






RTP COLOR • CONDUCTIVE • FILM/SHEET • FLAME RETARDANT
STRUCTURAL • THERMOPLASTIC ELASTOMERS • WEAR

Answers to Your Burning Questions: Flame Retardants and Regulations

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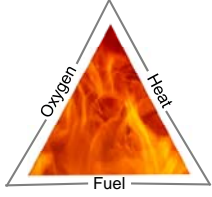





RTP FLAME RETARDANT (FR) MATERIALS

Definition

Materials that do not ignite readily or propagate flames under small to moderate fire exposures

- Materials are combustible
- Fire retardants reduce the intensity and spread of fire
- Reduces smoke and toxic by-products of combustion



Fire Triangle

RTP GOALS OF FLAME RETARDANT COMPOUNDS

- Increase resistance to ignition
- Reduce rate of flame spread
- Reduce rate of heat release
- Reduce smoke emission

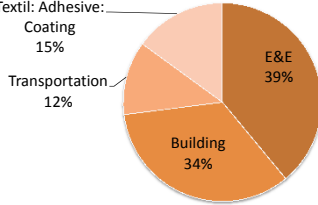
End Goal:

- Meet FR specifications
- Make the world a safer place!



RTP MARKETS FOR FR THERMOPLASTICS

Segmentation of FR Consumption by Value



Market	Percentage
E&E	39%
Building	34%
Textile: Adhesive: Coating	15%
Transportation	12%

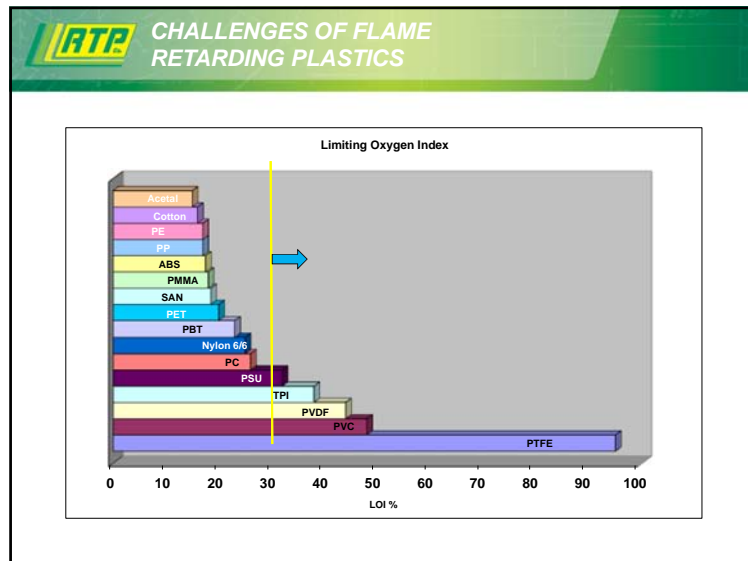
- Electrical Parts
- Electronic Enclosures
- Wire and Cable
- Appliances
- Transportation
- Building and Construction

RTP OVERVIEW

- Thermoplastic Flammability
 - Flame Retardant Additive Chemistries and Mechanisms
- Regulatory Landscape
- Testing Standards
- Case studies
- Hospital Cleaner Resistant Technology

RTP THERMOPLASTIC RESIN FLAMMABILITY

Flammable	Inherently Flame Resistant
<ul style="list-style-type: none"> • Polyolefins • Nylons • Polycarbonate • Polyesters • Styrenics • TPEs 	<ul style="list-style-type: none"> • Polysulfones • Polyphenylene Sulfide • Polyetheretherketone • Polyetherimide • Fluoropolymers



RTP COMMON TYPES OF FR ADDITIVES

Halogenated FR's

- Brominated
- Chlorinated

Halogen Free FR's

- Metal hydroxides
- Phosphorous Based
- Melamine Based

Flame Retardant Additive Usage, 2011

Additive Type	Percentage
Inorganics	44%
Bromine	22%
Phosphorus	16%
Chlorine	12%
Other	6%

RTP HALOGENATED FR MECHANISM

- Halogenated technology inhibits the chemical reaction in the gas/vapor phase
- Various molecules that efficiently get large amounts of free radicals to the gas phase

Additive Type	Polymeric Type
<ul style="list-style-type: none"> • Higher Halogen Content • Lower Loadings • High Thermal Stability 	<ul style="list-style-type: none"> • Melt Blendable • Less effect on physical properties • Enhanced Flow

