 7 February 2023, ECHA/NR/23/04 https://echa.europa.eu/-/echa-publishes-pfas-restriction-proposal

MARKET STUDIES

Flame retardant "market reports"

Market studies, for sale online, expect sustained growth in flame retardants worldwide, but numbers vary widely. Most reports suggest electronics, construction and transport as key growth sectors.

The range in numbers given as estimates for today's global flame retardant market is more than a factor of four. This suggests that possibly these reports, which all claim to cover the world "flame retardant" market, may not be including the same things. The range in estimates of expected annual market growth is over 60%. All reports however expect sustained annual growth of the world flame retardant market, of 4.5% to 7.3 % CAGR. Estimates for market growth of non-halogenated FRs are generally slightly higher, but given the wide variations it is doubtful whether this is meaningful.

Billion US$	*Growth CAGR*	*Current market*	*To reach*
Global market all FRs			
BrainyInsights	7.3%	8.6 bn US$ (2022)	15.0 bn US$ (2030)
DataBridge	6.2%	12.8 bn US$ (2021)	20.7 bn US$ (2029)
Emergen	5.1%	6.7 bn US$ (2021)	10.5 bn US$ (2030)
FutureMarketInsights	7.1%	7.5 bn US$ (2020)	17.0 bn US$ (2032)
For comparison: previous report FutureMarketInsights	*5.9%*	*7.5 bn US$ (2020)*	*11.2 bn US$ (2027)*
ReportLinker	4.5%	15.3 bn US$ (2022)	21.7 bn US$ (2030)
ResearchandMarkets	5.1%	7.2 bn US$ (2022)	9.2 bn US$ (2027)
For comparison: previous report ResearchandMarkets	*5.9%*	*8.2 bn US$ (2021)*	*13.6 bn US$ (2030)*
GrandViewResearch (GVR)	*8.0 %*	*7.5 bn US$ (2020)*	*13.8 bn US$ (2028)*
Other previous reports			
MarketResearchGuru	*4.3%*	*3.3 bn US$ (2022)*	*4.3 bn US$ (2028)*
AlliedMarketResearch	*6.6%*	*7.4 bn US$ (2020)*	*14.0 bn US$ (2030)*
MarketsandMarkets	*5.1%*	*7.2 bn US$ (2022)*	*9.2 bn US$ (2027)*
P&SIntelligence	*5.3%*	*7.6 bn US$ (2021)*	*12.0 bn US$ (2030)*
Global market non-halogenated FRs			
Zion	8.5%	4.1 bn US$ (2021)	6.8 bn US$ (2028)
Other previous reports			
CoherentMarketInsights	*6.4%*	*3.0 bn US$ (2019)*	*5.0 bn US$ (2027)*
IndustryArc	*8.0%*	*4.9 bn US$ (2022)*	*7.2 bn US$ (2027)*
VerifiedMarketResearch	*8.6%*	*4.1 bn US$ (2020)*	*7.9 bn US$ (2028)*

** See summary of numbers from ten other studies in pinfa Newsletter n°143, November 2022.*

INNOVATION AND RESEARCH

PIN FR VOC emissions free

Burnblock's PIN flame / fire retardant has been certified EN16516 with no detectable VOC emissions after 28 days. All (100%) of the different chemical substances constituting the Burnblock® ingredient are natural, the Burnblock® ingredients are 100% biodegradable and are non-toxic (no hazard label for environmental or health end-points). The product can be applied as liquid to any absorbing surface (predominately used for timber, plywood, composite boards (eg. MDF), wooden/natural fibres …) in construction, public buildings, and other applications. Treated products achieve EU Construction Products Directive B-s1,d0 fire performance (highest level). Also, after covering with appropriate coatings (paint, lacquer etc.). Burnblock® is a Copenhagen (DK) SME specialized in sustainable fire safety solutions. The Burnblock ingredient is Cradle to Cradle Certified™ at the Gold level.

"Burnblock is now emission free!", 4th July 2022
https://burnblock.com/burnblock-is-now-emission-free/
Photo ©Hufton+Crown/WJ Group

PIN FR synergies in polyamide

Fire performance synergies are shown between phosphorus PIN flame retardant and different PIN mineral additives. The well-recognised PIN phosphorus flame retardant DEPAL (aluminium diethyl phosphinate) was tested in injection molded polyamide 6 alone (15%) or with combinations of four different PIN minerals (1 to 5%): magnesium hydroxide (MDH), ammonium polyphosphate, high molecular weight siloxane, boehmite (aluminium oxide hydroxide mineral), zinc borate. Fire performance, mechanical properties and densities of a total of sixteen different formulations were tested. Neat polyamide was UL 94 V-2 and GWI 750°C, but achieved UL 94 V-0 (1.5 mm) and GWI 960°C with DEPAL only. LOI was around 25% higher with DEPAL only (compared to neat polyamide) but was doubled with some synergist combinations, in particular with MDH. Smoke density with DEPAL only was around half that with neat polyamide, but could be significantly further reduced by inclusion of synergists. Similarly, carbon monoxide emissions, reduced by DEPAL alone, were further reduced with synergists. Combinations of DEPAL with MDH, and with MDH plus other synergists offer high LOI and achieve the low smoke density requirement of the EU railway standard R22-EN45545.

