



Encapsulated EPFR-APP series applied to intumescent fire proof coating

Eco-Friendly Halogen-free Flame Retardant

Product Form: white powder



Version 1.4
2014-10

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Testing methods and standards of APP on the market that we know

Items	Standard/method	Test equipment
pH value	25°C , 10% suspension	pH Meter
Water content	105°C/2h	Drying Oven
Water solubility	25°C , 10% suspension	High-speed mixer, Drying Oven
Particle size	ASTM E112-1996	Malvern Mastersize 2000
Viscosity	ASTM D445-06	Viscosity Checker
TGA	ASTM D3850-12	TA Q500
Polymerization degree	³¹ P NMR	Bruker-400 NMR

Comparison on TDS data of MF encapsulated APP

Item code	Phosphorus content (%)	Nitrogen content (%)	pH	Viscosity (mPa·s)	Polymerization degree	Water content (%)	Solubility (%)	Particle size D ₅₀ (μm)
EPFR-APP262	~29	~16.5	5.5~7.5	≤20	≥1000	≤0.5	≤0.04	~10
EPFR-APP263	~29	~16.5	5.5~7.5	≤20	≥1000	≤0.5	≤0.04	~20
APP-C2	29~31	15~17	6.5~8.5	≤20	≥1000	≤0.5	≤0.04	~20
APP-J2	~30	--	4.0~7.0	≤5	≥1000	≤0.5	≤0.04	~18
APP-B2	~29	--	6.0~7.0	--	≥1000	≤0.5	~0.01	~18

Comparison on basic data of MF encapsulated APP

Item code	Whiteness (%)	pH value	Viscosity (mPa·s)	Water content (%)	Water solubility (%)
EPFR-APP262	94.7	6.38	6.5	0.14	0
EPFR-APP263	92.4	6.90	6.5	0.04	0.02
APP-C2	86.7	7.17	9.2	0.52	0.01
APP-J2	87.7	6.56	9.2	0.36	0.03
APP-B2	93.2	5.43	10.2	1.03	0.03

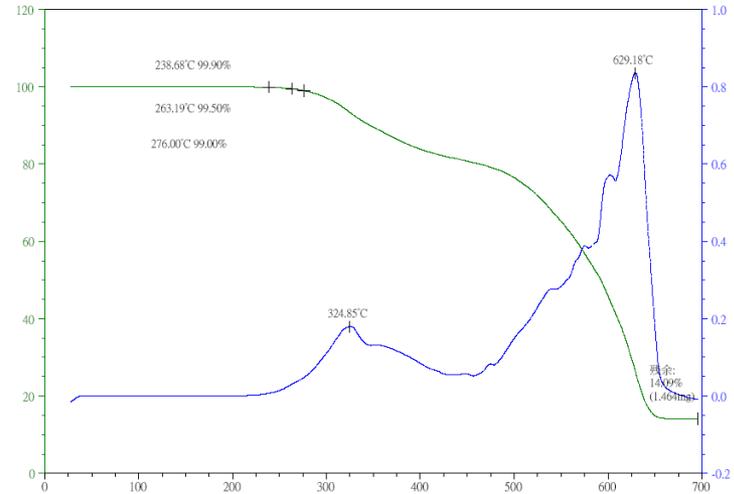
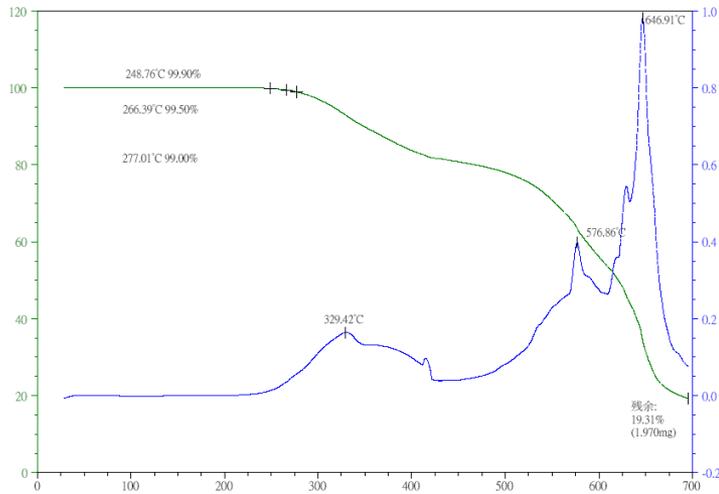
Comparison on basic data of MF encapsulated APP

Item code	Particle size(μm)		Polymerization Degree	Small molecule(%)	TGA ($^{\circ}\text{C}$)				
	D ₅₀	D ₉₀			0.1%	0.5%	1.0%	DTG1	DTG2
EPFR-APP262	12.21	23.48	3333	0.21	248.76	266.39	277.01	329.42	576.86
EPFR-APP263	20.62	36.94	10000	0.21	238.68	263.19	276.00	324.85	629.18
APP-C2	18.33	34.92	3333	0.11	73.59	237.60	254.65	304.23	534.66
APP-J2	20.71	38.87	1818	0.36	49.64	236.66	260.11	304.92	539.77
APP-B2	19.26	38.74	4000	0.30	30.18	240.44	247.91	348.99	534.45

Comparison on TGA curves of MF encapsulated APP

Preniphor™ EPFR-APP262

Preniphor™ EPFR-APP263

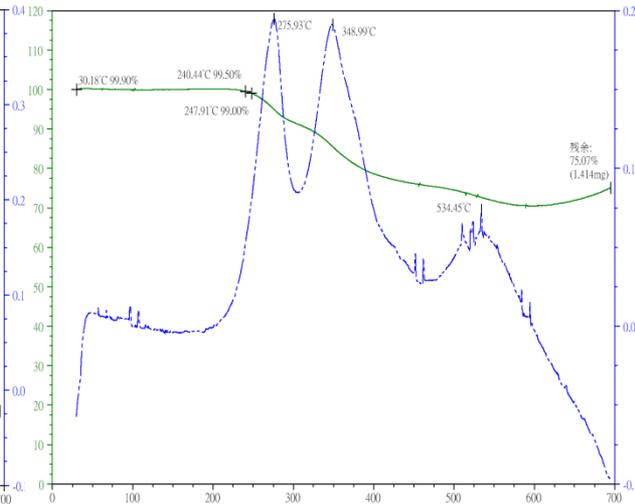
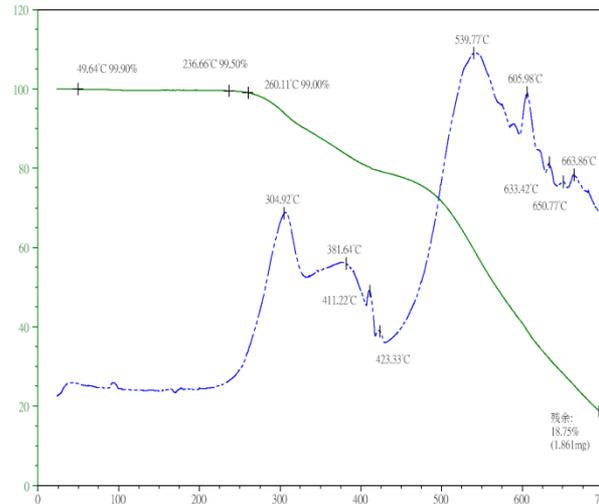
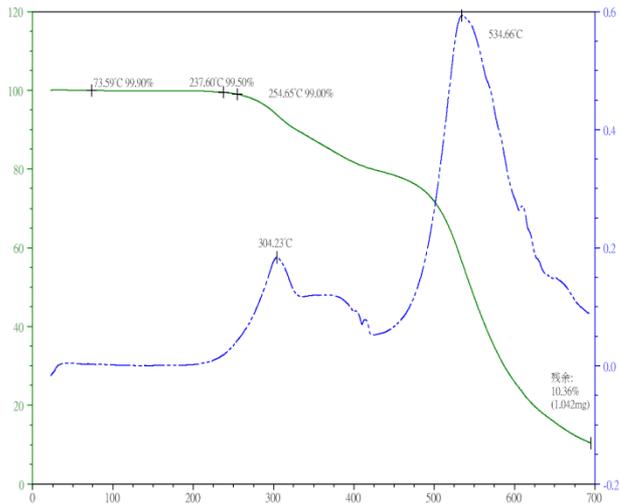