Halogenated flame retardants are compatible in most resin systems with the exception of Acetal

RTP NON-HALOGEN MECHANISMS

Phosphorous	Hydrated Minerals	Melamine Cyanurate
<ul style="list-style-type: none"> • Various forms • Contributes to the condensed phase char formation 	<ul style="list-style-type: none"> • Produce water during combustion process, dilute flammable vapors • Insulative char formation 	<ul style="list-style-type: none"> • Endothermic decomposition • Physical removal of flame from surface
Resin Systems		
Polyolefins, Polyamides, Polyesters, Polycarbonate and alloys	Polyolefins, Polyamides	Polyamides, used as a synergist for other Phosphorous technologies

RTP HALOGEN VS. HALOGEN-FREE

Halogenated	Halogen Free
<ul style="list-style-type: none"> • Lower Cost • Better Processing • Better Efficiency • Better Physical Properties 	<ul style="list-style-type: none"> • Evolving Economics • Improved Processability • Wide Variety of Products • Low Smoke • Lower Toxicity • Less Corrosive • Lower Specific Gravity

RTP CHOOSING A FR SYSTEM

How do we decide which FR mechanism to use?

- Resins System
- FR Specification
- Part Function
- Fillers/Additives
- Regulatory Concerns
 - Halogen, RoHS, etc


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ROHS DIRECTIVE

- Restriction of Hazardous Substances (RoHS)
 - EU Directive in effect as of July 2006
- Banned Substances
 - Lead (Pb)
 - Mercury (Hg)
 - Cadmium (Cd)
 - Hexavalent Chromium (CrVI)
 - Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ethers (PBDE)
- Flame Retardants and Pigments

Does not need to be Halogen Free!


IMPACT OF ROHS

How does RoHS compliance affect material selection?

- Drop in replacements available
- Identical Properties
 - Physical, Flow, Heat Resistance, Processability
- Cost Premium


EVOLUTION OF HALOGEN-FREE TECHNOLOGIES

- More “self-policing”/customer driven bans
- New FR standards
- Green Movement
- More Effective/Economical FR Chemicals
- Increased Performance
- Competition in the Market

RTP HALOGEN RESTRICTIONS

- OEM Driven Ban on Halogenated Chemicals
 - HP, DELL, IBM etc.
- Eco Labels
 - Blue Angel, White Swan, Ecolabel etc.





RTP IMPACT OF HALOGEN-FREE

- Resin Limitations
- Physical Properties
 - Strength/Impact
 - Flow
 - Heat Resistance
 - Resin Dependent
- Flammability
- Cost
- Reduction in Specific Gravity

RTP 30% GF NYLON 6/6


Mechanical Properties	RTP 205 FR	RTP 205 FR Halogen Free
Tensile Strength, psi	21000	19500
Tensile Modulus, psi E6	1.65	1.45
Tensile Elongation, %	2-4%	2-4%
Flexural Strength, psi	33000	31500
Flexural Modulus, psi E6	1.55	1.45
Impact Notched, ft-lb/in	2	1.8
Impact Un-notched, ft-lb/in	16	16
HDT @ 264 psi	470	470
Specific Gravity	1.66	1.41
Flammability	V-0 @ 1/32	V-0 @ 1/32

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RTP INDUSTRY AND MARKET DRIVEN

Electrical and Electronics (E&E)




- UL 94
 - V, 5V, HB
- UL 746
 - HAI, HWI, CTI

RTP RTP COMPANY UL CERTIFICATION

RTP Company has 600+ UL Yellowcards

- Continuous expansion of UL listed products



UL Certified Laboratory under Client Test Data Program (CTDP)

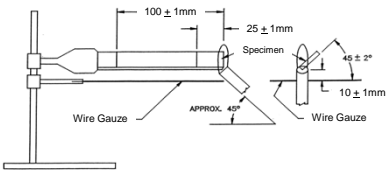
- Short term properties to UL94
- Long term thermal aging (RTI)

RTP Company offers custom UL certifications to achieve full commercialization

- Quick turnaround
- **Compress your Time to Market!**

RTP UL94 - HB

Horizontal burning test for HB classification



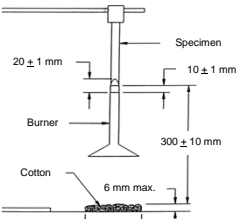
Classification Criterion

3.0 mm to 13.0 mm thickness	< 3.0 mm thickness
• slower than 40 mm/minute or...	• slower than 75 mm/minute or...
• combustion ceases prematurely	• combustion ceases prematurely

