for a better future

KEP

Characteristics of KEPEX (PBT, PET)

R&D Center

KOREA ENGINEERING PLASTICS CO.,LTD.

1. Outline

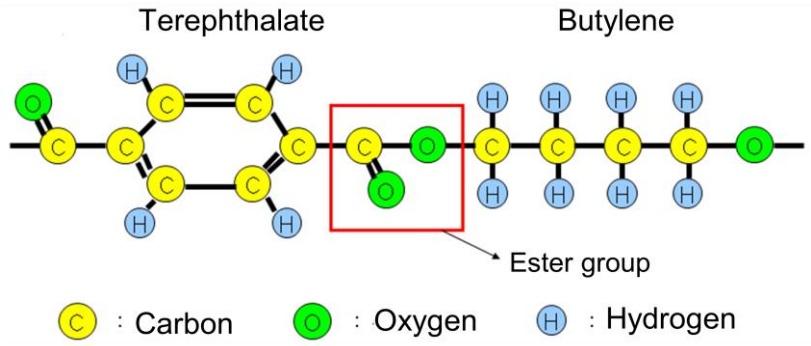
Polyester is a thermoplastic resin that has an ester functional group (-COO-) in the molecular chain and is classified as a crystalline polymer. Polyester has superior toughness, stiffness, fatigue, and chemical resistance properties.

KEPEX is the trade name for the polyester products of KOREA ENGINEERING PLASTICS Co., LTD. KEPEX has two types of products, divided into PBT and PET.

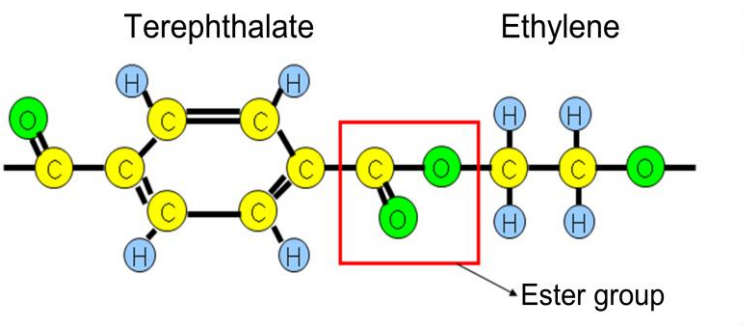
The major characteristics of KEPEX are as follows:
- Good mechanical properties
- Good surface gloss
- Long-term dimensional stability with low water absorption
- Good wear properties
- Good chemical resistance
- Good electrical properties
- High stiffness by reinforcing glass fiber
- Good creep and fatigue properties
- Long-term high heat stability
- Good flammability by adding flame retardants

2. Molecular Structure of PBT, PET

(1) PBT (Polybutylene Terephthalate)

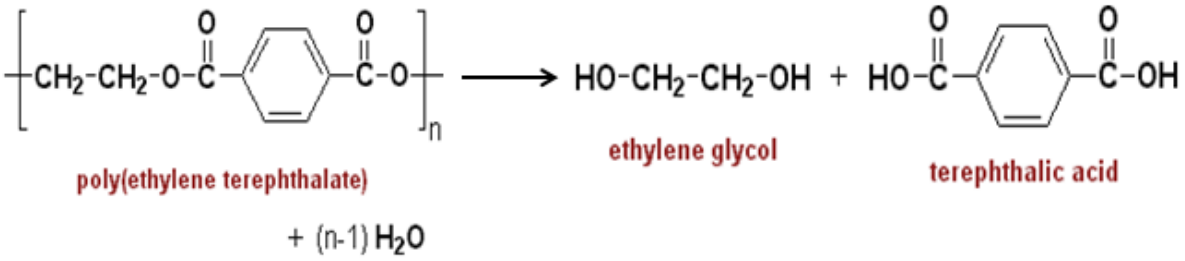


(2) PET (Polyethylene Terephthalate)



3. Hydrolysis

(1) Hydrolysis Mechanism



Polyester undergoes hydrolysis when it melts under the presence of moisture. The ester group breaks down into a carboxyl and a hydroxyl group. In other words, when PET that absorbed moisture is injection molded at high temperatures, it can cause deterioration of the material's tensile and impact strength. The polymer chain degrades into EG(ethylene glycol) and TPA(terephthalic acid) monomer.

In particular, PET has good chemical resistance to water, acid and bases but undergoes hydrolysis over 100℃. The speed of hydrolysis at 100% R.H., 100 ℃ ~ 200℃ is 10,000 times faster than thermal decomposition and 5,000 times faster than oxidative decomposition. The acid value of PET affects hydrolysis. PET resists hydrolysis better as the acid value is lower. Pre-drying of PBT/PET is absolutely necessary.