Comparison on TGA curves of MF encapsulated APP

APP-C2

APP-J2

APP-B2



Comparison on particle size of MF encapsulated APP

Preniphor™ EPFR-APP262

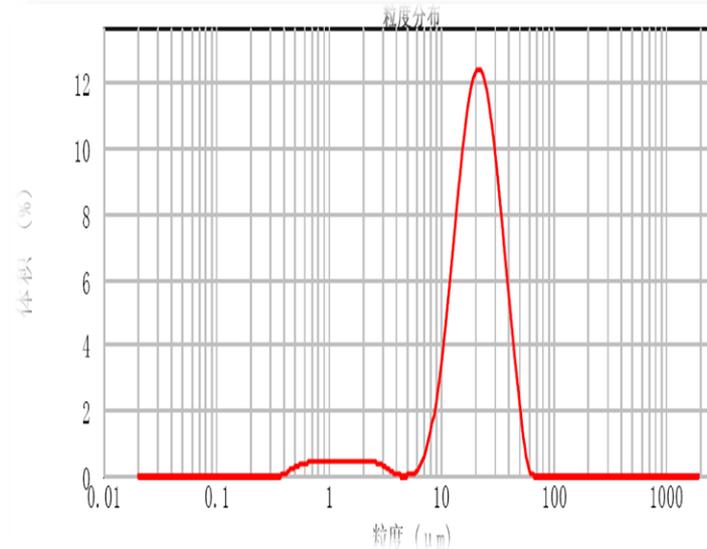
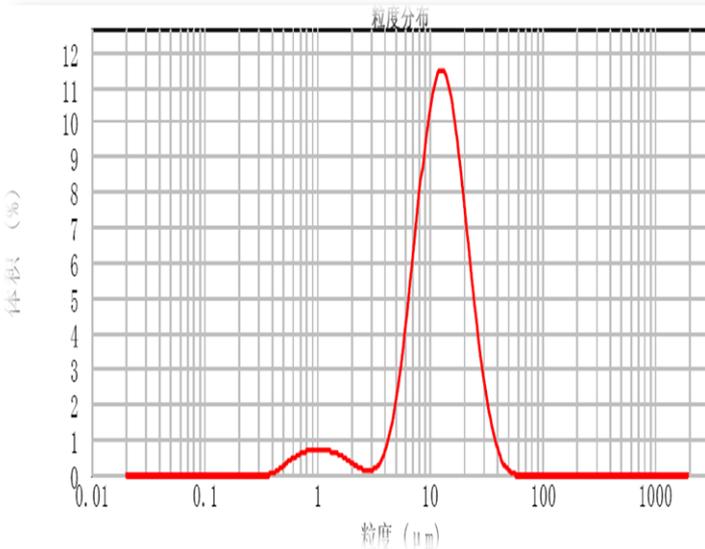
Particle size distribution

D ₁₀	5.65 μm	D ₅₀	12.21 μm
D ₉₀	23.48 μm	D ₉₈	33.32 μm

Preniphor™ EPFR-APP263

Particle size distribution

D ₁₀	10.26 μm	D ₅₀	20.62 μm
D ₉₀	36.94 μm	D ₉₈	47.85 μm



Comparison on particle size of MF encapsulated APP

APP-C2

Particle size distribution

D ₁₀	7.64 μm	D ₅₀	18.33 μm
D ₉₀	34.92 μm	D ₉₈	45.35 μm

APP-J2

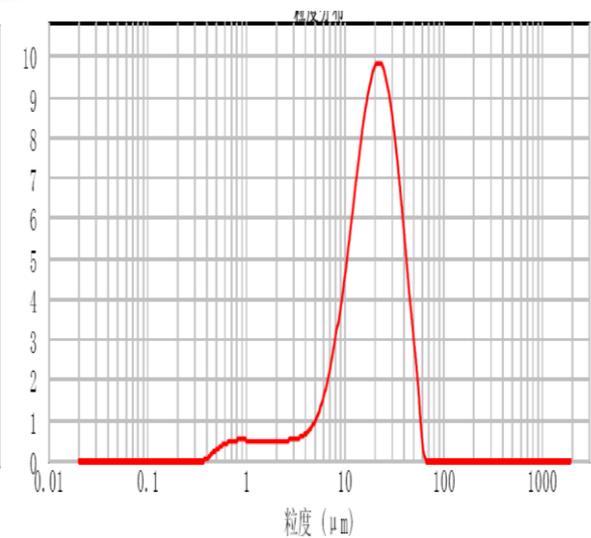
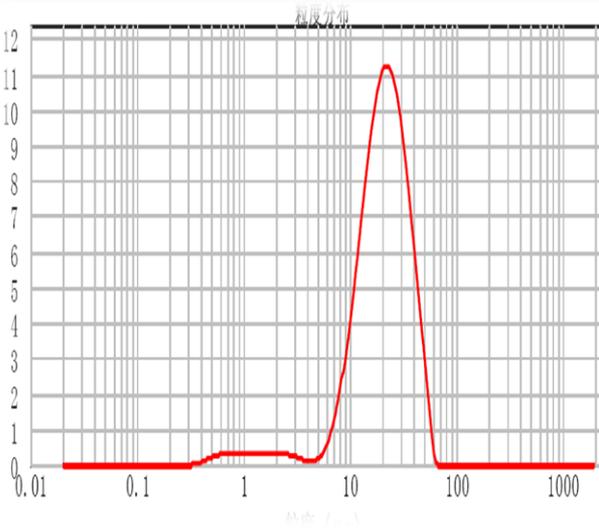
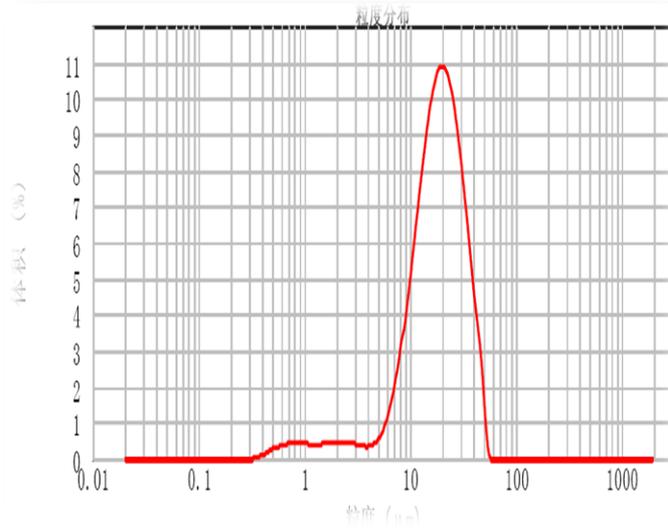
Particle size distribution