*** In general most thermoplastics meet this criteria***

RTP UL94 - VB


Classification Criteria	V-0	V-1	V-2
Number of bar specimens	5	5	5
Maximum flame time per specimen per flame application, sec	10	30	30
Maximum total flame time 5 specimens, 2 ignitions, sec	50	250	250
Specimen drips, ignites cotton	NO	NO	YES
Maximum afterglow time per specimen, sec	30	60	60
Burn to holding clamp	NO	NO	NO



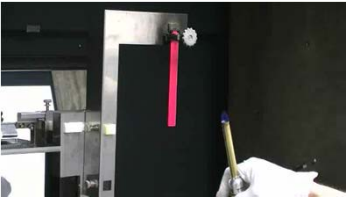
Thickness dependent ratings

RTP UL94 VERTICAL BURN DEMO

Flame Retardant – V-0



Non- Flame Retardant – No Rating




RTP AEROSPACE

FAR 25.853

- Flammability:
 - 15-Second Horizontal Burn
 - 12-Second Vertical Burn
 - 60-Second Vertical Burn
- Smoke Density:
 - Ds@4min <200
 - ABD0031 or BSS 7238 or ASTM E-662
- Ohio State University Heat Release:
 - Calorimetry Test Measures Peak and Total Heat Release
 - <100/100, <65/65, & <55/55 are common

OEM Driven Requirements

- Toxic Gas Emission:
 - Varies by OEM
 - ABD0031 or BSS 7239



Requirements vary by part size and location

RTP BUILDING / INDUSTRIAL

- Requirements focus on:
 - Low Smoke, Heat Release, Burn Rate, Flame Spread
- Various standard that apply:
 - UL2043, UL723/ASTM E84, ASTM E1354, NFPA 701, FM 4996, CAL TB133



Applications:

Wall coverings, Furniture, Plenum, Pallets, Storage systems, Roofing, Floor coverings, Ventilation

RTP RECAP


Designing for an FR application

- Regulatory Landscape
 - RoHS, Halogen Restrictions
- Specifications
 - UL94, FAR, ASTM, etc.
- Part Function
 - Performance Requirements, Application Environment, etc.
- Economics
 - Price is a Property

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RTP FR MEETS TRANSPARENCY



LED Lens Cover

Market:	Consumer
Problem:	UL 94 V-0, High Light Transmission, UV, Light Diffusion, RoHS Compliance
Solution:	PC – Transparent, Flame retardant, Specialty pigment package
Benefits:	Provided ample diffusion of high powered LED lights with a proprietary pigment technology while achieving the required flame performance


RTP FR MEETS OUTDOORS / UV



Marine Connector

Market:	Consumer
Problem:	Strength/impact, UV resistance, specialty color, UL94 V-0, F1
Solution:	PC/PBT – Glass reinforced, UV stabilized, Flame Retardant
Benefits:	Product was able to pass the required drop impact testing and stringent UL outdoor and flammability ratings

RTP FR BREAKS THROUGH THE CEILING



Speaker Unit

Market:	Industrial
Problem:	Plenum location, UL 2043, UL94 5VA, Rigidity
Solution:	Polypropylene – Glass fiber reinforced, Halogen free Flame Retardant
Benefits:	Provided structural requirements needed for function and stringent UL flame resistance

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RTP PROBLEM STATEMENT

Hospital Acquired Infections


- 2,000,000 new cases per year (USA)
- 100,000 deaths per year (USA)
- \$11 Billion additional cost (USA)
- Global trend

Costs have been driven back to healthcare providers



RTP PROBLEM STATEMENT

- Added costs have led to an increase in cleaner usage and frequency
- Harsh chemicals causing failures in plastic housings



RTP RISING TO THE CHALLENGE

Product Development Criteria



- Increased chemical resistance to healthcare cleaners vs. traditional housing materials
 - PC/ABS, PC/PBT, ABS, PC, PC/ASA
- High Impact/Ductility
- Good dimensional stability with shrinkage similar to PC/ABS
- Colorable
- Flame retardant grade for electronic housings

RTP TEST METHOD EVALUATION

Days	BIREX	CAVICIDE	CIDEX PLUS	ENVIROCID	VESPHINE
0	5.5	5.5	5.5	5.5	5.5
3	4.5	4.5	5.0	5.0	5.0
6	4.0	4.5	5.5	5.5	5.5
9	3.5	4.0	5.5	5.5	5.5

