APPLICATIONS….

RYNO 9000® fiber is suitable for a range of applications including:

- filter bags for filtration of flue gas from coal-fired boilers
- woven and nonwoven filter fabrics for liquid and gas filtration
- papermakers' felts
- electrolytic membranes
- dry and wet-laid fabrics for filtration and other uses
- composites
- electrical insulation

AVAILABILITY…

RYNO 9000® staple fiber is available in 1.8 and 2.7 denier (2.0 and 3.0 dtex). Standard cut lengths for 1.8 denier are 1.5" and 2.5" (38mm and 63mm), while the 2.7 denier is available in cut lengths of 2" and 3-1/4" (50mm and 83mm). Other lengths are available on request. The fibers' natural color is gold.

RYNO 9000® fiber is shipped in bales 27 inches (68.6 cm) high x 42 inches (107 cm) wide x 54 inches (137 cm) long. A full bale weighs approximately 500 lbs. (225 kg).

PROPERTIES…

1. **PHYSICAL PROPERTIES**
   Typical physical properties of RYNO 9000® fiber are shown in Table 1. Note that tenacity, elongation, modulus, elastic recovery and moisture regain are quite satisfactory for textile applications. Of great interest is the high melting point (545°F, 285°C).

2. **HEAT RESISTANCE**
   RYNO 9000® fiber has excellent ability to perform at high temperatures. Fig. 1 shows retained strength at temperatures up to 500°F. Even after 1000 hours at that high temperature, the fiber still retains over 60% of its strength as measured under standard conditions.

   In test installations, filter bags made with RYNO 9000® fiber have been continuously subjected to temperatures of 360°F – 375°F (182°C – 190°C), for more than four years without any sign of failure. The maximum recommended operating temperatures are:

Continuous	375°F (190°C)
Surges*	450 °F (232°C)

*To a maximum of 200 hours/year in 2 hour increments (not to exceed 450°F).

Most "new" man-made fibers in the past ten years have been physical or chemical varians of existing fibers. However, RYNO 9000® fiber, based on a different chemical structure was clearly outside the current classes of fibers recognized by the Federal Trade Commission. Accordingly, in July 1986, the FTC granted the fiber a new generic name, recognizing this unique structure.

RYNO 9000® fiber possesses outstanding properties for specialty applications:

- outstanding heat resistance
- excellent chemical resistance
- flame retardancy (self-extinguishing)
- good physical properties
- good electrical properties

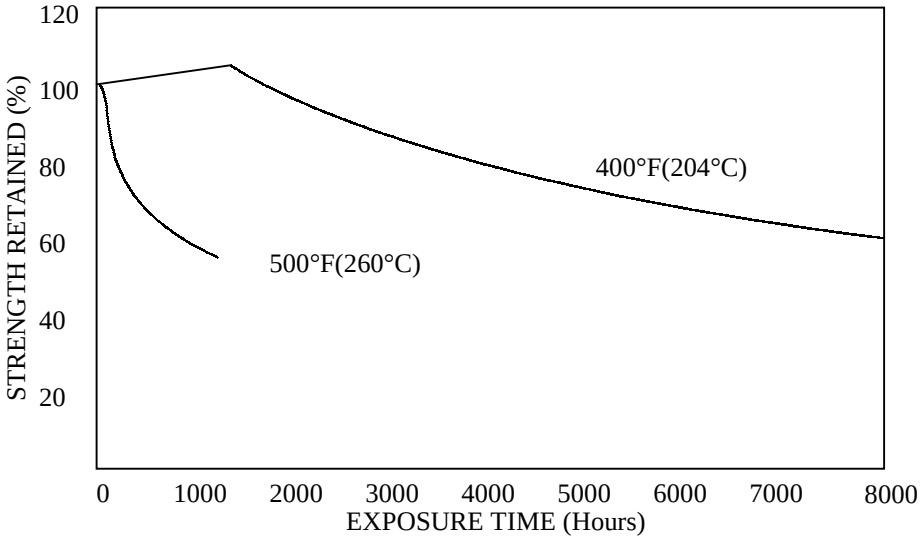
Table 1 – Physical Properties of RYNO 9000® Fiber

Tenacity, good	4.6
Elongation % at Break	35
Modulus at 10% Extension	16
Elastic Recovery, %	
2% Extension	100
5% Extension	96
10% Extension	86
Moisture Regain, %	0.6
Specific Gravity	1.37
Melting Point	545°F (285 C)

Figure 1 – Strength Retention of RYNO 9000® Fiber after Exposure in Air at High Temperatures*

RYNO 9000® has outstanding strength retention upon exposure to heat. RYNO 9000® retains 60% of its original strength after exposure to 500 ° F (260°C) for 1000 hours.