D ₁₀	9.61 μm	D ₅₀	20.71 μm
D ₉₀	38.87 μm	D ₉₈	50.47 μm

APP-B2

Particle size distribution

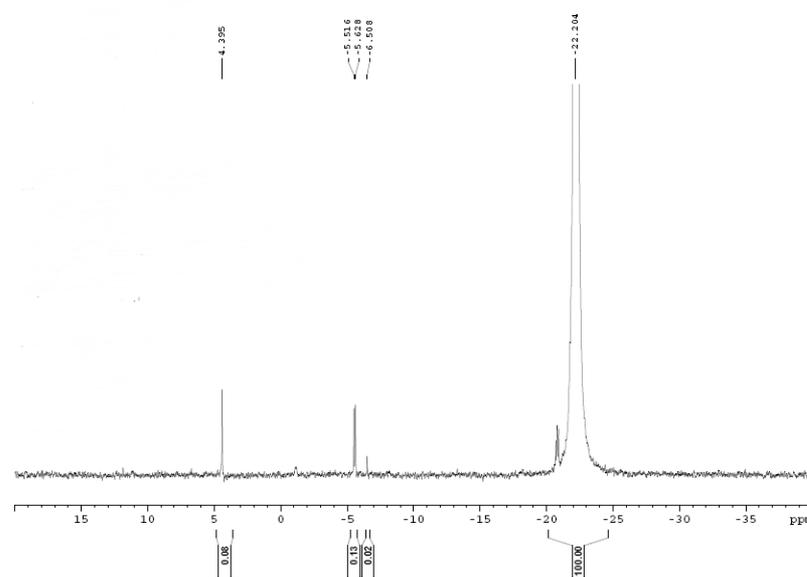
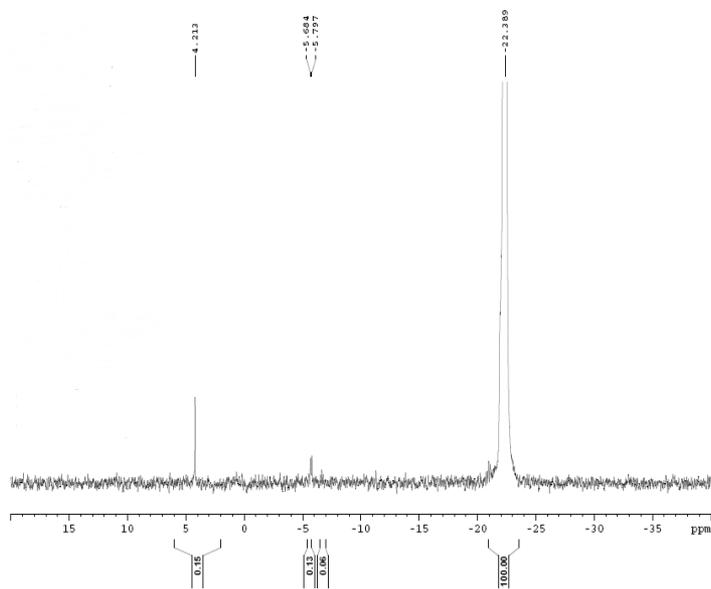
D ₁₀	6.51 μm	D ₅₀	19.26 μm
D ₉₀	38.74 μm	D ₉₈	51.31 μm



Comparison on P³¹ NMR of MF encapsulated APP

Preniphor™ EPFR-APP262

Preniphor™ EPFR-APP263

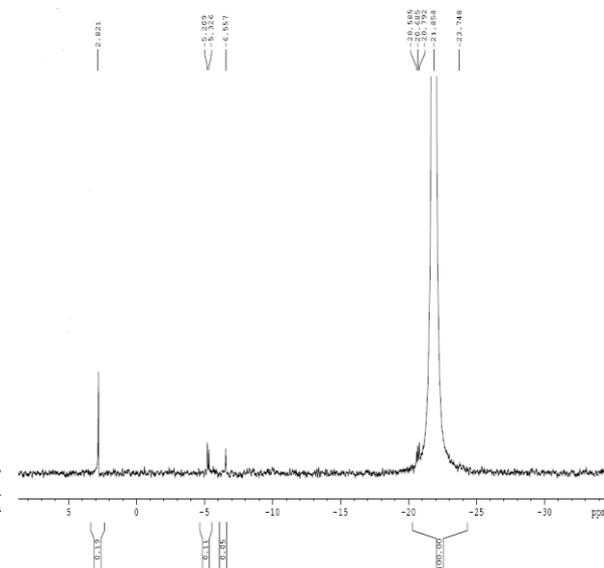
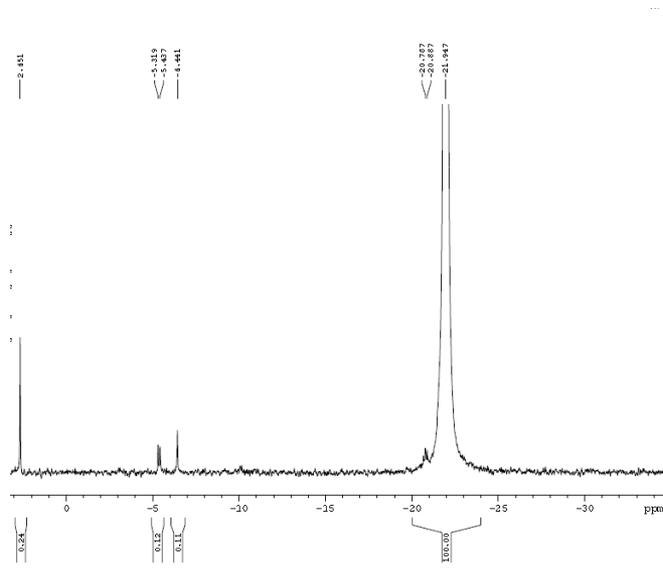
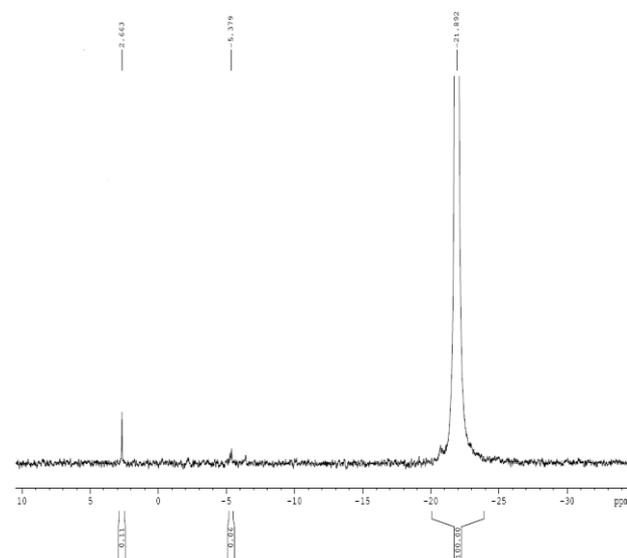


