

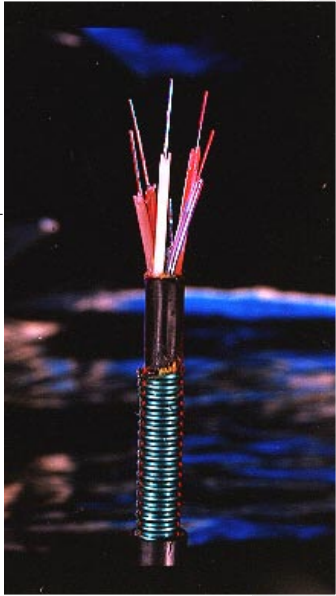
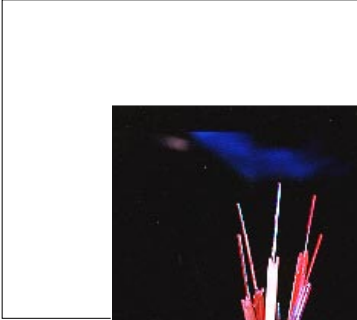
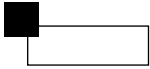
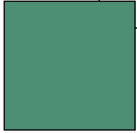
THE POWER OF INDUSTRY



Rilsan[®]

Polyamide Resins





RILSAN® POLYAMIDE RESINS

Outstanding properties of RILSAN polyamide resins include:

- Excellent stability at high temperatures
- High pressure resistance
- Highly resistant to climate extremes
- Excellent chemical resistance
- Good stress cracking resistance
- Very low specific gravity
- High impact resistance at sub-zero temperatures
- Low moisture absorption (0.9%)
- Low coefficient of friction
- High abrasion resistance
- Good creep resistance
- High dimensional stability

RILSAN polyamides 11 and 12 are high-performance technical polymers developed by ATOFINA Chemicals, Inc. in 1942. Derived from a series of complex chemical operations, RILSAN PA 11 is one of the few polymers in existence produced from a 'green' raw material — castor beans. RILSAN PA resins have earned a preferred material status in the most demanding applications due largely to their unique combination of thermal, physical, chemical and mechanical properties. This results in an outstanding Cost Performance Ratio.

Processing ease is another major benefit of RILSAN polyamide resins. Supplied in powder or pellet form,

RILSAN PA resins can be processed by injection molding, extrusion, blown film extrusion, extrusion blow molding or rotomolding. RILSAN PA 11 and 12 are available in rigid, semi-flexible and flexible grades. Reinforced and conductive grades are also produced.

RILSAN polyamide resins have a unique combination of properties. Their ease of processing has led designers to select them for industries as diverse as offshore drilling, electrical cables, automotive, and pneumatic and hydraulic hose.

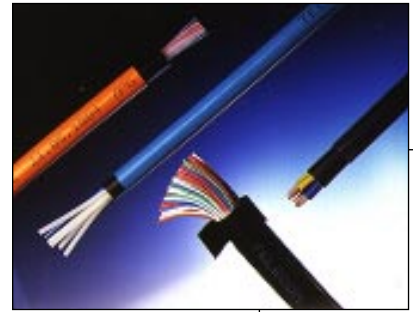
The most demanding applications require RILSAN polyamide resins.



RILSAN® polyamide resin nomenclature

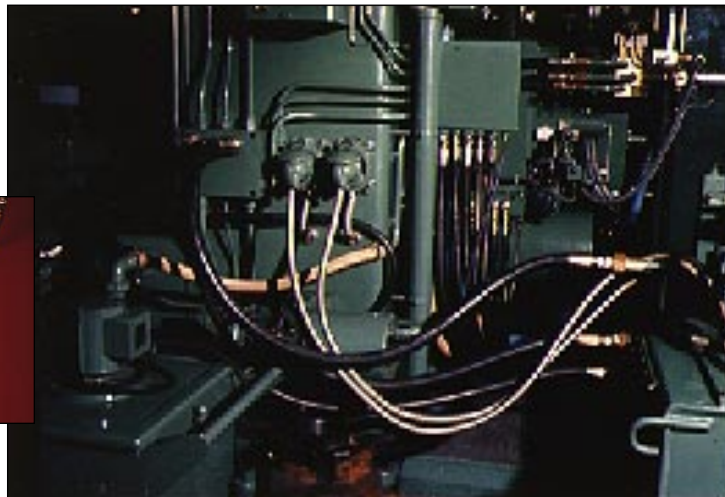
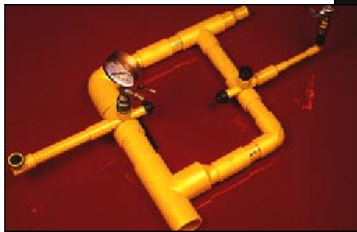
Each RILSAN PA resin grade is designated by a series of letters and figures:

| | |
|---------------------------|--|
| Polyamide Family Type | A = PA 12; B = PA 11 |
| Processing Method | M = molding grade R = rotomolding grade ES = general purpose extrusion grade EC = cable extrusion grade |
| Viscosity | N = normal; V = high |
| Color | 0 = natural; BLK = black |
| Index of Flexibility | P10; P20; P40 |
| Heat and Light Stabilized | TL; TLM; TL3 |
| Reinforced | Z = glass |