(2) Effect of hydrolysis

Figure 1 shows the degree of hydrolysis depending on moisture content. It is content of carboxylic acid(COOH) which is generated due to hydrolysis by using FT-IR. As the content of moisture increases, the resin is more degraded by hydrolysis.

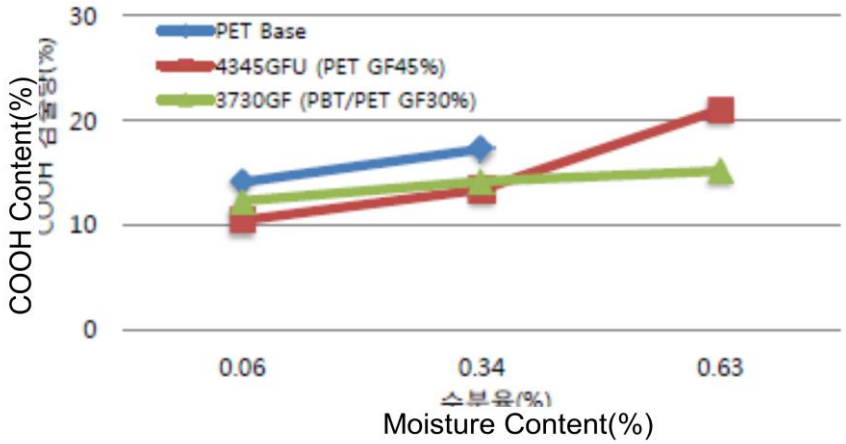


Figure 1. Effect of hydrolysis depending on moisture content(by FT-IR analysis)

Figures 2 and 3 clearly show the change of product strength depending on the moisture content of polyester. 3730GF reduced its strength by roughly 20%, 4345GF by 30%, PET base by 35%. PET is more affected by hydrolysis than PBT.