Comparison on P³¹ NMR of MF encapsulated APP

APP-C2

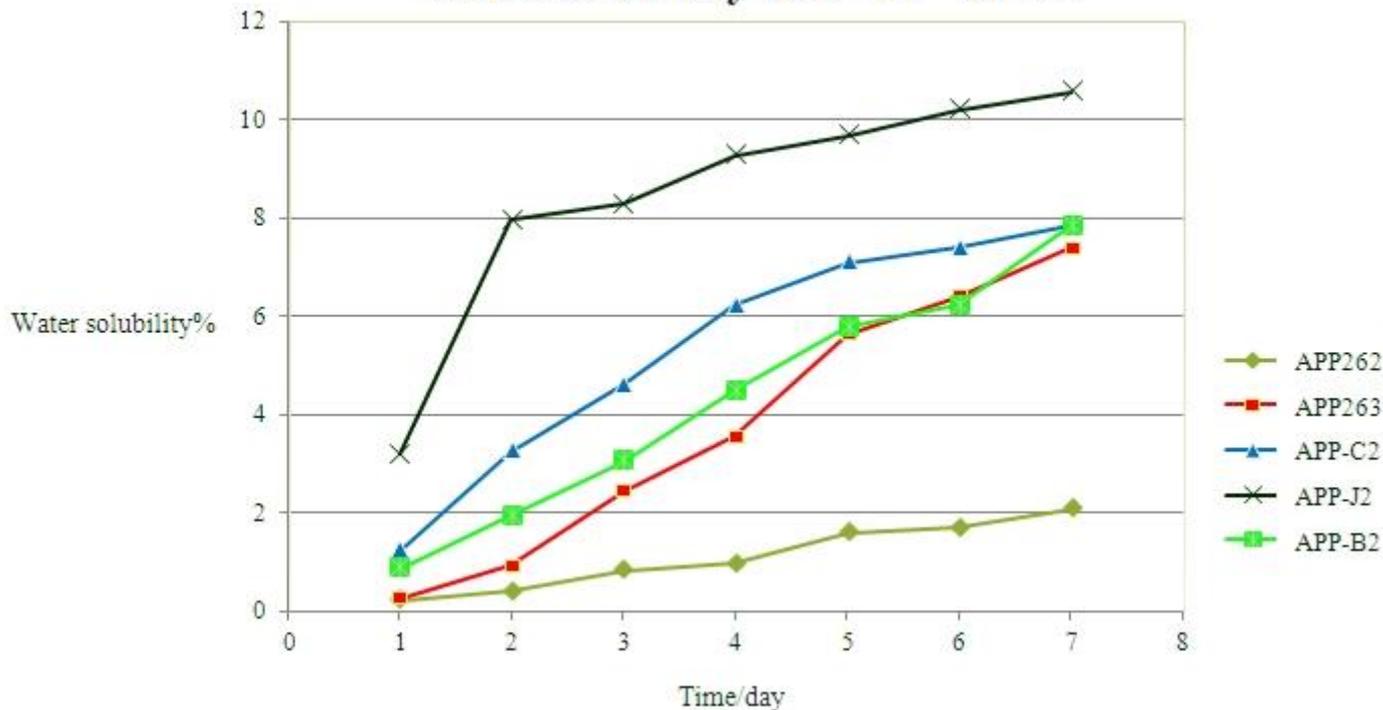
APP-J2

APP-B2



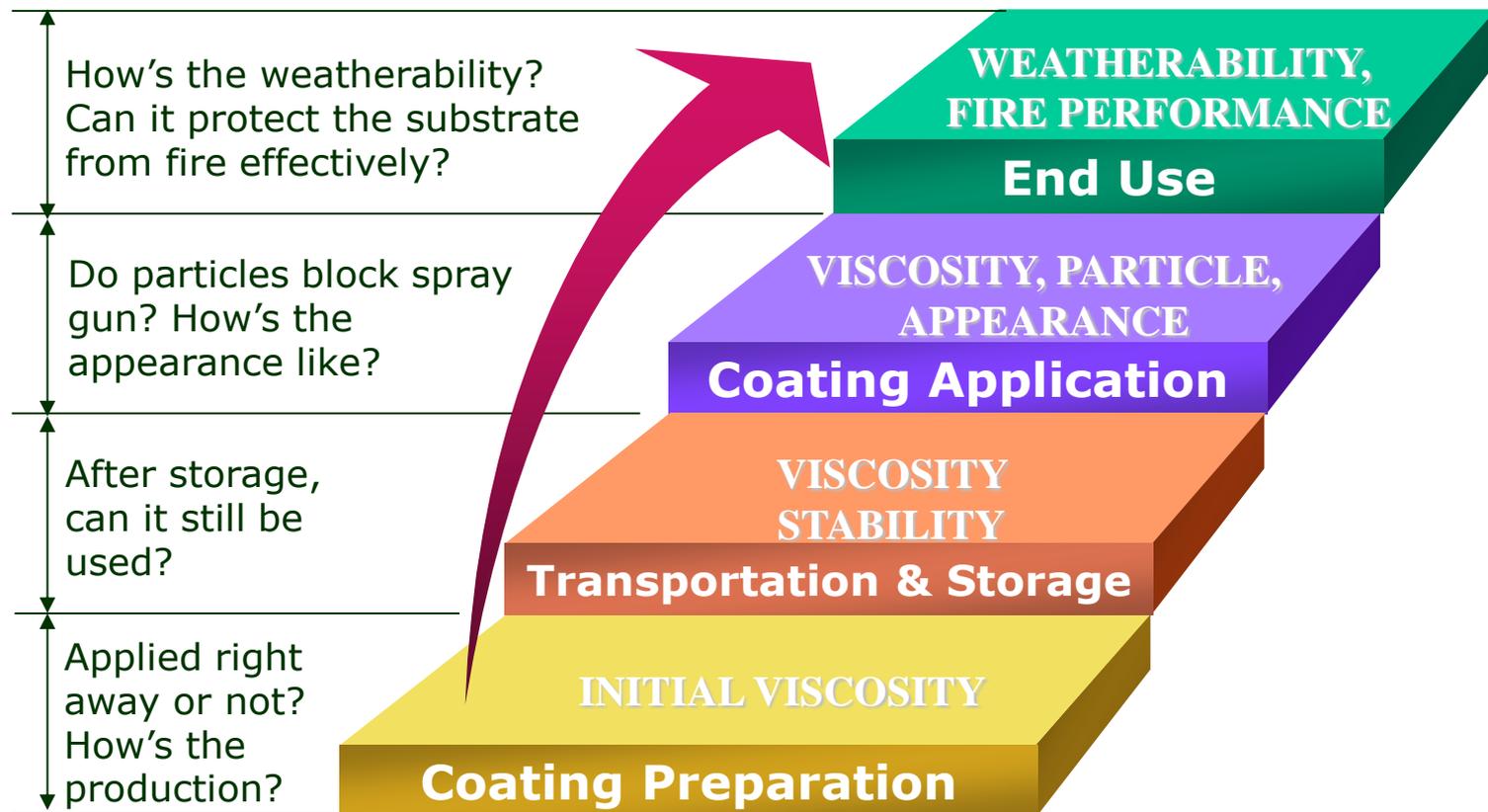
Comparison on water resistance of MF encapsulated APP