Examples by class

| | |
|---------------|-----------------------------|
| Rigid | BMNO TL; BESNO TL; BESVO TL |
| Semi-flexible | BESNO P20 TL |
| Flexible | BESNO P40 TL |
| Reinforced | BZM 23 BLK TL |



PROPERTIES

Physical properties for RILSAN® PA resin grades

| | UNIT | ASTM TEST METHOD | AESNO TL | AESNO P40 TL | BESNO TL | BESNO P20 TL | BESNO P40 TL | BMNO TL |
|---|------|------------------|----------|--------------|----------|--------------|--------------|---------|
| Melting Point, DSC | °C | D 3418 | 177 | 172 | 189 | 183 | 180 | 189 |
| Specific Gravity | g/cc | D 792 | 1.02 | 1.03 | 1.03 | 1.04 | 1.05 | 1.03 |
| Moisture Absorption, Saturation @ 50% RH & 23°C | % | D 570 | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 | 0.9 |

Mechanical properties for RILSAN PA resin grades

| | UNIT | ASTM TEST METHOD | AESNO TL | AESNO P40 TL | BESNO TL | BESNO P20 TL | BESNO P40 TL | BMNO TL |
|--------------------------------------|------|------------------|----------|--------------|----------|--------------|--------------|---------|
| Tensile Strength at Break | MPa | D 638 | 69 | 63 | 69 | 67 | 65 | 69 |
| Tensile Strength at Yield | MPa | D 638 | 48 | NY | 42 | 32 | NA | 40 |
| Elongation at Break | % | D 638 | 330 | 360 | 380 | 360 | 360 | 390 |
| Elongation at Yield | % | D 638 | 5 | NY | 19 | 40 | NY | 10 |
| Tensile Modulus, Tangent | MPa | D 638 | 1400 | 370 | 1300 | 490 | 320 | 1200 |
| Flexural Modulus, Tangent | MPa | D 790 | 1200 | 390 | 1100 | 440 | 320 | 1100 |
| Impact Strength, Izod Notched, 23 °C | J/m | D 256 | 140 | NB | 96 | 210 | NB | 75 |
| Unnotched, 23 °C | | | NB | NB | NB | NB | NB | NB |
| Notched, -40 °C | | | 20 | 16 | 21 | 21 | 21 | 27 |
| Unnotched, -40 °C | | | NB | NB | NB | NB | NB | NB |
| Hardness, Rockwell "R" Scale | | D 785 | 106 | 75 | 108 | 87 | 78 | 108 |

NB = No Break

NY = No Yield

NA = Not Applicable

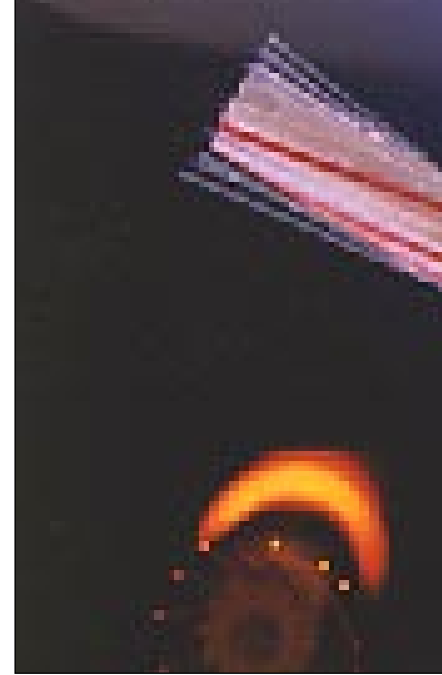
Thermal Properties

RILSAN® PA resins have excellent thermal stability. The melting point range for RILSAN PA 11 is 180°C – 189°C. RILSAN PA 12 exhibits a lower melting point range, 170°C – 177°C. RILSAN PA resins can be exposed continuously to temperatures up to 100°C with intermittent peaks up to 125°C. While other nylons display weak hydrolysis resistance, RILSAN PA resins present excellent characteristics in water environments. In hydrocarbon environments, they have been exposed to continuous temperatures of 100°C for extended periods of time with no detrimental effects. Its brittleness temperature, according to ASTM

D746, is lower than -80°C. The heat deflection temperature under 66 psi is 135°C.

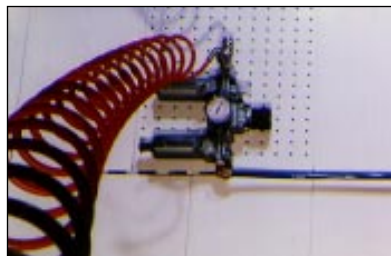
According to ASTM 1929–77 procedure B, the auto ignition temperature of RILSAN PA resins is in the range of 420°C – 450°C. The by-products resulting from the thermal decomposition of RILSAN PA resins are non-toxic. Contact your **ATOFINA Chemicals, Inc.** Technical Representative for more information.