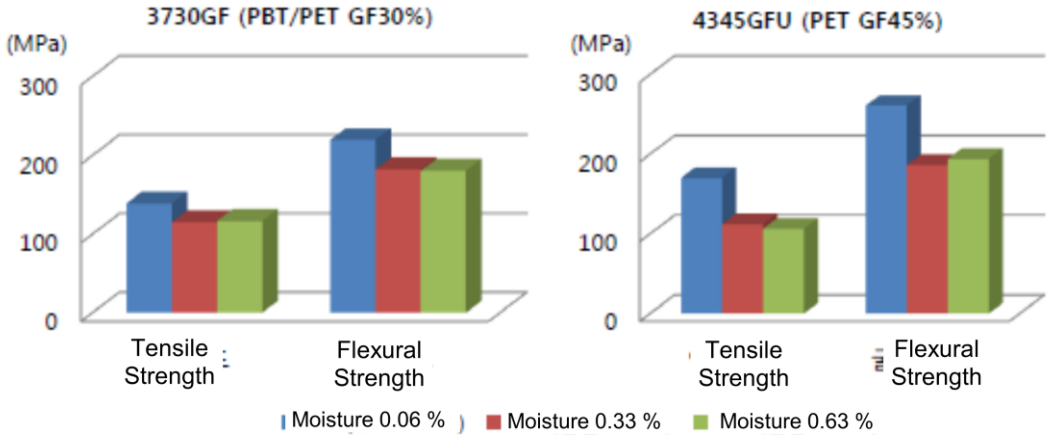


Figure 2. Changes of mechanical properties depending on moisture content

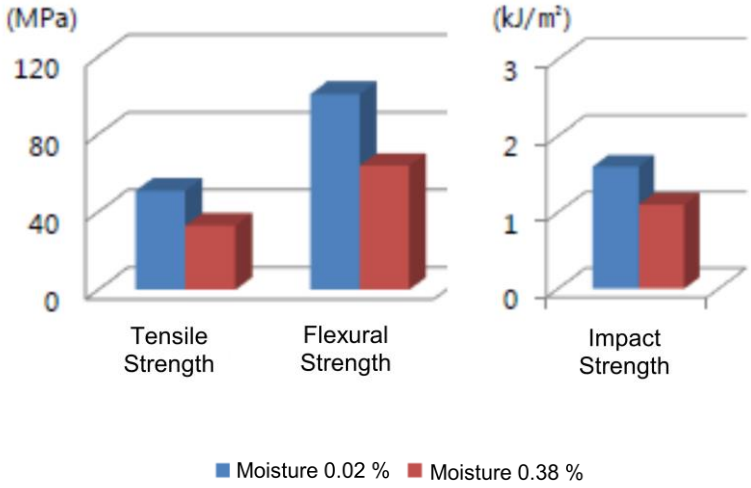


Figure 3. Changes of mechanical properties of PET base

4. Pre-drying

Polyester resin can become degraded under a very small amount of moisture (0.003% at high temperatures). That means only a trace amount of moisture can cause degradation of polyester resin while processing due to hydrolysis reaction and this can cause deterioration of the material's tensile and impact strength. To avoid inferior products, one must use a dehumidifying dryer and hopper dryer and the content of moisture of resin injected must be consistently maintained. In addition, a sustained temperature of the hopper of the injection machine at over 100 ℃ is required.

In general, it is recommended that the water content of the material's pellets should be maintained below 0.02%, the marginal moisture content. It should be dried thoroughly for good quality of the molded articles.

5. Chemical Resistance

PBT is a crystalline polymer and has good chemical resistance properties. It has great resistance to organic solvent, oil, and so on, but it is weak in strong acid, alkali, and steam because of ester group degradation by hydrolysis.

[Table 1. Chemical resistance property of plastics]

Classification	PBT	MPPO	POM	PA6, PA66	PC
Water Absorption	0.08	0.07	0.22	1.90, 1.20	0.15
Weak Acid	◎	○	△	○	◎
Strong Acid	△	○	X	X	△
Weak Base	○	○	○	○	○
Strong Base	X	○	○	○	X
Oil	◎	○	○	○	△
Acetone	○	○	○	○	X
Benzene	○	X	○	◎	X
CCl_4	◎	X	◎	○	X
Alcohol	◎	○	◎	△	△
Ester	○	X	○	◎	X
Gasoline	◎	△	◎	◎	X
Solvent	Chlorophenol	CCl_4	Phenol	Phenol, Formic Acid, m-cresol	Methylene Chloride, CCl_4

(◎ : excellent, ○ : good, △ : normal, X : weak)

6. Heat Resistance

The melting point of PET and PBT is 256℃ and 220℃ respectively, and high and glass transition temperature is 70 ℃ and 40 ℃. HDT of PET is high and HDT of PBT can increase by reinforcing glass fiber. For example, HDT of glass fiber 30%-reinforced PBT is high (210℃) and it can endure under 150℃ in the long term.

[Figure 2. Heat resistance property]

Resin	HDT (℃)		RTI (℃)
	Unfilled	GF 30%	
PBT	55	210	130
PET	65	225	140
PA6	65	210	115
PA66	75	250	125
POM	110	160	100
PC	140	150	130
MPPO	105	140	110

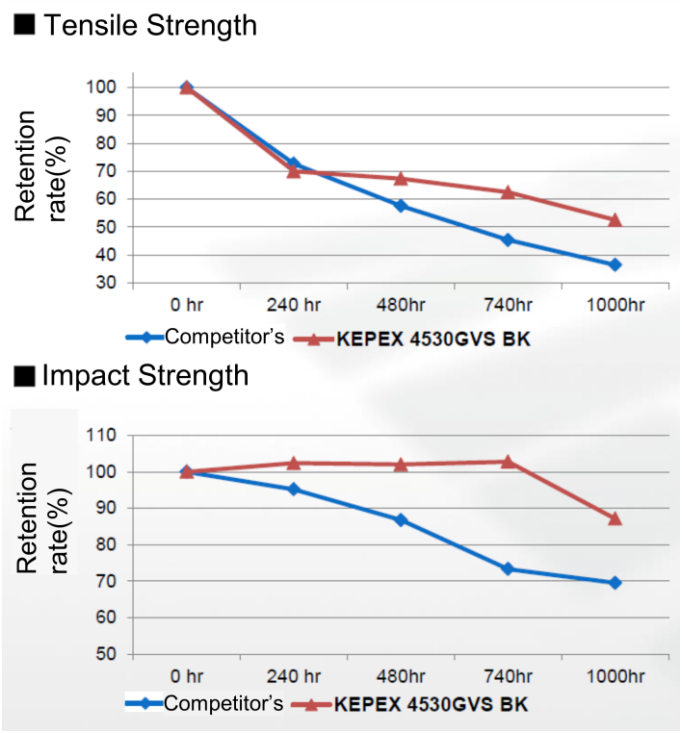


Figure 4. The retention rate of strength of KEPEX 4530GVS (210 ℃, 1000 h)

