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Phosphorus, Inorganic & Nitrogen Flame Retardants Association

AMI CONFERENCES
Bringing the plastics industry together

pinfa Newsletter special edition n°80 – June 2017

FIRE RETARDANTS IN PLASTICS 2017

Pittsburgh, Pennsylvania, 25-26 April 2017

The next AMI Fire Resistance in Plastics conferences will take place in:

Europe (Cologne)
5-7 December 2017

and

North America
(Pittsburgh April 2018)

www.amiconferences.com

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Conference key messages

*This special edition of the **pinfa Newsletter** summarises AMI's 7th North America "Fire Resistance in Plastics" conference (Pittsburgh April 2017) and presents interviews of a selection of participants.*

The conference brought together 150 participants, in particular compounders and polymer companies, flame retardant and synergist suppliers, processing technologies, research and supply chain experts.

For pinfa, key messages from the conference are:

- *Expected increasing demand for flame retardants in the automobile sector, driven by increasing fire risks in electrical vehicles (batteries, high currents) and onboard electronics.*

  Note that pinfa-na with SAMPE are organising a seminar on Fire Safety Requirements in Automotive Design, 26-28 Sept., Dearborn, MI, near Detroit, USA. Info: Timothy.Reilly@clariant.com
- *The strongest driver for flame retardant use is fire safety regulation, but in many cases industry (including automotive) may take the lead with the objective of ensuring product safety, for reasons of image and risk liability. Also, industry anticipates that fire safety regulations will tighten or be put into place in new sectors*
- *Studies do show that flame retardants are effective in real life situations, but there is a need for dialogue with end-user industries, regulators and stakeholders to improve understanding of how FRs contribute to saving lives and protecting property, particularly in the contexts of increasing use of polymers and increasing presence of electronics in today's world*
- *Many industry sectors in North America are expressing strong interest in moving to PIN flame retardants, because of global supply-chain sustainability requirements, as well as low smoke – low corrosivity. Reactive and polymeric flame retardants are also seen as positive developments.*
- *Nearly all the R&D presented into new FR systems, both in research institutes and in industry, is focussing on PIN FR systems. R&D is addressing both innovative bio-based PIN solutions and novel PIN FRs, as well as the improvement of existing PIN solutions by use of synergists and combinations of available PIN FRs.*

Claudia Whitcombe, Head of Marketing, AMI, considers that the Fire Retardants in Plastics conferences twice a year (Europe, USA) correspond to a continuing demand for dialogue between flame retardant and synergist producers, polymer companies, compounders and formulation experts, researchers and end-users. Polymer and FR technologies are evolving rapidly, to correspond to developments such as appliance connectivity and electronics, energy efficiency and sustainability, and to the societal demand for fire safety, so that each conference brings new information and new perspectives.

Peter Mapleston, Conference Chair and Technology Editor of Compounding World, sees flame retardants being increasingly needed in many areas to ensure fire protection and prevention, in response to society's general concern about safety, in particularly in electrical equipment and appliances, in buildings and in the automobile industry. Even where regulation does not require fire safety, industry will want to stay ahead and ensure safety, for reasons of image and legal liability. At the same time, more scientific data is needed to establish the health and environmental safety of flame retardants, along with dialogue between industry and stakeholders on these challenges. Discussion can be expected to widen from halogenated versus PIN to the advantages of reactive FRs and oligo-molecular or polymer FRs in reducing emissions risks.