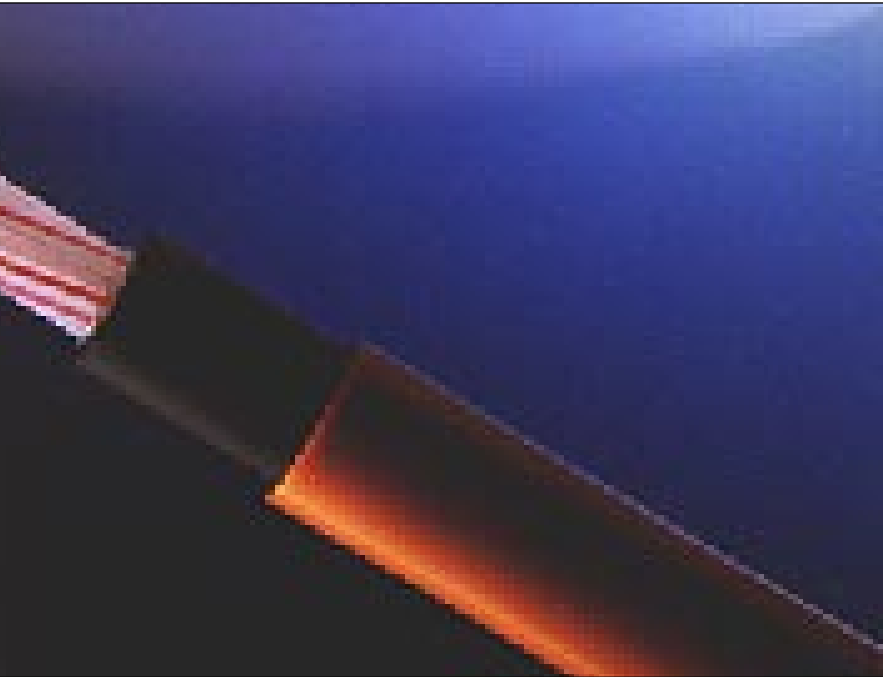
Even though the melting point of RILSAN PA resins is lower than that of other nylons, its continuous service temperature is similar, and it is not subject to the many restrictions involved with Nylons 6 and 66.



Thermal properties of RILSAN PA resins vs. nylons

| | RILSAN PA 11 | RILSAN PA 12 | Nylon 6 | Nylon 66 |
|-----------------------------------|--------------|--------------|---------|----------|
| Melting Point (°C) | 186 | 175 | 215 | 265 |
| Glass Transition Temperature (°C) | 45 | 35 | 57 | 50 |
| Service Temperature (°C) | 100 | 90 | 100 | 110 |



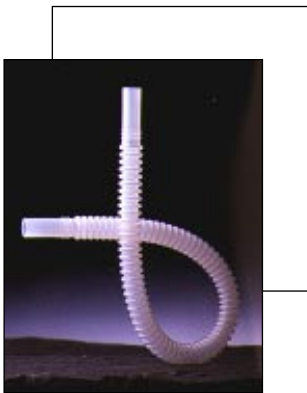


Moisture Absorption

RILSAN® PA 11 and 12 resin grades exhibit low moisture absorption characteristics in comparison to other nylons. Nylons show a hydrophilic behavior due to the polarity of the amide functions. Because of their lower concentration of amide functions, RILSAN PA 11 and 12 perform significantly better in wet environments than Nylons 6 and 66.

Water absorption of RILSAN PA resins vs. nylons at 23° C

| | RILSAN PA 11 | RILSAN PA 12 | Nylon 6 | Nylon 66 | Nylon 6-12 |
|------------------------|--------------|--------------|---------|----------|------------|
| at equilibrium, 50% RH | 0.9 | 0.8 | 3.3 | 3.2 | 1.5 |
| Saturation | 1.9 | 1.8 | 10.5 | 8.5 | 2.8 |



The absorption characteristics of RILSAN PA resins are similar when exposed to polar fluids such as alcohols, acids, and esters. Their

low moisture absorption leads to excellent dimensional stability (refer to SAE J844).

Dimensional stability of RILSAN PA 11 and Nylon 6 after 25 weeks immersion in water at 20°C

| | Length Variance | Weight Variance |
|--------------|-----------------|-----------------|
| RILSAN PA 11 | 0.2 - 0.5 % | 1.9 % |
| Nylon 6 | 2.2 - 2.7 % | 9.5 % |

Tensile Properties

RILSAN® polyamide resins show remarkable strength over a wide range of temperatures. They provide a combination of high yield properties and flexibility. The tensile stress at yield of the various grades is in the range of 32 – 48 MPa. Elongation at yield ranges from 5% to 40%. Their excellent creep resistance ensures fitting integrity under dynamic cyclic loading.