7. Flame Retardant

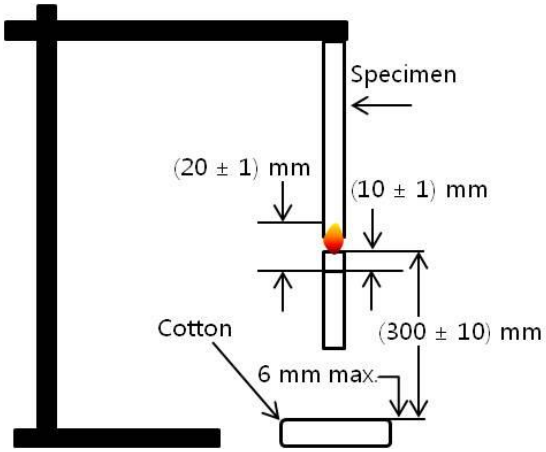
Polyester resin, PBT and PET, is flammable, yet there is a flame-retardant grade that burns poorly through adding flame retardants. Bromic flame retardant is normally used for PBT and PET and there are many glass fiber-reinforced flame retardant grades.

[Table 3. PBT and PET Flame retardant grade]

Classification	Characteristics	Grade	UL Class	Impact Strength (kJ/㎡)	Tensile Strength (MPa)
PBT	GF 15%-reinforced, Flame retardant	3315GVS	V-0	5.5	100
	GF 30%-reinforced, Flame retardant	3330GVS	V-0	6.8	120
	GF 30%-reinforced, Flame retardant, Toughness	3330GVT	V-0	9.0	130
	GF 30%-reinforced, Flame retardant, Weather resistant	3315GVU	V-0	3.5	88
PET	GF 45%-reinforced, Flame retardant	4530GVS	V-0	8.5	140

UL Testing Standard

Rank	V-0	V-1	V-2
Burning time(s)	≤ 10	≤ 30	≤ 30
Total burning time(s) (5 specimen/10 times)	≤ 50	≤ 250	≤ 250
Drip burn	No	No	Yes



8. Weather Resistance

With exposure to external or internal environments, plastics degrade by light and heat. The main cause of degradation is ultraviolet rays. UV causes discoloration and surface chalking resulting in decomposition, and finally serious deterioration of mechanical properties.

Light stabilizers can prolong the service life of plastics. Resistance to light and weather is usually evaluated through accelerated weathering tests of outdoor exposures and for specific times. Outdoor exposures are mostly conducted in Florida and Arizona and there is a test site in Seosan in Korea as well. Results from separate test sites are basically different and incompatible.

The weather resistance of weather resistance grade, 3730GF BK and 3750GF BK, is measured according to MS210-06 in Table 4. As you can see, they have good weather-resistant properties. Figure 5 shows the retention rate of tensile strength of KEPEX weather resistance grade measured according to SAE J2412.

[Table 4. Weather Resistance of KEPEX]

Grade	Gray scale	△E	Note
3730GF BK	4 - 5	2.2	No crack, No break.
3750GF BK	4 - 5	2.3	No crack, No break.

(Footnotes) 1. Test Conditions (MS210-06) : 65.5 W/m^2(Amount of light), 1800h(Weather-O-meter)

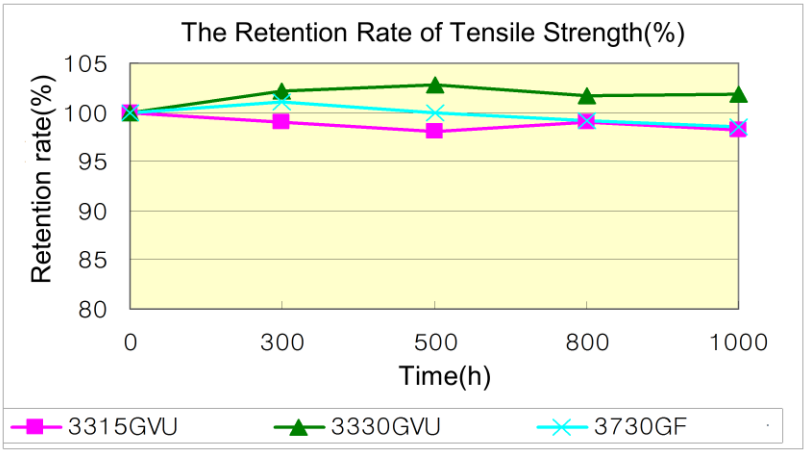


Figure 5. The Retention Rate of Tensile Strength of KEPEX Weather Resistance Grade(SAE J2412)

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