Interviews:

Globalisation driving fire safety standards

Shawn Osborn, Ascend Performance Materials

In response to more stringent customer requirements and the environmental demands for non-halogenated flame retardants, Ascend has increased its product catalogue to meet global customers' needs in promoting PIN FR product offerings. These versatile materials are suitable for a range of electrical applications and are even making their way into the automotive sector to provide increased fire safety performance in electrical and electronic components and connectors incorporated in the high-voltage environments of hybrid and electric vehicles. Furthermore, the trend toward miniaturisation of electrical components demands improved flammability requirements of UL94 V0 down to 0.4 and even 0.2mm. While halogen-containing formulations are able to meet the current V0 specification, their primary drawback is their inability to attain a comparative tracking index (CTI) of >400 volts, while the majority of PIN FRs are able to achieve the maximum 600 volt rating. Ascend provides flame retardant polyamide formulations with high levels of processability, colorability, and thermal, mechanical, and electrical properties. Shawn Osborn sees the AMI Fire Retardants in Plastics conference as an indispensable opportunity for obtaining the latest information on additive technologies and for networking throughout the industry.

Ascend is the world's leading manufacturer of polyamide Nylon 66 with integrated production and compounding of formulations adapted to a wide range of industries and applications, including automobile and E&E www.ascendmaterials.com

Joao Lorenzoni and Steven Devlies, Unimin

Fire safety is increasingly important in today's world as polymers are more extensively present and the population more urban. Fire safety standards in developing countries can be expected to progressively tighten. Already today, manufacturers worldwide tend to produce to US or EU fire safety standards because supply chains are globalised. Unimin expects developments in polyolefins, as performance is improved to enable replacement of more expensive engineering polymers. Challenges in FR development include ensuring low smoke emissions (visibility is important for escape), sustainability and recyclability, health and environmental safety. PIN FR solutions include high-grade mineral FRs (with engineered particle size distribution and surface treatment) to address materials performance challenges and new combination packages of existing PIN FRs and synergists. For Unimin, this AMI conference enables new industry contacts and networking and a vision of the North American FR industry status and challenges. It is also considered an excellent occasion to present to the industry Sibelco group's growth ambitions in mineral flame retardants for the North-American market.

Unimin is part of Sibelco, a global mineral (non fuel) mining company with 9 500 employees. The company's core competence is milling, with dedicated processes for different minerals, enabling production of specific grades and characteristics. www.unimin.com

Andrew Meyer, Mormon Innovation & Technology

Increasing industry interest in LSZH (low smoke zero halogen) is being driven by a combination of obligation to fulfil regulatory requirements or customer specifications in some applications and image perception. However, industry also tends to resist change, because of the difficulty and delay for obtaining new product qualifications (e.g. military, nuclear) or because of cost and risk of modifying product and process. Standards for e.g. electrical insulation durability are currently not the same across the world whereas global harmonisation is anticipated, leading to uncertainty about future requirements. On the other hand, EU regulations (REACH, RoHS) are driving product choice worldwide. An important challenge identified by Mormon Innovation is to develop PIN FR intumescent solutions effective in cross-linked thermosets. This AMI conference enables to see new developments in PIN FRs, to dialogue with other sectors facing similar formulation challenges and to update regulatory perspectives.

Mormon Innovation & Technology is the research division of Gendon Polymer Services www.gendon.com in particular, supplying wire and cable for engineering and specialist applications including oil and gas, military and industry, with a polymer range from polyethylene through to PEEK.

New technologies in PIN FRs

Hendrik Wermter, Chemische Fabrik Budenheim, presented results with their new PIN FR systems. These systems are mainly based on melamine polyphosphate and a recently developed polymeric DOPO-derivative (organo-phosphorus PIN FR). The new PIN FR systems are especially designed for GF (glass filled) engineering plastic applications. In glass filled PA-6 and PA 6.6, UL94-V0 (0.8mm) at 20 – 23% loading combined with very good GWIT (>800°C) results (glow wire ignition test) have been achieved. The observed smoke toxicity was very low (3-8 times lower than standard under DIN 5510-2). Compounders show high interest in this new PIN FR system due to its very good processing properties i.e. good thermal stability, no migration at storage test (85°C, 85% humidity for seven days) and especially low corrosion.