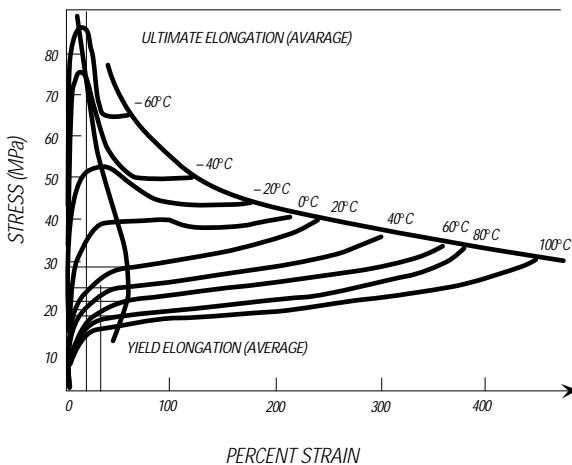
The tensile modulus of BESNO P40 TL at various temperatures is listed in the following table:

Tensile modulus of BESNO P40 TL vs. temperature

| | | | | |
|-----------------------|-----|-----|-----|-----|
| Temperature (°C) | 23 | 60 | 80 | 100 |
| Tensile Modulus (MPa) | 335 | 173 | 166 | 160 |

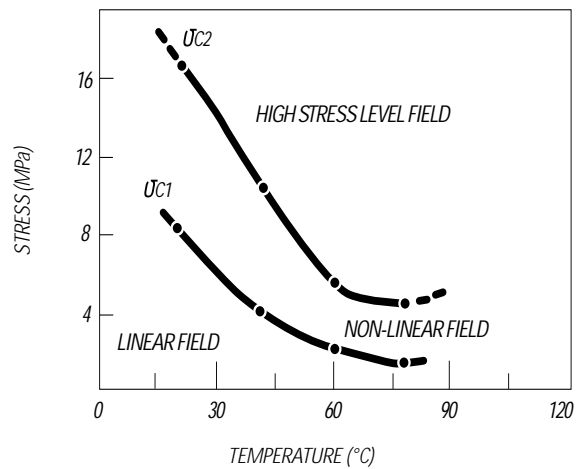
The influence of temperature on the tensile behavior of RILSAN PA resins is typical of thermoplastic behavior as demonstrated by the graph below.

RILSAN BESNO P40 TL stress/strain curve at various temperatures



The creep rate of RILSAN PA resins accelerates above 70°C. A stress/temperature criterion can be defined to properly design the application. A linear field ($<\dot{\sigma}_{C1}$) defines the combination of stress and temperature that can be applied on a part to ensure long term performance without any damage. Designing in the non-linear field ($>\dot{\sigma}_{C1}$ and $<\dot{\sigma}_{C2}$) is possible if the stress/temperature sequences are intermittent to allow long relaxation periods. Designing in the high stress level field ($>\dot{\sigma}_{C2}$) is not recommended.

Maximum stress in creep vs. temperature for BESNO TL



Flexural Properties

RILSAN® polyamide resins are available in a wide range of flexibilities. Their flexural modulus varies from 1200 MPa for an unplasticized grade down to approximately 170 MPa for a highly plasticized grade. Reinforced grades of RILSAN PA resins are available to increase flexural modulus performance.

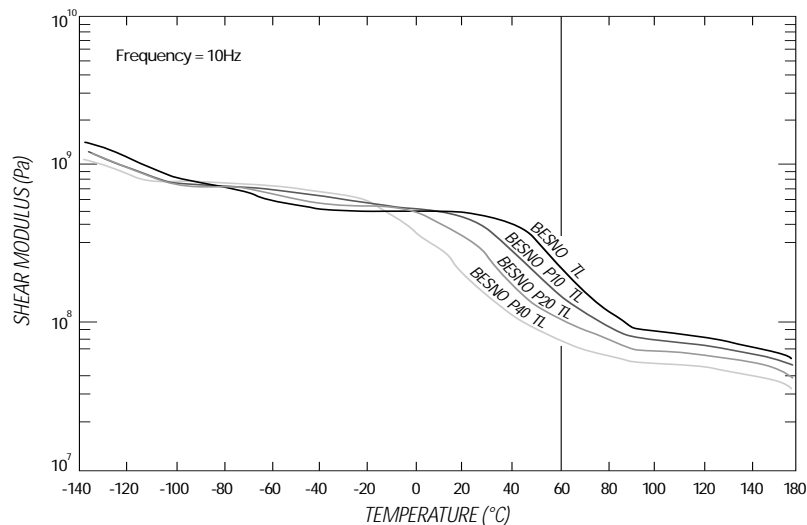
Many materials will show significant variation of

their properties when saturated with water. The following chart presents the decrease in flexural modulus for different polyamides when exposed to humid environments. The decrease in flexural modulus for RILSAN PA resins is minimal compared to other nylons. RILSAN PA resins are also capable of maintaining their mechanical properties in humid environments.

Influence of humidity on flexural modulus for RILSAN PA resins vs. nylons

| | Flexural Modulus of samples conditioned dry as molded at 23°C (MPa) | Flexural Modulus after conditioning at 50% RH and 23°C (MPa) | Percent drop in Flexural Modulus (%) |
|---------------------|---|--|--------------------------------------|
| RILSAN PA 11 | 1200 | 1100 | 8 |
| RILSAN PA 12 | 1100 | 1000 | 9 |
| Nylon 6 | 2200 | 1200 | 45 |
| Nylon 66 | 3000 | 1250 | 58 |

Shear modulus vs. temperature for various RILSAN PA 11 grades



Impact Strength Properties

RILSAN® PA resins display excellent impact resistance at ambient and low temperatures. All

unfilled RILSAN PA resin grades maintain their integrity when tested according to ASTM D256.