It retains 90% strength after exposure to 400°F (204°C) air for 2000 hours – 70% after 5000 hours and almost 60% after 8000 hours.



*ASTM D-461
**Based on laboratory tests
+Based on lab and feld data

Table 2 – Chemical Resistance of RYNO 9000® Fiber

	% Strength Retained*
Acids	
48% Sulfuric Acid	100
10% Hydrochloric Acid	100
Conc. Hydrochloric Acid**	100
Conc. Phosphoric Acid	95
Acetic Acid	100
Formic Acid	100
Alkalis	
10% Sodium Hydroxide	100
30% Sodium Hydroxide	100
Organic Solvents	
Acetone**	100
Carbon Tetrachloride**	100
Chloroform**	100
Ethylene Dichloride**	100
Perchlorethylene**	100
Toluene	100
Xylene (mixed)	100
Oxidizing Agents	
10% Nitric Acid	75
Conc. Nitric Acid	0
50% Chromic Acid	0-10
5% Sodium Hypochlorite	20
Conc. Sulfuric Acid	10
Br_2 (free bromine)	0

*% Tensile strength retained after exposure to various chemicals at 200°F for one week.
**Fiber exposed at boiling point of chemical.

Table 3 – Chemical Resistance of RYNO 9000® Fiber vs. Nomex® vs. P84 - % Strength Retained

1 Week at 95 °C

	10% Nitric Acid	50% Sulfuric Acid	10% Hydrochloric Acid	25% Sodium Hydroxide	5.5% Sodium Hypochlorite
RYNO 9000®	54	114	119	112	18
Nomex	D	D	D	D	8
P-84	D	20	D	D	D

D – Dissolved or Decomposed

Table 4 – Flame Resistance

NASA spacecraft materials. Test results on molding resin.

TEST	PPS R-4 RATING
Upward Flame Propagation Rage	Self-Extinguishing in 0.17 in. (.43 cm)
Flash and Fire Point	None
Odor	1.6 (No Dilution)
Carbon Monoxide	0.4 mg/g
Total Organics	1.0 mg/g
Volatile Condensible Materials*	0.0046%
Total Weight Loss	0.0650%
Limiting Oxygen Index	34

*24 hour at 125°C and 6.1 x 10^{-7} TORR

3. CHEMICAL RESISTANCE

RYNO 9000® fiber has excellent resistance to strength loss upon exposure to chemicals. Fiber was immersed for one week in the chemicals listed in Table 2 at 200°F (93°C) and strength retention was measured. Resistance to acids and alkalis is outstanding. Only strong oxidizing agents cause degradation.

RYNO 9000® fiber is not soluble in any known solvent below 392°F (200°C). The fiber shows limited solubility in a few solvents above this temperature.

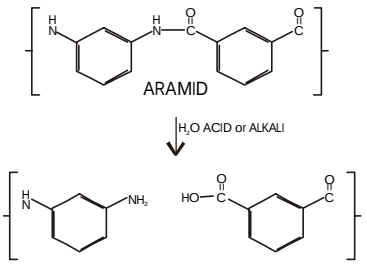
4. HYDROLYSIS

A major cause of bag failure is the chemical reaction of hydrolysis. Hydrolysis is defined as a chemical process of decomposition that involves splitting a bond and the addition of the elements of water.

The man-made fibers made from condensation polymers are subject to hydrolysis. The condensation polymers are polyester, nylon, or polyamide, polyimide and aramid. Water is a by-product of the polymerization of some condensation polymers.