Tatsuya Shimizu, Adeka, noted that automobiles increasingly use polymers, both to reduce weight and for batteries, electrical and electronic installations. This will drive increasing need for flame retardancy and for additives to ensure weathering and UV resistance. He presented solutions combining intumescent PIN flame retardants with additives to protect against UV and polymer oxidisation in a range of polymers (PP, PE, HDPE). Adeka's tests show that the intumescent PIN FR solution less dense smoke and 30 – 1 000 times lower smoke toxic gases than halogenated FR solutions. Use of a nitrogen based adjuvant can additionally increase polymer transparency and processing speed, whilst ensuring thermal stability and low discoloration.

Bob Howell, Central Michigan University, presented phosphorus reacted isosorbides as possible bio-sourced PIN FRs. Production is starch -> D-glucose -> D-sorbitol -> isosorbitol -> phosphorus esters. The resulting molecules are phosphates, phosphinates or phosphonates / propanoate, enoate or thiatetradecanoate. They can be optimised to have lower oxygen than phosphorus content in order to be active in gas phase flame inhibition. These molecules were selected because their structure leads to expect them to be biodegradable and of low toxicity.

Mahash Patil, Indian Oxides, presented his vision for flame retardants (FRs) of the future: polymeric or react into polymers (to avoid possible environmental losses and toxicity), biodegradeable and not contributing to toxic smoke in fires. They should also support not deteriorate polymer properties, and face the challenge of achieving this whilst keeping costs down. He summarised a range of possible developments in this direction: nanopolymer composites (e.g. layered double hydroxides), organic modified clays, carbon nanotubes, phosphate-functionalised graphene oxide, siloxanes (POSS), renewable-based FRs (e.g. using DNA from fish waste or cellulose). He noted the important need for tighter fire safety regulation in developing countries, which will drive demand for FRs, and the need to educate decision makers and the public that FRs serve a vital purpose in reducing fire risks.

Douglas Fox, American University, presented different possible routes for producing bio-sourced PIN flame retardants: cellulose (from wood and forest by-products), seaweed, chitin (from crustaceans or insects), phytase (non-digestible phosphorus storage molecule in seeds), tannic acid, taurine. Cellulose is readily available, cheap to extract and is an effective char generator, but is poorly mixable with most polymers. Also, work with lignins shows that the char generated tends to peel away exposing the polymer to the fire. Cellulose processed into a thermoplastic carbohydrate shows promise however, achieving a 2/3 reduction in peak heat release rate in PEMA (poly ethyl methyl acrylate).

Glade Squires, OMYA (distributor for Italmatch), presented new PIN FRs based on mineral phosphites (magnesium, calcium, aluminium). These products offer a high phosphorus content and combine two flame retardant mechanisms: water release and polyphosphoric acid which contributes to intumescence and char formation. Effectiveness is improved by combining forms of phosphorus at different valent states. UL94-V0 was achieved in a number of tested polymers (polypropylene, polyethylene HDPE – LDPE – LLDPE, EVA) at loadings of 22-32%. Blooming (migration) was not detectable after 42 days and corrosion of processing equipment was considerably lower than a reference halogenated FR system.

Interviews:

Meeting tomorrow's requirements for fire safety

Scott Ferguson, Textile Rubber & Chemical

Tomorrow's flame retardants will need to respect both demanding performance requirements and severe environmental and health specifications. Technical requirements are sector-specific and can include abrasion resistance, non-fogging (reduced migration), smoke emission. Sustainability criteria are increasingly specified, often leading to select PIN FR solutions. Key challenges include developing FR packages for polypropylene which avoid burning dripping, and adapting FR solutions from polymers to water-based applications. This AMI conference provides information on new technologies which can be adapted to the transport sector where health and environmental safety, fire performance and smoke emission are particularly important, alongside FR cost.