Impact strength (Izod, Unnotched) of RILSAN PA 11 vs. Nylon 6, Nylon 66, Acetal & PBT

| | Units | RILSAN PA 11 (Plasticized & unplasticized) | NYLON 6 | NYLON 66 | ACETAL | PBT |
|---------|-------|---|---------|----------|--------|-----|
| @ 23°C | (J/m) | NB | 75 | 50 | 57 | NB |
| @ -40°C | (J/m) | NB | 40 | 40 | 50 | 36 |

NB = No Break

Processing parameters can affect the low temperature impact performance of some materials. But, the

flexible RILSAN BESNO P40 TL exhibits high dart impact performance down to -60°C.

Dart impact performance of RILSAN BESNO P40 TL

| Temperature (°C) | -20°C | -30°C | -40°C | -50°C | -60°C |
|----------------------------------|-------|-------|-------|-------|-------|
| No. of failures per 20 specimens | 0 | 0 | 0 | 0 | 3 |

Specimen type: 90 mm O.D. pipe with a 7mm wall thickness
Dart impact energy: 200 J (11 lb. dart falling from 12 ft.)

Abrasion Properties

RILSAN PA resins have excellent abrasion properties when compared to other nylons, PBT, acetal and polycarbonate. RILSAN PA resins also exhibit

better wear resistance. The wear index, according to NFT 46-102, of selected materials relative to RILSAN PA resins is indicated in the following table.

Wear index of RILSAN PA resins vs. nylons, acetal, PBT & polycarbonate

| | RILSAN PA resins | Nylon 6 | Nylon 66 | PBT | Acetal | Polycarbonate |
|------------|------------------|---------|----------|-----|--------|---------------|
| wear index | 1 | 1.5x | 2.8x | 4x | 10x | 20x |

APPLICATIONS





Oil & Gas Offshore

The flexible pipe program started in 1958 when the Institut Francais du Petrole was involved in the material selection of a new concept of flexible pipe.

RILSAN PA 11 provides specific properties required for flexible pipe applications. After a 14 year research program, RILSAN PA 11 was selected from over one hundred various thermoplastics. The OTC paper 5231 “Improved Thermoplastic Materials for Offshore Flexible Pipes” clearly explains the performance of RILSAN PA 11.

RILSAN® PA 11 is used as the liner material in flexible pipe and provides these benefits:

- leak proof pipe
- corrosion and abrasion resistance
- continuous manufacturing of pipe
- Temperature and pressure resistance up to 100°C and 172 MPa

Since 1972, flexible pipe has been used in the following applications:

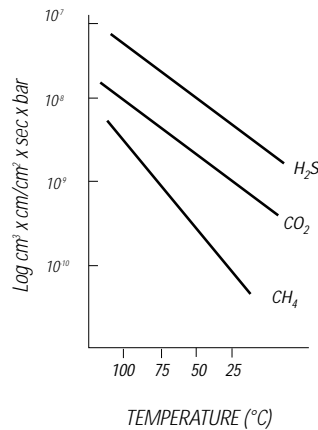
- Offshore oil & gas production and test lines
- Gas & water injection lines
- Gas lift lines
- Production risers
- Choke & kill lines
- Nitrogen lines
- Hydraulic lines

Permeation

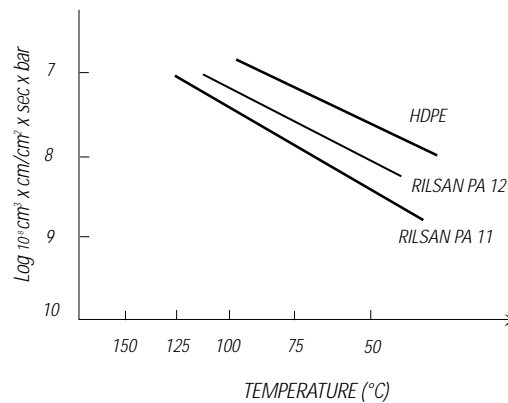
The permeation rate of RILSAN PA 11 to hydrogen sulfide, carbon dioxide and methane is between

150 to 500 times less than that of nitrile rubber, and polyolefin materials.

Permeability of RILSAN PA 11 to H₂S, CO₂, CH₄



Permeability of HDPE, RILSAN PA 11, RILSAN PA 12 to CH₄ (methane)



Aging Properties of RILSAN® PA 11 Liners in Crude Oil

The tensile properties, particularly the yield point evolution of RILSAN PA 11, were monitored at temperatures ranging from 120°C to 150°C. The yield point is extremely important in production risers where the RILSAN PA 11 liner is exposed to dynamic stress cycles created by sea motion. Test results conclude that RILSAN PA 11 will perform in dry crude oil applications for a period of 10 years at a continuous

temperature of 100°C. Obviously, the life will increase if the service temperature is lower and if the liner is not exposed to dynamic stress cycles.