- Nine day soak test showed no change in physical properties
- Most field failures are seen in areas where stress is applied
- Need a test method that replicates field failures

RTP TEST METHODOLOGY

- Exposure @ 1% strain
- Patch method
 - Saturate patch every 24 hours
 - Air dry
- Test physical properties after exposure (96 hours)

Test replicated field failures and relative resistance

RTP CHEMICAL CLASSES

Wide variety of chemical cleaners used to help avoid the spread of hospital acquired infections:

- Alcohols
- Aldehydes
- Quaternary compounds
- Alkylamine derivatives
- Chlorine releasing compounds
- Acidic / Basic solutions
- Etc.

RTP CHEMICAL CLASSES STUDIED

Base Chemical Class	Typical Brand Names
Alkylamine	T-Spray II
Glutaraldehyde	Cidex Plus
Glucoprotamin	Incidin Plus
Phenol	Birex
Quaternary compound	Sani-Cloth AF3 Sani-Cloth Active
Chlorine releasing compound	Sani-Cloth Bleach Clorox
Alcohol	CaviCide 1 Super Sani-Cloth Sani-Cloth Plus Incides N Incidin Pro

Disinfectant Examples:

- Wipes/cloth
- Liquid sprays

RTP Continues Testing

- Provide a sample
- Will report results


RTP CHEMICALS TESTED

Cleaning Agent	Base Chemical Class
Birex	Phenol
CaviCide 1	Isopropanol / Ethanol
Cidex Plus	Glutaraldehyde
Incides N	Propanol
Incidin Plus	Glucoprotamin / Ethanol
Incidin Pro	Alkylamine / Ethanol
Sani-Cloth Active	Quaternary compound
Sani-Cloth Bleach	Chlorine releasing compound
Sani-Cloth Plus	Isopropanol / Ethanol
Super Sani-Cloth	Isopropanol
T-Spray II	Alkylamine


RTP DEVELOPMENT

- Numerous compositions screened for physical property and chemical resistance
 - Over a dozen polymers tested
 - Extensive alloy testing
- Proprietary polyester alloy was proven as best performer
- Alloy was optimized for physicals, chemical resistance and flame performance

Introducing RTP 2000 HC series:




RTP PASS/FAIL CRITERIA



Tensile Strength

- 75% retention or greater



Tensile Elongation

- Minimum 10% tensile elongation


RTP TENSILE STRENGTH

Cleaner	RTP 2000 HC FR A	FR PC/ABS	FR PC/PBT
T-Spray II	✓	✗	✓
Cidex Plus	✓	✗	✓
Incidin Plus	✓	✗	✗
Birex	✓	✓	✓
Sani-Cloth Active	✓	✗	✓
Sani-Cloth Bleach	✓	✓	✓
CaviCide 1	✓	✗	✗
Super Sani-Cloth	✓	✓	✓
Sani-Cloth Plus	✓	✗	✗
Incides N	✓	✓	✓
Incidin Pro	✓	✗	✗

RTP TENSILE ELONGATION

Cleaner	RTP 2000 HC FR A	FR PC/ABS	FR PC/PBT
T-Spray II	✓	✗	✓
Cidex Plus	✓	✗	✓
Incidin Plus	✓	✗	✗
Birex	✓	✓	✓
Sani-Cloth Active	✓	✗	✗
Sani-Cloth Bleach	✓	✓	✓
CaviCide 1	✓	✗	✗
Super Sani-Cloth	✓	✗	✓
Sani-Cloth Plus	✓	✗	✗
Incides N	✓	✗	✓
Incidin Pro	✓	✗	✗

RTP CASE STUDY



Electronic Control Housing

Market:	Medical
Problem:	Experiencing field failures and all commercially available housing materials were failing chemical testing
Solution:	RTP 2000 HC FR A
Benefits:	Provided required cleaner resistance, utilizing the existing tooling

- ### RTP CONCLUSIONS
- RTP 2000 HC offers resistance to healthcare cleaners
 - Available in UL94 V-0/5VA grade
 - Physical properties well suited for housings
 - Dimensional stability
 - Similar molding conditions in existing tooling (PC/ABS, PC/PBT, ABS, PC, PC/ASA)
 - Fully colorable
 - Available for immediate sampling/testing

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Thank You!

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