Textile Rubber and Chemical develop and supply specialty coating formulations for various industries including sectors such as carpets, upholstery textiles and nonwoven for automobile, railway and aviation carpets, air conditioning duct insulation and furnishings. www.trcc.com

Leeanne Taylor, Hexion

Phenolic resins are commonly used in many FR composite applications meeting low fire, smoke and toxicity requirements. Epoxy resins are expanding in this area due to their manufacturing advantages and because of user concerns about possible phenol or formaldehyde emissions from phenolic resins. Epoxy resins pose specific challenges for flame retardant dispersion because they are liquid and depending on the application solid inorganic additives are not appropriate. Polymer phosphate FRs have shown to be effective in some cases. End user industries are looking for PIN FR solutions for low smoke density and toxicity, either because this is already a requirement (e.g. in aviation) or because they expect it to become so in the future. Studies show that FRs are effective in real life situations, for example FAA studies showing that heat release rates impact escape time in airplanes, but dialogue is needed to communicate this to decision makers and the public. This AMI conference is important for networking, but more information on thermosets would be welcome as it is a growing market, as well as dialogue on health and environment questions.

Hexion is a global leader in thermoset polymers, in particular epoxy and phenolic resins, to a wide range of applications including forest products, aviation, automobile, wind energy, printed circuit boards and paints and coatings. www.hexion.com

Jinfeng Zhuge, SABIC

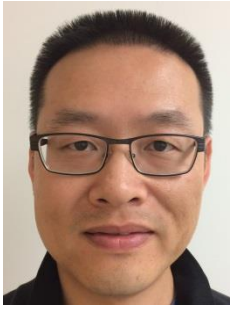
SABIC's customers are looking for PIN flame retardant (FR) solutions, especially in the market segments of Mass Transportation, Consumer Electronics, and E&E. SABIC offers a portfolio of innovative FR solutions, specific to the regulatory and customer requirements of various different industries sectors. As an example, some of SABIC's thermoplastic resin solutions meet the stringent fire safety requirements under the CEN/TS 45445 and NFPA 130 standards. Material suppliers and FR suppliers need to stay actively involved in regulatory and standards development affecting fire safety requirements to ensure that these requirements reflect real-life applications. Many SABIC customers have asked us to try to push the existing boundaries in flame retardant thin wall solutions. Challenges are often seen when these thin wall FR parts need to also balance other requirements, which could include properties such as impact resistance, chemical resistance, and transparency. This AMI conference enabled SABIC to connect with FR suppliers and to see new developments in PIN FR solutions.

Saudi Basic Industries Corporation (SABIC) www.sabic.com is a global petrochemical company, and a major producer of polyethylene, polypropylene and other advanced thermoplastics. SABIC operates in more than 40 countries and manufactures in the Americas, Europe, the Middle East and Asia Pacific.

Peng Ye, Farrel Pomini

Farrel Pomini's unique extrusion technology enables implementation of innovative PIN FR polymer packages, because it reduces sheer pressure which can cause decomposition of temperature sensitive components, as well as offering low energy consumption, high throughput and capacity to process compounds with high FR loadings. Farrel Pomini carry out processing trials for formulators, and recently have successfully demonstrated processing of polymeric FRs, high loading mineral ATH, a plated-structure clay-based PIN FR (overcoming problems posed by its tendency to agglomerate and not disperse in the polymer) and a high-end phosphorus FR (temperature sensitive). This AMI conference is highly informative, with a wealth of new information about PIN FR developments which will require new processing approaches.

With history in pumps technology back to the 1840's, Farrel Pomini is a global leader in development and manufacturing of continuous mixing systems for polymer processing www.farrel-pomini.com



Zheng Qian, Polymer Dynamix

Flame retardant polymers are increasingly complex, requiring expertise to meet different fire performance standards in different markets with increasingly sophisticated FR – synergist – polymer packages posing challenges for processing. Polymer Dynamix sees end-users across the market, in particular leading wire and cable companies, pushing to move towards non-halogenated FRs and low-smoke emission. This can require new processing technologies or a change in the polymer system. Polymer Dynamix recently developed different versions of silicone based synergist which can be effective in boosting the fire performance and processing aid with different FR systems. Silicones can improve processing at all temperatures. This AMI conference provides Polymer Dynamix with both an overview of FR developments and specific technical information, with information on technologies, markets and regulations, as well as important networking.

