Fire Retardant Coatings
Intumescence

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Fire Retardant Coatings
and Intumescence

- Flame retardants
  - Industries
- Intumescent
  - Development
  - Usage
  - Sources
  - Properties
  - Advantages
  - Continuous Improvement
Flame Retardants

- Flame retardants
  - Key Components
  - Impact(s)

- Chemicals and Properties
  - Effectiveness

Flame Retardant Major Areas

- Transportation
- Furnishings
- Building and Construction Material
- Electronics and Electrical Devices
Transportation

- Airplanes
- Trains
- Automobiles

Furnishings

- Carpet
- Foam
- Curtains
Building and Construction Material

- Electrical Wire and Cables
- Insulation
- Roofing

Electronics and Electrical Devices

- Computers
- Laptops
- Refrigerators
- Small Household Appliances
Development of Intumescence Coatings, Water-Solvent Base

- Solvent-Based Intumescence
  - Introduced - late 1970’s, replacing the more common form of Fire Protection (Concrete)
- Water-Based Intumescence
  - Commercially Introduced in the 1990’s

Intumescence in General

- Expand
- Absorbs Heat
- Environmental Influences
- Compartmentalize Fire
- Physical Activity
  - (swelling)
- Chemical Activity
  - (loss of bound water and char formation)
Fire Retardant Thin Film Coatings

- Conventional Intumescent Material
  - Binder or Resin Source
  - Phosphorus Source
    - Ammonium Polyphosphate (APP)
  - Carbon Source
    - Pentaerythritol (C5H12O4)
  - Gas Source
    - Melamine (C3H6N6)

Fire Retardant - Development of Water and Solvent Based

**Water**
- Acid Donor
- Binder
- Blowing Agent
- Carbon Source
- Other
  - Pigment, Dispersing
  - Preservatives
  - Plasticizers, Modifier

**Solvent**
- Acid Donor
- Binder
- Blowing Agent
- Carbon Source
- Other
  - Modifier, Solvent
  - Pigments
Formula Properties

- Performance Criteria
  - Raw Materials
  - Substrate
  - Compatibility
  - Cost

- Performance Criteria
  - Thermal Degradation
    - Stability
    - Interaction: Acid $\rightarrow$ Phosphate $\rightarrow$ Char
      $\rightarrow$ Acid/H₂O/NH₄OH, Other: NH₄OH/CO₂

Formula Properties (Cont.)

- Performance Criteria (Cont.)
  - Intumescence Morphology
    - Images (SEM)
  - Thermal Insulation
    - Critical Temperature
    - Thickness Decreases
  - Other
    - Thermal Microscopy
    - Rheology
Binder Source

- Vinyl, Acrylic, Styrene-Acrylic
- Contribution(s):
  - Rheology
  - Char
- Thermal Stability
- Loading

Phosphorus Source

- Charring
  - Combustion Process
- Heat Source
  - Phosphoric Acid
  - Decomposition Process (Pyrolysis)
- Barrier
  - Between Material and Heat Source
Carbon Source

- Carbon Char Layer Insulates Resin
  - Pentaerythritol (Mono, Di or Tri)
  - Reduces Thermal Damage

- Duel Carbonific Review
  - Resin Combustion
  - Reduced due to Secondary Source

Gas Source / Blowing Agent

- Heat Decomposition
  - NH₄OH, CH₃N₃O, H₂O, CO₂

- Swell and Expand
  - Volume of the Char

- Thermal Char
  - Multi-Cellular

- Insulates
  - Substrate
Advantages of Intumescence Flame Retardant Coatings

- Combination flame retardants used with multi-fiber blends
- Polymer can be very soft to very firm
- Low Toxicity
  - Absence of Dioxin and Halogen Acids
  - Low Smoke
- Recycle-able
  - Nitrogen and Phosphorus

Application for Intumescence Flame Retardants

- Pad Solution
- Roller / Brush
- Spray (Airless)
- Coating (Drop or Foam)
On-Going Development Work to Improve Intumescence

- Reduced Physical Properties of Binder
  - Tensile Strength
  - Impact Strength
  - Elongation
- Loading Levels of the FR Additive
- Drip Retardants (Suppressants)
- Use of Additives
  - Fiber Glass
  - Polytetrafluoroethylene Powder

Flame Retardant Selection

- Performance of Product
  - Testing Specifications
- Fire Rating Standards
- Understand Testing
Question?