A field test was performed in a sour gas environment (9.3 wt % of CO₂ and 15.3 wt % of H₂S) in Lacq, France. After 3 years at 50°C and a pressure of 90 bars, the RILSAN PA 11 properties remained outstanding.

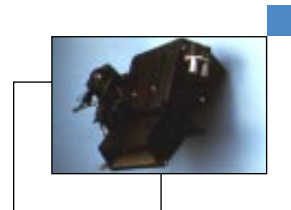
Blistering

It is common for thermoplastic piping materials to swell when exposed to oil at high temperature and pressure. If the pipe is exposed to sudden variations in pressure, the polymer liner will blister, tear or crack. Flexible pipe made from RILSAN PA 11 will not

blister, tear or crack under similar conditions. It displays superior resistance to blistering compared to other materials. The following table shows the blistering resistance of RILSAN PA 11 compared to other liner materials.

Blistering performance of polymers during pressurization and depressurization cycles in the presence of crude oil and methane at 100°C

| | 200 Hours | 1000 Hours | 2000 Hours | 4000 Hours | 10000 Hours |
|-----------------------|-----------|------------|------------|------------|-------------|
| RILSAN PA 11 | good | good | good | good | good |
| HDPE | good | good | fair | poor | poor |
| Neoprene | poor | poor | poor | poor | poor |
| Nitrile Rubber | good | fair | poor | poor | poor |



Offshore Umbilicals

RILSAN® PA 11 has been used for at least 15 years in umbilical applications. An umbilical is a group of hydraulic fluid lines and/or electrical cables reinforced with metal wires. RILSAN PA 11 was introduced successfully in 1970 as a liner material. However, the use of RILSAN PA 11 increased rapidly in the 1980's because of concerns due to new control fluids as well as new well service chemicals.

RILSAN PA 11 has superior corrosion resistance and stress aging capabilities. It has a proven service life in excess of 20 years for temperatures up to 40°C. Comparatively, thermoplastic polyesters exhibit problems of stress cracking and hydrolysis when exposed to lubricant and biocide additives in control

fluids. The more demanding fluids have led to specific grades of RILSAN PA 11 for this market. As a reference, the OTC paper 7272 describes the use of RILSAN PA 11 in umbilical systems.

RILSAN PA 11 meets SAE J517 (100 R7 & R8), the old reference standard, and the recently developed API 17 E standard that more specifically addresses subsea umbilical issues. Tests were conducted at the National Laboratory in Glasgow. Reinforced aramid braided hoses made of RILSAN PA 11 and thermoplastic polyester elastomer were submitted to repeated internal pressure cycles at 70°C and 40°C. Half-life time in tensile was characterized for each material.

Immersion test in hydraulic fluid: half-life properties of RILSAN PA 11 vs. polyester

| | RILSAN PA 11 | | POLYESTER | |
|----------------------------|--------------|-----------|-----------|-----------|
| | 70°C | 40°C | 70°C | 40°C |
| Black Smith UK 50® | 1 year | 25 months | 26 days | 25 months |
| Water/glycol | 1 year | 25 months | 45 days | 25 months |
| Edgar Vaughan Aqualink 40® | 120 days | 25 months | 22 days | 25 months |
| Marston Bentley HW 540® | 1 year | 25 months | 12 days | 300 days |

Natural Gas Distribution Piping System

RILSAN® PA 11 was chosen by Australia Gas Light (AGL) for pipelines which will lie buried for hundreds of years. Its extraordinary properties include excellent stress crack resistance to natural gas and its contaminants, low permeation to methane and hydrogen, high HDB rating at 20°C, 60°C and 80°C, superior impact resistance, squeeze off, and dependable UV performance for outside storage.

Stress Crack Resistance

RILSAN PA 11 displays excellent characteristics with natural gas, odorant additives and possible environments such as cements and hydrocarbons. An immersion test in a mix of benzene, toluene, xylene, kerosene, styrene, and phenol shows the following variation:

Immersion test

| | RILSAN PA 11 | MDPE |
|---------------------------|--------------|------|
| Weight Gain (%) | 7.2 | 7.5 |
| Length Variation (%) | 0.9 | 2.5 |
| Diameter Variation (%) | 0.5 | 2.4 |
| Hoop Stress Reduction (%) | 10.4 | 30.1 |

Slow Crack Growth (SCG)

All SCG tests up to 80°C for RILSAN PA 11 exhibit no slow crack growth phenomenon. Furthermore, AGL has not experienced any SCG field failures of RILSAN PA 11 after 24 years of service.



Low Permeation

The permeation rate of RILSAN PA 11 is 30 times less than that of HDPE for natural gas and 3 times lower for hydrogen.