Polymer Dynamix is a leading compounder, developing, testing and supplying performance polymer solutions to varieties of industries including to the wire and cable sector and the E&E industry www.polymerdynamix.com

Formulating with PIN FRs

A panel discussion on "Formulating with non-halogenated flame retardants", was led by **Maggie Baumann, FRX Polymers** and **pinfa-na**, with **Steven Blazey, A. Schulman**, **Roger Avakian, Polyone**, **Kerry Smith, Nabaltec**, **Subra Narayan, Clariant** and **Chris Thornton**, consultant to **pinfa**.

Maggie Baumann presented pinfa-na principal activities: dialogue with regulators and the value chain, organisation of thematic workshops to enable dialogue with end-users and stakeholders.

A show of hands in the conference indicated that more participants are today working with or intending to work with PIN FRs than halogenated

Drivers to move to PIN FRs: were identified by the panel as existing regulations and expected future regulation, sustainability image, low corrosion in processing, low corrosion in use, low smoke emission and low smoke toxicity, and low product density in the polymer.

The panellists emphasised that the move to PIN FR is very rarely a simple replacement, and requires new understanding to identify appropriate new polymer – PIN FR – synergist solutions. Legacy small molecule additive FRs such as Deca-BDE were "one-for-all" FRs, whereas PIN solutions are polymer and application specific.

Dialogue must start with the customer, to define their real needs and requirements, but also their constraints in terms of timing. Often non-halogenated packages can provide the best available solution, in particular with low smoke emission, low heat release rate, colour and UV stability.

An advantage of moving to PIN FR formulation is generally to improve understanding of performance requirements, including aspects such as colour dispersion, weathering, electrical characteristics. Dialogue on reformulation should start with defining the polymer system which it may be appropriate to update.

PIN FRs offer importantly varying characteristics, for example different grades of mineral PIN FRs will offer different performance and different polymer and processing compatibility. Specific expertise is needed, regarding choice of PIN FR – polymer – synergist package, to define appropriate testing, and to address processing challenges. As this AMI conference shows, this expertise is today available through compounders, the PIN FR and polymer industries, processing equipment companies and formulation specialists who can ensure dialogue between these different actors.

Conference participants' comments noted that industry end-users, for example major cable manufacturers, are moving to PIN FR formulations in order to be able to supply the same product worldwide. Regulations already push to move to PIN FRs in some applications (e.g. smoke emission and toxicity in aviation, railways, and in the EU Construction Product Directive) or some regions of the world (e.g. obligation to separate electrical and electronic wastes containing brominated FRs under the EU WEEE Directive) and companies are moving to PIN FRs or wish to prepare this move in anticipation of future further such regulation. The move to PIN FRs is also driven by sustainability requirements imposed by leading global OEMs or supermarkets.

Interviews

PIN flame retardants protecting lives and property

Kathrin Lehmann & Ido Offenbach, Evonik

Evonik sees flame retardants as essential in tomorrow's world. Every life saved from fire counts. Increasing use of plastics in buildings, transport, makes fire safety vital. Fire safety can become a positive image for industry, enabling compounders to provide FR solutions as an added value. FR demand is also driven by regulation, for example the EU Construction Products Regulation for smoke emission and smoke toxicity in building materials. Challenges on end-of-life recycling and supply-chain sustainability objectives push towards PIN FRs and polymeric non-halogenated FRs offer a positive profile. PIN FRs can also deliver performance, e.g. high CTI (tracking index) with minerals. Evonik is looking for new PIN FR solutions for high temperature polyamides, where Fs must resist thermal decomposition in processing, and for thermoplastic elastomer esters (TPEE, TPEV-TPS), where mechanical properties are a challenge. This AMI conference enables Evonik to see new R&D ideas which could be future FR solutions, and to connect with other companies sharing the same goals of saving lives from fire and ensuring environmental protection.