Water solubility test (T=80°C)

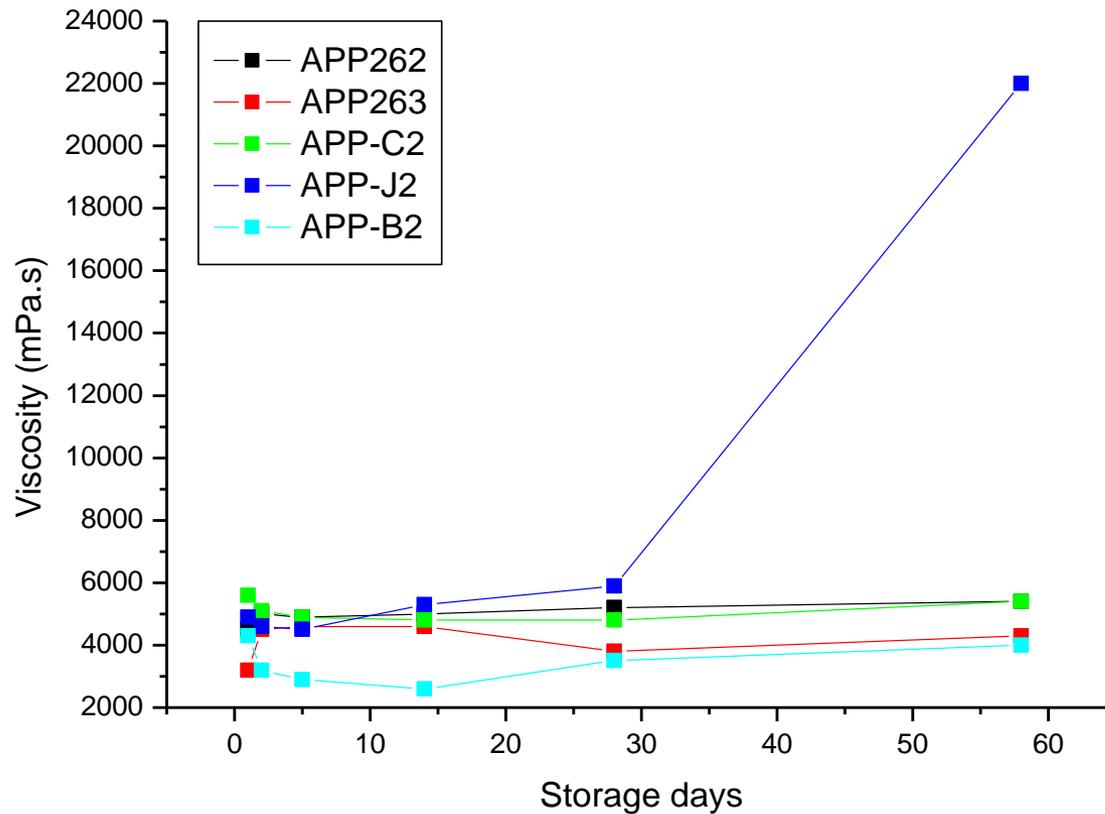


Test method: Make 10% saturated solution with 100g powder and 900ml water, then put it into 80°C thermostat water bath, take 50ml sample every 24h by dispersing solution evenly. We can get the water solubility after centrifugation, suction filtration, drying and weighing.

Coating's life and APP



Viscosity storage stability of MF encapsulated APP in latex



Stimulate storage

Sample preparation: Mix 50% APP with acrylic latex (water-based, solid content 40%), and then test its viscosity with time change to evaluate APP's viscosity storage stability.

Test equipment and Sample preparation

✓ Fire performance testing equipment



Sample preparation

✓ Samples

Samples	Note
Blank Sample	Coating without adding APP, for reference
EPFR-APP 262	Coating that adds EPFR-APP 262 from PRESAFER
EPFR-APP 263	Coating that adds EPFR-APP 263 from PRESAFER
APP-C2	Coating that adds APP from German company C
APP-J2	Coating that adds APP from China company J
APP-B2	Coating that adds APP from German company B

✓ Sample preparation

- ◆ Paint the undercoat (thickness is about 0.1mm) on the surface of a clean steel plate.
- ◆ Paint fire-proof coating after the undercoat dried. Calculate the specific content of fire-proof coating on the steel plate according to the solid content. Making sure that the thickness of the dry coating on the steel plate is $1.00\text{mm} \pm 0.05\text{mm}$. The thickness of the fire-proof coating should be as even as possible .
- ◆ The specimen with FR coating should be air-dry after 7 days, or at least after 1-2 days, and then get dried below $40\text{ }^{\circ}\text{C}$ for 1-2days, until the actual thickness is within 0.05mm of the calculation value.
- ◆ Measure the thickness of the coating layer and record.