Permeation rate at 23°C

| Permeation | RILSAN PA 11 | HDPE |
|------------|--------------|--------|
| Methane | 0.0022 | 0.7070 |
| Hydrogen | 0.0698 | 0.2400 |

rate in m³/bar/day

HDB Rating

Long term burst data has been generated using ASTM D2837 to characterize the Hydrostatic Design Basis (HDB) of RILSAN PA 11. The HDB values, as listed by the Plastic Pipe Institute (PPI) for RILSAN PA 11 compared to other plastic materials are shown below:

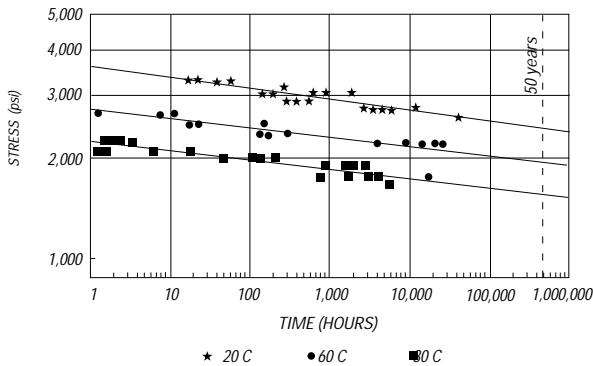
HDB values

| Temperature °C | RILSAN PA 11 | HDPE | MDPE | PVC |
|----------------|--------------|-------|-------|-------|
| 23 | 2,500 | 1,600 | 1,250 | 4,000 |
| 60 | 1,600 | 800 | 1,000 | NA |
| 80 | 1,250 | NA | NA | NA |

NA = Not Applicable

Due to the higher HDB rating of RILSAN® PA 11 versus HDPE at room temperatures and its rating at 80°C (no knee behavior), it is possible to design pipe lines operating at greater pressures and temperatures. For retrofit applications, the higher HDB rating of RILSAN PA 11 compared to other polymers enables the wall thickness of pipe for a given outside diameter to be reduced, thus allowing a greater volume of gas to flow. The graph below shows the results of a test done on pipe made from RILSAN PA 11 at various temperatures.

Long term hydrostatic strength of pipe made from RILSAN PA 11



Until recently, utilities have been forced to rely on metal pipe, even though many would prefer to use plastic pipe, to transport natural gas at high pressures.

Utilities have long desired a plastic pipe alternative for feeder lines that transport natural gas from major producers to their systems, but were forced to wait for the development of a material able to withstand the high pressures (150 to 250 psig) of the system. Pipe made from RILSAN PA 11 resin meets these requirements.

Pipe made from RILSAN PA 11 resin offers many of the features of polyethylene pipe that the gas industry is already familiar with.

These features include:

- Joining by butt fusion.
- Controlling flow by squeezing off the pipe.
- Available in long coils that can be plowed or planted.
- No need for cathodic protection.
- Outstanding resistance to stress cracking.

RILSAN PA 11 is also a material of choice for mechanical fittings and tapping tees. It has demonstrated excellent performance in high pH environments such as cements. During the set up of cements, the pH can reach high levels that can stress crack some materials.



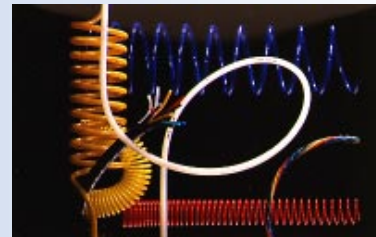
Hydraulic & Pneumatic Hoses

RILSAN® PA resins have been used for years in hydraulic and pneumatic fluid handling hoses. Two of the major concerns with nylons and polyesters are

moisture absorption and stress cracking. RILSAN PA 11 and 12 alleviate such concerns with their outstanding resistance to humidity and stress cracking.

Major benefits include:

- High degree of flexibility: RILSAN PA resins will meet low bending radius requirements without kinking and will maintain their flexibility at -40°C.
- High pressure rating compared to other polymers.
- Elastic memory which allows repeated flexing without fatigue or crack failures.
- High impact resistance at low temperature. Excellent crush and abrasion resistance.
- Excellent fitting/coupling retention due to its high creep resistance (no leak after 1 million pressure cycles).



- Excellent resistance to oil, lubricants and various aggressive fluids.
- Dimensional stability and good retention of properties in severe environments.
- Good UV resistance and aging resistance.
- Easy to extrude and meets tight tolerances.

The following chart provides the performance of two grades of RILSAN PA 11 in various sizes of hose

| OD MM | ID MM | t MM | Instant Burst Pressure (MPa) | | Operating Pressure (MPa) | | Min Bending Radius (mm) | |
|----------|----------|---------|------------------------------|----------|--------------------------|----------|-------------------------|----------|
| | | | BESNO P40 TL | BESNO TL | BESNO P40 TL | BESNO TL | BESNO P40 TL | BESNO TL |
| 4 | 2 | 1 | 13.3 | 28.0 | 3.3 | 7.0 | 16 | 25 |
| 8 | 6 | 1 | 5.7 | 12.0 | 1.4 | 3.0 | 65 | 102 |
| 16 | 12 | 2 | 5.7 | 12.0 | 1.4 | 3.0 | 200 | 312 |
| 16 | 14 | 1 | 2.7 | 5.6 | 0.7 | 1.4 | 250 | 390 |
| 40 | 34 | 3 | 3.2 | 6.8 | 0.8 | 1.7 | 480 | 720 |

OD = Outside Diameter, ID = Inside Diameter, t = Wall Thickness

$$\text{Operating Pressure} = \frac{\text{Burst Pressure}}{4}$$

A correction factor as a function of temperature determines the operating pressure at a given service temperature.