Evonik, http://corporate.evonik.com/en/ is one of the world's leading specialty chemicals companies. Evonik concentrates on high-growth megatrends, especially health, nutrition, resource efficiency and globalization. Evonik produces specialist synergists and provides expertise on formulation to compounders and polymer suppliers.

Steven Houpert, SACO AEI Polymers

Low smoke emission and low smoke corrosivity are increasingly a performance requirement for wire and cable as well as electrical equipment manufacturers. Sensitive electronic equipment can be damaged and critical data lost even in the case of a small fire. Alongside sustainability criteria, this means that in North America PIN FRs are increasingly considered. Their future growth will be facilitated by continuing improvements in relative price and performance with new synergists and new PIN FR products. However, industry has 40 years' experience of legacy FRs and new expertise and support is needed to accompany the change to PIN FRs. At the same time, industry needs to dialogue with architects and specifying organisations such as LEED (green building label) about how fire standards and FR use are effective in saving lives and contribute to the public good. This AMI conference enables dialogue with different customers and industry sectors, and access to information about new PIN FR developments.

SACO AEI Polymers Inc. is a global compounder specialised in polymers for wire and cable, pipe, flame retardant additives, flame retardant masterbatches and flame retardant compounds. www.sacoaei.com

Doug Marti, Trelleborg

The oil and marine industries are highly safety conscious because of the specific fire risks of the sectors and the difficulty of escape in case of fire. This leads to a 'conservative' use of materials such as steel, even when new high performance composite materials are now available and certified by safety authorities (US Coast Guard, International Marine Organisation). Information and training for the industry on new materials and their fire safety performance is therefore important. For Mr Marti, this AMI conference provides new information on new PIN FR materials being developed and offers opportunities to transfer know-how and technologies from one industry sector to another.

Trelleborg employs around 23 000 people in 50 countries worldwide and is a world leader in engineered polymer solutions, it seals, damps and protects critical applications in demanding environments. www.trelleborg.com

Jim Innes, Flame Retardant Associates

Jim Innes sees society's need for flame retardants to expand, as buildings and equipment contain increasing loads of flammable materials. Tomorrow's automobile will contain critical potential ignition sources (batteries, high current power supply) as well as plastics in electronics, bodywork and motors, so FRs will be critical to ensure fire safety. Safety standards for construction, electrical, electronic and other markets will also require more FR solutions. Tomorrow's FR solutions, to ensure both fire performance and mechanical-electrical properties, will need polymer specific, tailored FR systems to address the processing challenges. Mineral FRs and char-generating PIN FRs are effective in reducing smoke emission, and FR performance can often be improved with carefully selected synergists. For example, nano-synergists can improve char formed by generating a better refractory layer that reflects heat.

Flame Retardants Associates provides market development and technology expertise to FR and FR compound producers and processers since 1992.

Peter Pfortner, Advanced Color Technologies

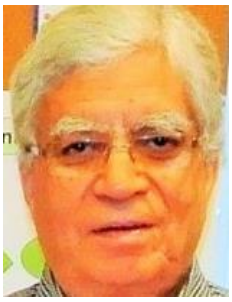
Flame retardants are needed to ensure fire safety in fibres in a many applications, including carpets in public buildings, industrial high-tenacity fibres (belts and cords), textiles and woven sound insulation materials in vehicles. Standards can be expected to be tightened in applications such as automobile, construction in many countries, artificial turf (which can pose a fire risk when installed next to buildings). New PIN FR solutions for nylon fibres could enable replacement of wool in aviation, with weight and cleaning maintenance advantages. Fibre production is highly demanding for polymer performance and homogeneity, requiring specific solutions for different fibres and applications.