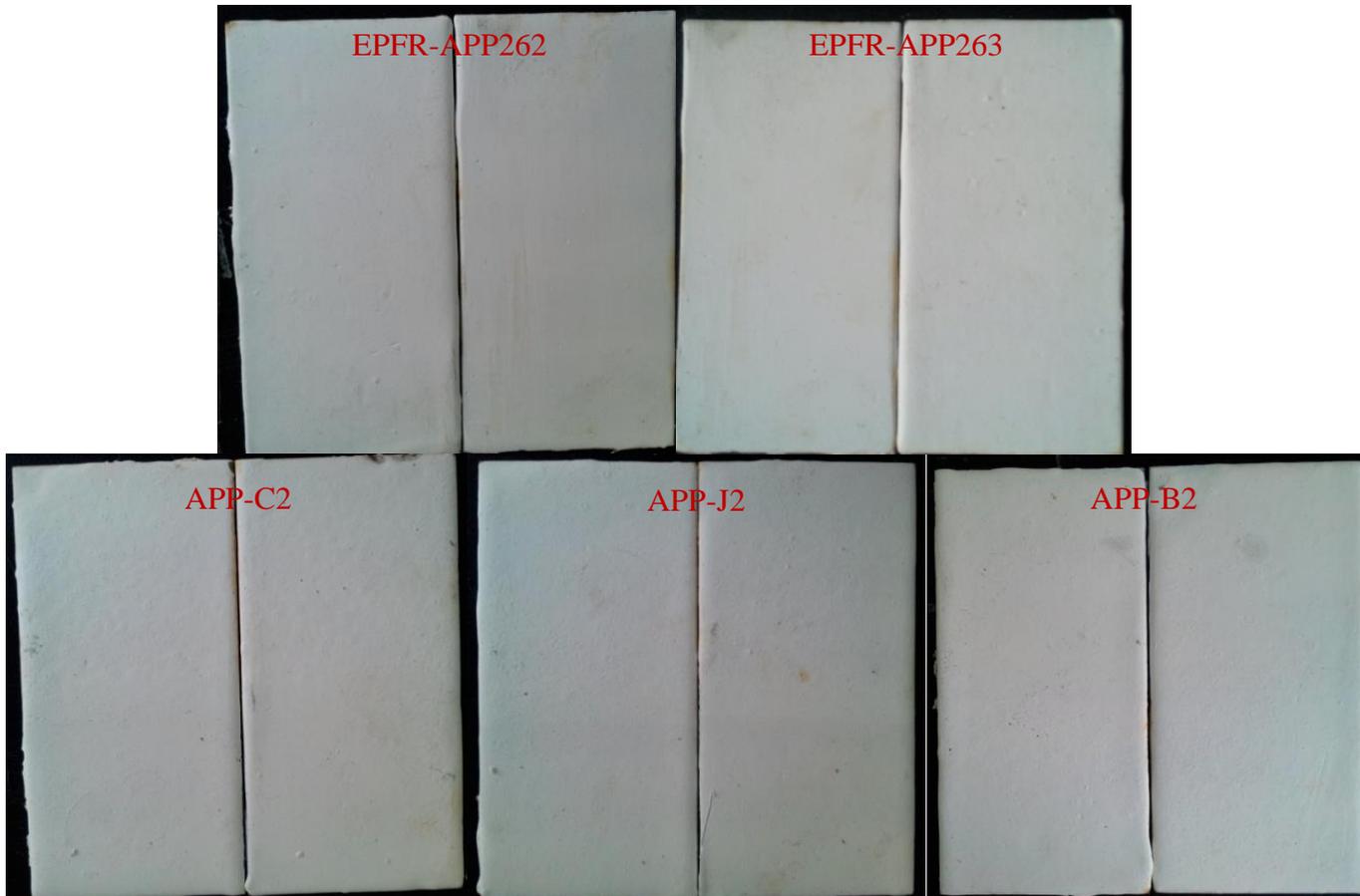
Solventborne acrylic intumescent flame retardant coating

✓ Typical formula

Raw materials	Loading (wt %)
Acrylic resin (Pliolite AC80/AC4)	10-12
Ammonium polyphosphate	27-29
Pentaerythritol (Charmor® PM40)	10-12
Melamine (Industrial grade)	9-12
Chlorinated paraffin (CP-70)	3-5
Titanium dioxide (R103)	8-12
Other filler and additives	3-5
Solvent	20-25
Total content	100

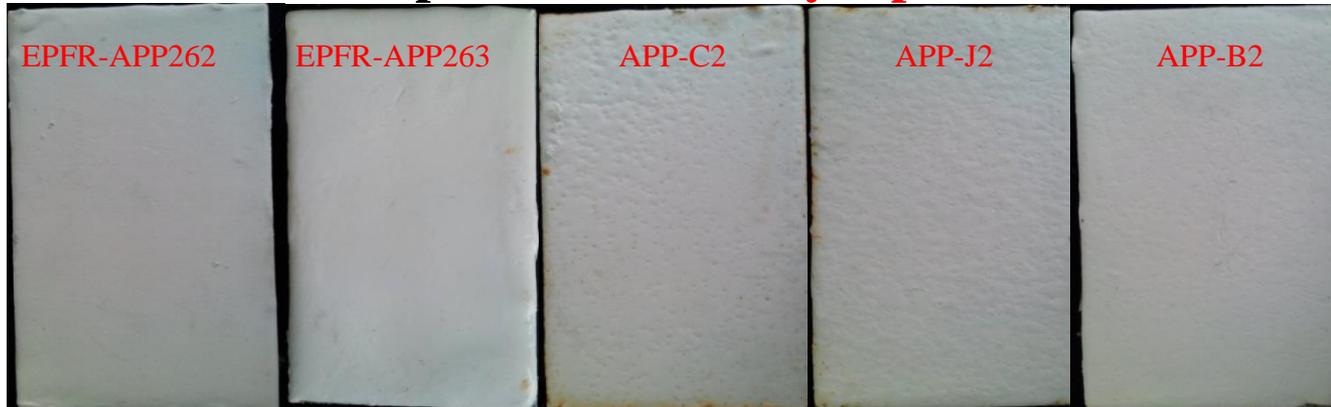
Solventborne acrylic intumescent flame retardant coating