"Investigation of the Fire Performance of Polyamide 6-Based Composites with Halogen-free Flame Retardants and Synergistic Materials", T. Uysalman et al., CS Omega 2022, 7, 33, 28885–28895
https://doi.org/10.1021/acsomega.2c02018

PIN FR thermoplastic piping system

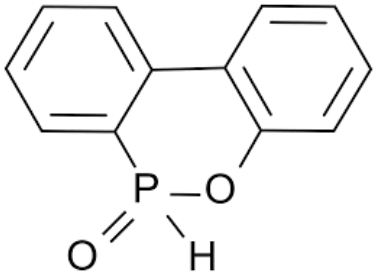
GF Piping Systems non-halogen pipe jacket solution for fire-protection of lightweight, corrosion-free maritime applications. The HEAT-FIT pipe jacket system uses non-halogenated, intumescent flame retardants to achieve strict IMO (International Marine Organisation) fire endurance standards, including resisting c. 1000°C for 30 minutes under pressure, flame spread and surface flammability, smoke and toxicity to IMO A653 2010 FTP Code Part 5 and Part 2. They can be used with ecoFIT (PE100) pipes and fittings in essential applications (L3) including ballast water, fresh- and seawater cooling, exhaust gas scrubbers in shipping, offshore platforms, floating wind farms. The material is water based, does not contain hazardous chemicals and is Hong Kong Convention Green Ship Passport compliant. The jacket uses glass fibre and intumescent coating, exterior protected by TPU to resist harsh marine conditions. Pipes can be joined and sealed onboard with butt fusion or electrofusion, without special skills and with full traceability.

GF Piping Systems https://www.gfps.com/com/en/products-solutions/systems/heat-fit.html

Testing new silicon – nitrogen PIN FRs

Silylamine and siloxyamine compounds showed flame retardancy in PP, PE and epoxy and synergy with P FR. Seventeen different N-Si and N-O-Si were synthesised, based on phthalimide (reacted to silyphthalimides or siloxyphthalimides) or on pyromelletic diimides. These were tested as PIN flame retardants in polypropylene films, linear low-density polyethylene and in epoxy resin. Sterical hindrance in the compounds (presence of bulky groups in the molecule) improved their thermal stability, facilitating processing. In each polymer tested, one or two (only) of the nitrogen silicon compounds at low loadings in combination with a spirocyclic phosphonate PIN FR achieved UL 94 V-0 (1.6 mm). The flame retardant mechanisms were identified as release of aminyl, silyl and oxygen-centred radicals acting in the gas phase and also causing earlier and enhanced activation of the phosphorus PIN FR, release of inert nitrogen gas and contribution of silicon to charring. pinfa notes that possible eco/tox safety of these new molecules should be assessed before further development.

"Synthesis of silylamine and siloxyamine compounds: A novel approach to flame retardancy of polypropylene and Epoxy resins", T. Ääritalo et al., Polymer Degradation and Stability 211 (2023) 110336, https://doi.org/10.1016/j.polymdegradstab.2023.110336



DOPO plus sulphur based PIN FR for epoxy

Macromolecular P-N-S PIN flame retardant improves fire performance, thermal stability and strength of epoxy. The well-known phosphorus PIN FR molecule DOPO was combined with nitrogen-containing molecules and a phosphorus-sulphur compound and polymerised to generate macromolecular DOPONH_2S (14% P content). This was tested at 0 – 10% in DGEBA epoxy. Neat epoxy was not rated and showed dripping in UL 94 (3 mm) whereas with 5 – 10% DOPONH_2S V-0 no dripping was achieved. LOI was increased by around one third with 10% DOPONH_2S and char production was doubled. The authors attribute the fire performance to solid phase action (char layer) and to gas phase action of phosphorus and sulphur radicals. DOPONH_2S improves the tensile and impact strength of the epoxy, probably because amino groups cross-link to epoxy whilst flexible chains in DOPONH_2S improve toughness.

"A novel phosphorus-, nitrogen- and sulfur-containing macromolecule flame retardant for constructing high-performance epoxy resin composites", G. Jiang et al., Chemical Engineering Journal 451 (2023) 137823 https://doi.org/10.1016/j.cej.2022.137823

Bio-based PIN FR for cotton textiles

Bio-sourced taurine reacted with phosphorus and nitrogen for a wash-durable PIN flame retardant for cotton-nylon blends. Taurine is a sulphur-containing amino acid derivative, widely found in animals and plants (the name comes from its presence in bull's bile). It was here reacted with phosphorous acid (a P_4 derivate) and ammonia solution, then reacted onto cotton-nylon blend textile (150 g/m^2, 87.5% cotton, 12.5% nylon) by soaking with a catalyst and a swelling agent, resulting in a 2% P and 1% S loading (but lower N, higher C than in the neat fibres). LOI was increased from 18.5% to 37% and afterflame / afterglow eliminated in a vertical burn test. LOI was still 29% after 40 wash cycles. The FR mechanisms were identified as char formation and release of non-flammable gases. Olé.

"Improving the fire performance and washing durability of nylon-cotton blend fabrics by the incorporation taurine derivatives", L. Li et al., Progress in Organic Coatings 171 (2022) 107018, https://doi.org/10.1016/j.porgcoat.2022.107018

Review of possible new endothermic FRs

Metal complexes with endothermic properties (phase transition, cold crystallisation) could provide new FR solutions. This theory mini-review considers how certain metal complexes, which modify at lower temperatures than necessary for polymer ignition and absorb heat (endothermic) may provide new flame-retardant mechanisms. Heat absorption may be by modification of the crystal shape of the metal complex, or by cold crystallisation (endothermic dissolution in a form of supercooling with latent heat storage). To date research is at the theoretical stage, based on some examples of molecules known to exhibit such behaviour in other applications.

"Toward Flame Retardants or Thermal Stabilizers with New Mechanism for Polymers", T. Akitsu et al., FirePhysChem (2023), https://doi.org/10.1016/j.fpc.2023.03.004

PUBLISHER INFORMATION

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