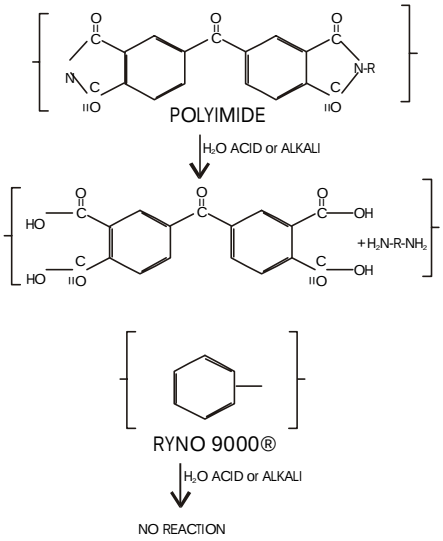
The combustion process itself generates moisture and acid-forming gases (oxides of sulfur and nitrogen) which, along with the elevated temperature form ideal conditions for hydrolysis.

The following illustration shows how hydrolysis degrades aromatic polyamides or aramid fibers.



At elevated temperatures, even as low as 325 ° F, moisture, catalyzed by acid or caustic, attacks the amide bond and cleaves the polymer molecule at the amid linkages.

A polyimide is also a condensation polymer and is, therefore, susceptible to hydrolysis.



Because it does not hydrolyze, RYNO 9000® fiber is well suited to the hot, harsh environments found in industrial coal fired boilers, Municipal Solid Waste incinerators and biomass incinerators.

5. FLAME RETARDANCY

In a NASA study (utilizing ASTM test D-461), twelve thermoplastics were ranked according to fire safety for aircraft interiors, RYNO 9000® resin was ranked as having the highest degree of fire safety.

RYNO 9000® fiber has an LOI (limiting oxygen index) of about 34 or 35, which means it is classified as nonflammable. It will not support combustion under normal atmospheric conditions. The autoignition temperature (the minimum air temperature which would provide a finite probability of ignition) is 390 ° C, as determined in tests at the Textile Research Institute.

6. ELECTRICAL PROPERTIES

RYNO 9000® fiber is characterized by excellent electrical insulation properties which suit it for a range of electrical applications.

Figure 2 – Needled Felt made with RYNO 9000® vs. Aramid – Tensile Strength Retained

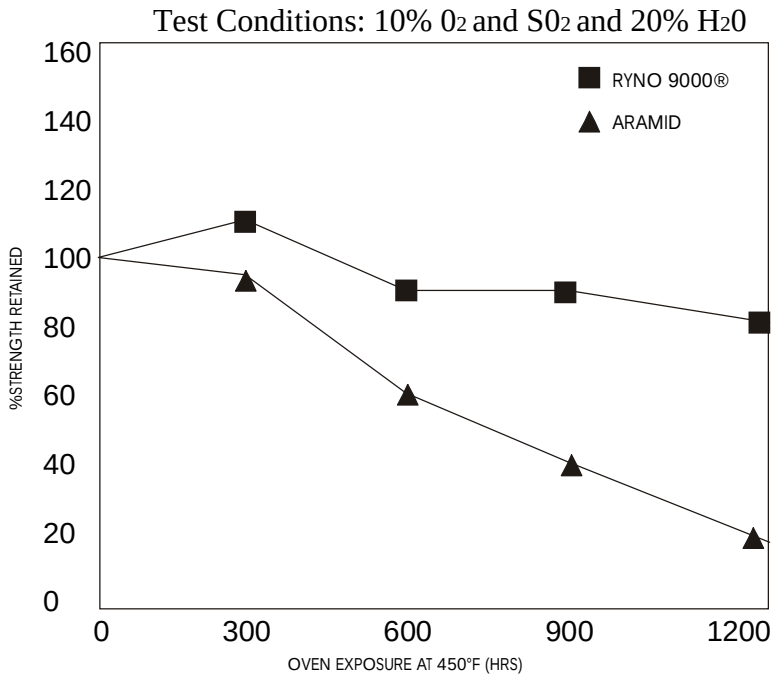


Table 5 – Gaseous Degradation Products of RYNO 9000® Fiber from Pyrolysis at 1292 ° F

Material	Amount Mg/G of PPS
CO_2	**1800**
SO_2	**425**
CO	**200**
COS	**2.5**
C_2H_2	**1.5**

Table 6 – Electrical Characteristics

Typical Electrical Properties

Dielectric Constant	
1 KHz	3.1 – 3.3
1 MHz	3.1 – 3.3
Dissipation Factor	
1 KHz	0.0003 – 0.0005
1 MHz	0.0005 – 0.0009
Volume Resistivity, ohm-cm	2.2-4.2 x 10^{16}