Photos of coated plates- **Immersed in still water for 24h**

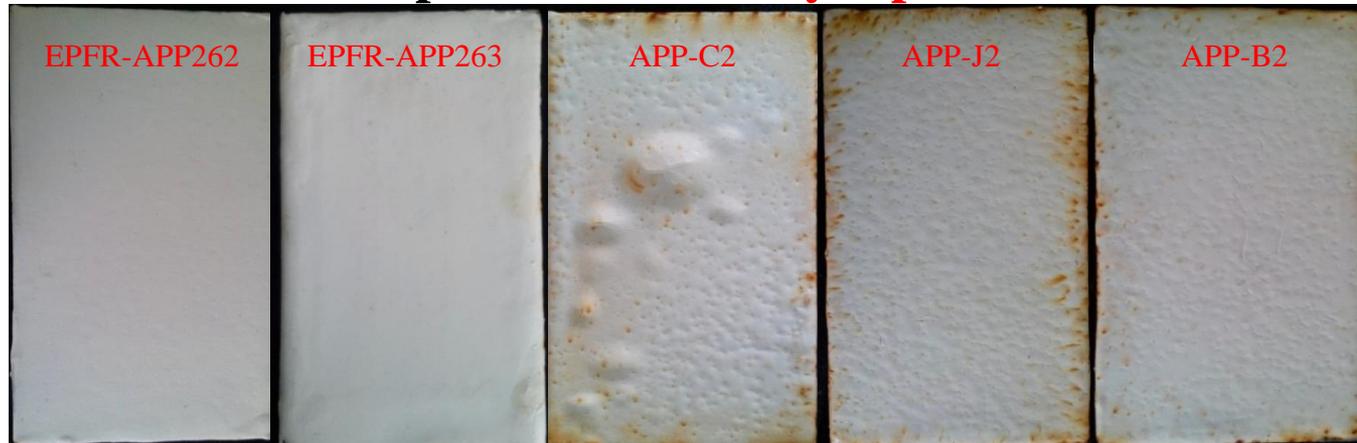


Solventborne acrylic intumescent flame retardant coating

Photos of coated plates - **Washed by tap-water for 24h**

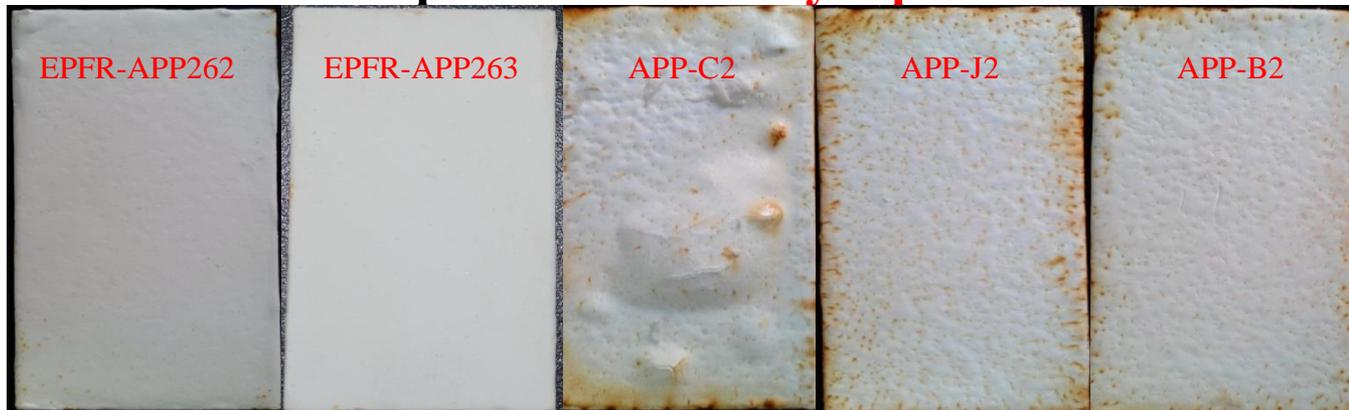


Photos of coated plates - **Washed by tap-water for 48h**

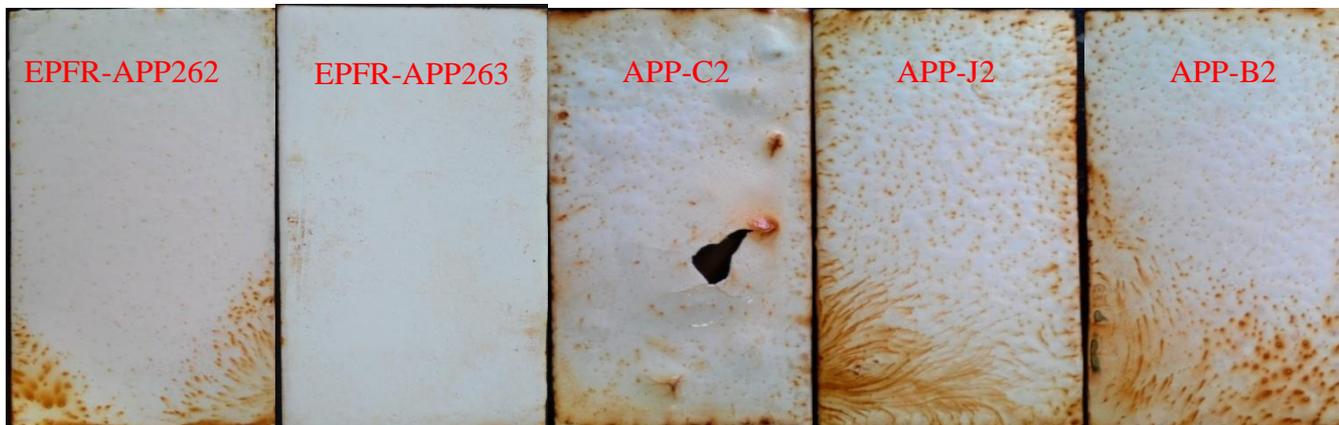


Solventborne acrylic intumescent flame retardant coating

Photos of coated plates - **Washed by tap-water for 72h**

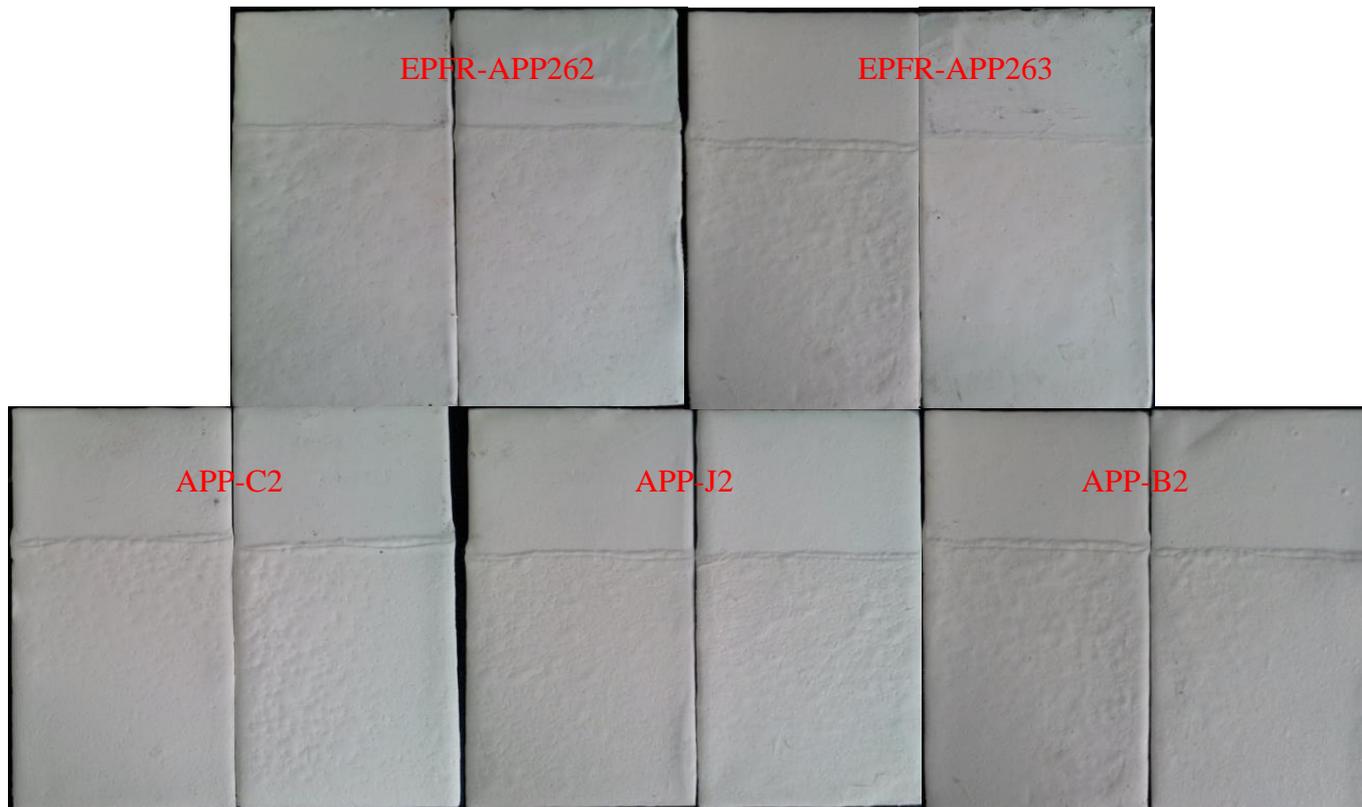


Photos of coated plates - **Washed by tap-water for 120h**

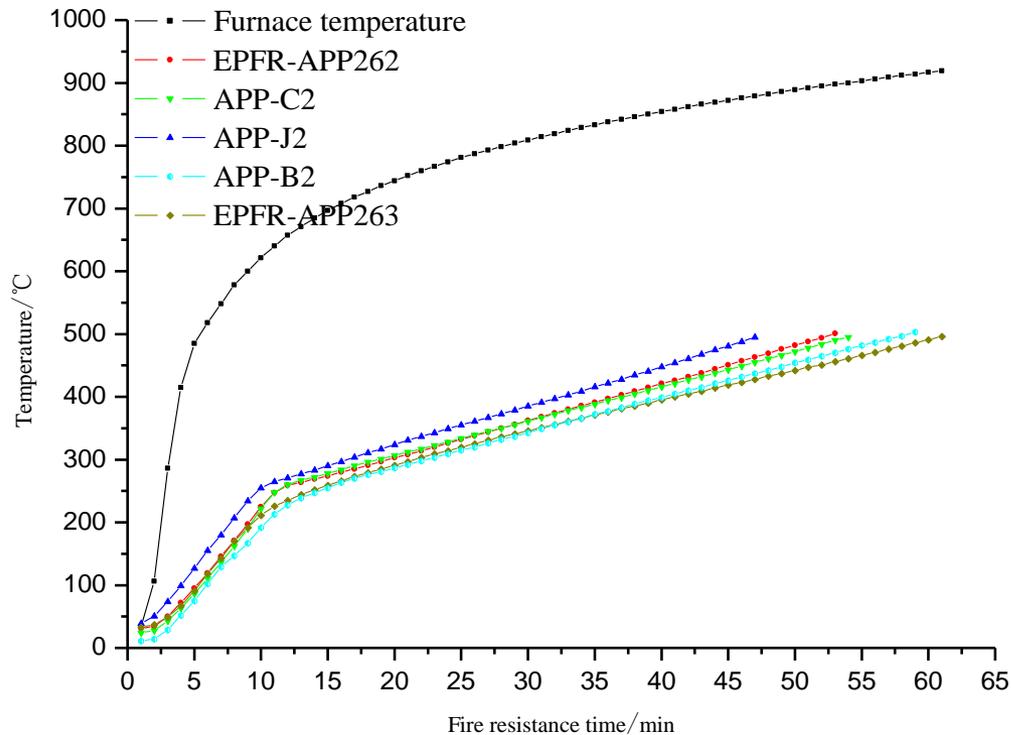


Solventborne acrylic intumescent flame retardant coating

Photos of coated plates - **Immersed in 3% NaOH solution for 24h**



Solventborne acrylic intumescent flame retardant coating



Sample	Fire-resistance time
EPFR-APP262	57min
EPFR-APP263	64min
APP-C2	58min
APP-J2	48min
APP-B2	59min

Solventborne acrylic intumescent flame retardant coating

Char photos



EPFR-APP262



EPFR-APP263



APP-C2

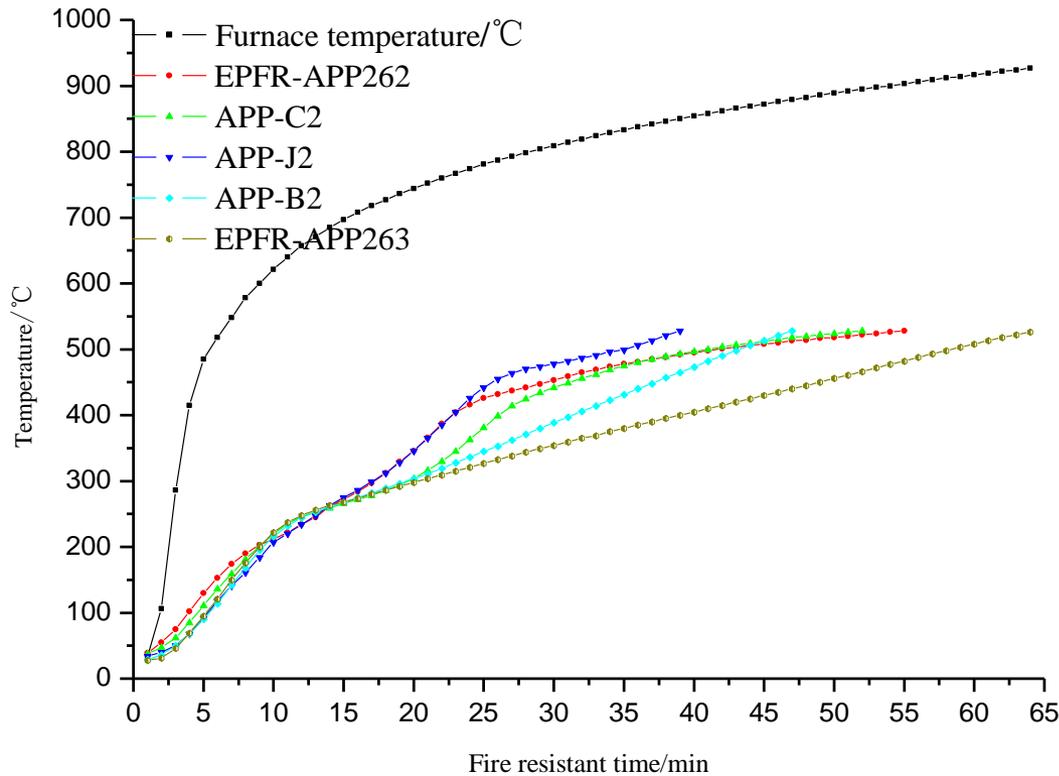


APP-J2



APP-B2

Fire performance after 1 year storage of coated plate with different APP



Sample	Fire-resistance time
EPFR-APP262	55min
EPFR-APP263	63min
APP-C2	52min
APP-J2	39min
APP-B2	47min

Fire performance after 1 year storage of coated plate with different APP

Char photos