Advanced Color Technologies is a specialist masterbatch formulator and supplier with 35 staff, especially to the polymer fibre (particularly polyester, polyamide, polypropylene), carpet and automotive industry http://advanced-color.com/

Performance mineral FRs and PIN synergists

Kaan Serpersu, Techmer PM, presented tests of the mineral PIN FR magnesium hydroxide in polyethylenes and polypropylene. He showed that different grades (particles size, shape, coatings, etc) impacted fire retardant performance and polymer mechanical properties differently. Organic and inorganic synergists enabled to reduce loadings of the mineral FR and still achieve UL 94-V0 (at 1.5 mm) and also improve mechanical properties. He underlined the effectiveness of these magnesium hydroxide based PIN FR systems in reducing smoke emissions (smoke density half that of halogenated systems).

Kysle King, Unimin, presented the company's milled mined minerals developed as PIN FRs and smoke suppressors. These are based on ATH (aluminium tri hydroxide), a huntite-hydromagnesite mixture and colemanite (calcium borate). Specific grades include different particle sizes, "low viscosity" (achieved by milling to rounded particles), low surface area, and blended micronised+course (which enables more compact 'packing' in the polymer).



Bansi Kaul, MCA Technologies, presented testing of different PIN FR additives in polypropylene: calcium carbonate, ultracarb (natural magnesium mineral supplied by OMYA), metal hydroxides (ATH, MDH), borates, nanoclays, including in combination with his company's PPM-triazine additives (a nitrogen containing polymeric PIN FR). He noted that the minerals can generate ceramic metal oxynitrides during combustion, contributing strength and heat resistance to char and also a reflective effect (so protecting polymers from melting and decomposition caused by heat and which feeds feed fire). He noted that coating of inorganic PIN FRs with siloxane can improve dispersion, polymer moisture resistance and mechanical properties and enable achievement of fire performance at lower FR loading through a more compact and resistant char formation.

Karen Janssens, Campine, presented antimony trioxide (ATO) as a flame retardant synergist and demonstrated that for many applications, halogen-antimony systems are still of the highest efficiency. Although China dominates world mining and smelting of antimony and production of ATO, this is changing with China's share of antimony mineral mining falling from 90% in 2010 to 74% today. Antimony is suspected toxic by inhalation (class 2 cancer classification IARC) so safe processing forms must be supplied, e.g. by whetting or as a highly filled masterbatch.. Campine also presented tests of ATO as a synergist with a PIN intumescent FR in thermoplastics, showing lower smoke emission and effective fire performance (lower heat release rate, UL94-V0 at 1.6mm).

PIN FR solutions in demanding applications

Doug Marti, Trelleborg, explained how PIN FRs ensure fire safety in the very demanding environment of offshore installations. Oil drilling platforms pose acute fire risk and material performance challenges. Materials are required to resist extreme climate conditions, weathering, chemicals, and corrosion while offering 30 to 120 minutes "jet fire" resistance (ISO 22899-1). Trelleborg uses PIN FRs to achieve this in intumescent coverings designed for steel structure protection against weather and fire and in PIN FR vulcanised rubbers, used for e.g. fire blocks and seals, valve covers, decking materials, and flexible piping systems. Trelleborg's multi-layer reinforced PIN FR rubber materials achieve this whilst offering design flexibility, for example an easily removable bolt cover, allowing inspection and maintenance as well as protecting bolts from elongation caused by heat in fires which could open joints or structures.