EPFR-APP262



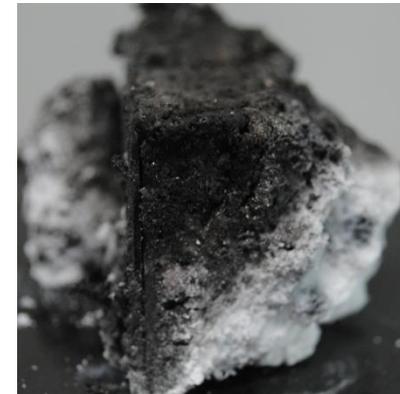
EPFR-APP263



APP-C2



APP-J2



APP-B2

Solventborne acrylic intumescent flame retardant coating

- ◆ Crossbeam test (thickness of coating is 2.0mm)



Item code	EPFR-APP262
Description	1.7m beam
Char	Even and dense char, high expansion ration and no crack

Item code	Fire proof time	Final temperature
EPFR-APP262	60min	518°C

Conclusion

- **Compared with other APP on the market, Preniphor™ EPFR-APP(II) has the advantages as below:**
 - ❖ **High polymerization degree**
 - ❖ **Good weather-resistance**
 - ❖ **Excellent flowability and dispersity**
 - ❖ **Small content of low polymerization degree substance**
 - ❖ **Outstanding thermal stability**



Halogen free flame retardant specialist

PRESAFER

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This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. All the data are typical data coming from our Lab based on Presafer's existing experimental conditions. It should not therefore be construed as guaranteeing specific properties of the products described or their suitability for a particular application. And Presafer should not take any responsibilities for the use of this information. Users of these products should be responsible for the suitability of presafer's products to their specific applications. More information please contact Presafer.