Rick Cazenave, Chemtura Corporation (now part of the LANXESS group), presented opportunities and challenges in flame retarding polyamides for automobile applications. A considerable development in FR polymers, in particular polyamides, can be expected in automobiles, driven by the increase in onboard electronics. At the same time, connectors are increasingly miniaturised, leading to demanding performance requirements including heat resistance, processing challenges (injection molding) to produce thin and complex parts including flow and FR dispersion, and avoidance of blistering. Polyamides tend to take up moisture, posing issues for electrical properties, and flame retardants must not accentuate this. At the same time, environment and health concerns are pushing to develop FRs which are large molecules or polymeric.

Kathrin Lehmann, Evonik, presented the company's range of different organo-modified siloxanes, which act to improve the mechanical properties of polymers containing flame retardants. These can have different branching structure or chemical groups, enabling anchoring in and compatibility with specific polymers. Examples presented showed how a 1 or 2% loading, either added into the polymer-FR compound, or used as surface coating of the FR before compounding, can significantly improve properties such as appearance, melt-flow, fire performance, mechanical strength, or prevention of die-drool, in polymers including polyamines, polyolefins, polypropylene, EVA/PE. Examples included mineral, phosphorus and nitrogen flame retardants: Evonik is not working with halogenated FRs because of product sustainability objectives.

Testing and assessing flame retardants

Joel Tenney, ICL, underlined the enigma of growing FR demand but end-user fears of "chemicals". Flame retardants will continue to be increasingly needed to ensure fire safety with increasing use of flammable materials in building insulation (energy efficiency), connected products (permanent power supply), automobile electronics, implementation of fire safety standards in developing countries and globalisation of safety requirements. The case for the lifesaving value of flame retardants is understood by the vast majority of fire scientists but better proof is, however, needed for sceptical journalists and some politicians that FRs really do save lives; the strong statistical data alone is not enough and laboratory testing is perceived as not representing real fire conditions. The debate on health and environment safety of FRs is difficult, because still framed by issues with legacy FRs such as HBCD, PBDEs and TCEP. NGOs are increasingly pushing for reactive and polymeric FRs to reduce exposure risk. He presented ICL SAFR system for assessing the sustainability of different FRs in different applications – see pinfa Newsletter n° 79 and www.safrworks.com

Dwayne Sloan, UL LLC, presented on the Steiner Tunnel fire test which applies large scale fire conditions to assess surface burning characteristics for building materials, such as drywall, cooler panels, ceiling coverings, and insulation. Derivatives of this test method are also used to assess sprinkler piping and wires & cables. UL94 on the other hand is not intended for building materials, but is a small scale fire test specifically intended for plastic materials used in devices and appliances. The 25 ft. (7.6 m) long test Steiner Tunnel apparatus enables assessment of flame spread and smoke development and is widely codified through UL723, also known as ASTM E84. The similar Canada CAL/ULC 102 and 102.2 methods are also adapted for building materials, as well as products such as floor coverings. One challenge of the Steiner Tunnel is that products can melt, flame or drip. Users of UL723 are guided to additionally report these floor burning characteristics when they carry out this testing. A single Steiner tests is quite involved, so often smaller scale tests, such as the cone calorimeter, can be conducted first for benchmarking.

Hsinjin Yang, Pioneer Scientific Solutions, presented work with the Micro Combustion Calorimeter (MCC) (ASTM D7309), which offers a 10-minute duration test using 3 – 5 mg of sample material. The objective is to offer reliable scientific data on fire performance: onset temperature, heat of combustion (HOC), heat release, pyrolysis kinetics. An empirical but quantitative equation for the flammability index (F_{index}) was developed to for hydrocarbon, PVC and fluoro- polymers, which showed to be consistent with performance rating in cable application and able to distinguish the degree of flammability among materials with the same UL94 V0 rating. A proposal for a US National Research Center on "Fire Retardant Materials and Safety" (FRMS-RC) has been submitted to the National Science Foundation (NSF) with the objective of developing understanding of new non-halogenated flame retardant solutions, material combustion mechanisms, flammability characterization and toxicity of smoke emissions during combustion process..

Publisher information:

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For abbreviations see: www.pinfa.org