Temperature Correction Factor

| | | | | | |
|------------------|------|------|------|------|------|
| Temp (°C) | 20 | 40 | 60 | 80 | 100 |
| Factor | 1.00 | 0.70 | 0.52 | 0.42 | 0.31 |

RILSAN PA 11 meets the following standards for pneumatic and hydraulic hoses:

NFE 49.100, DIN 73378, ISO/DIS 7628, SAE J517 (100R7 & R8), and SAE J844.

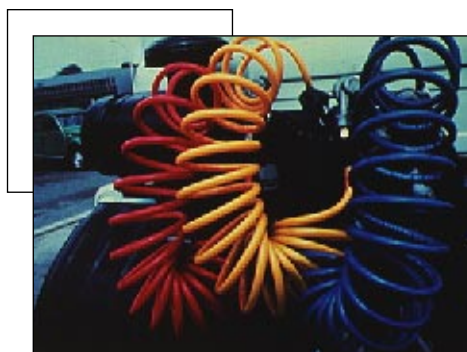
End use applications for RILSAN PA resins include: compressed air lines, grease lines, chemical dispenser hoses, refrigerant lines, hydraulic hoses, pneumatic hoses, air brakes for trucks and fuel lines for cars. Use of RILSAN PA resins for some applications complies with the Federal Food, Drug and Cosmetic Act. Contact your Elf Atochem Technical Representative for further information. RILSAN PA resins are also used for beverage tubing.

Comparative performance of RILSAN® PA 11 vs. other materials

| | Temp Range (°C) | OD (mm) | ID (mm) | t (mm) | Operating Pressure (MPa) at 23°C | Bend Radius (mm) |
|---------------------|-----------------|---------|---------|--------|----------------------------------|------------------|
| RILSAN PA 11 | - 40 to + 80 | 8 | 6 | 1 | 2.9 | 40 |
| Nylon 6 | - 10 to + 80 | 8 | 6 | 1 | 3.5 | 65 |
| HDPE | - 20 to + 60 | 8 | 6 | 1 | 1.4 | 40 |
| TPU | - 40 to + 60 | 8 | 6 | 1 | 1.2 | 40 |

Several grades of RILSAN PA resins with flexibilities ranging from 1,200 MPa to 170 MPa provide a wide choice of engineering solutions. Their impact strengths at low temperatures are extremely good.

In addition to these unique characteristics and applications, RILSAN PA 11 is one of the very few commercial technical polymers produced from a renewable resource, castor beans. The RILSAN PA 11 product line is an excellent example of Elf Atochem's dedication to the environment.



Anti-Termite Cable

Over twenty-five years ago, the Australian telecommunications industry office selected RILSAN® PA resins to be used for the sheathing of telephone cables to protect them from destruction by termites. RILSAN PA resins are ideally suited for this

application due to their chemical composition, smoothness and cut-through resistance. An added benefit is that RILSAN PA resins can be extruded very thin and very quickly.

Electrical properties of RILSAN PA 11 and PA 12

| | UNIT | ASTM TEST METHOD | AESNO TL | AESNO P40 TL | BESNO TL | BESNO P20 TL | BESNO P40 TL | BMNO TL |
|------------------------|----------------------------------|------------------|-----------|--------------------|-----------|--------------------|--------------------|-----------|
| Volume resistivity | $\Omega \cdot \text{cm}$ | D 257 | 10^{14} | 10^{11} | 10^{14} | 10^{12} | 10^{11} | 10^{14} |
| Surface resistivity | Ω/sq | D 257 | 10^{14} | 5×10^{11} | 10^{14} | 2×10^{12} | 5×10^{11} | 10^{14} |
| Dielectric strength | $\text{kV} \cdot \text{mm}^{-1}$ | D 149 | 30 | 24 | 30 | 26 | 23 | 30 |
| Resistance to tracking | V | KB method | >600 | >600 | >600 | >600 | >600 | >600 |
| | V | KC method | >600 | >600 | >600 | >600 | >600 | >600 |



Other Applications

The key properties of RILSAN® PA resins include excellent chemical resistance, impact resistance, abrasion resistance, thermal resistance and low moisture absorption. Due to their low moisture absorption, RILSAN PA resins have excellent dimensional stability and are able to maintain their physical and electrical properties over a wide range of temperatures and environments. Some specific applications in selected markets include:



Automotive

- Air brake hoses
- Fuel lines
- Air conditioning hoses
- Connectors
- Fasteners
- Battery housings
- Push/pull cable

Agriculture

- Rotomolded hydraulic tanks
- Chemical storage tanks
- Harvester tynes
- Irrigation systems

Electronics

- Optical fiber sheathing
- Submarine optical cables
- Cable ties
- Cable jacketing

Athletic

- Snowboards
- Shoe soles
- Racing yacht tackle
- Binding strips of tennis rackets (grommets)
- Skis
- Badminton shuttlecocks

Aviation

- Sheathing of electrical cables
- Hydraulic hoses
- Battery housings

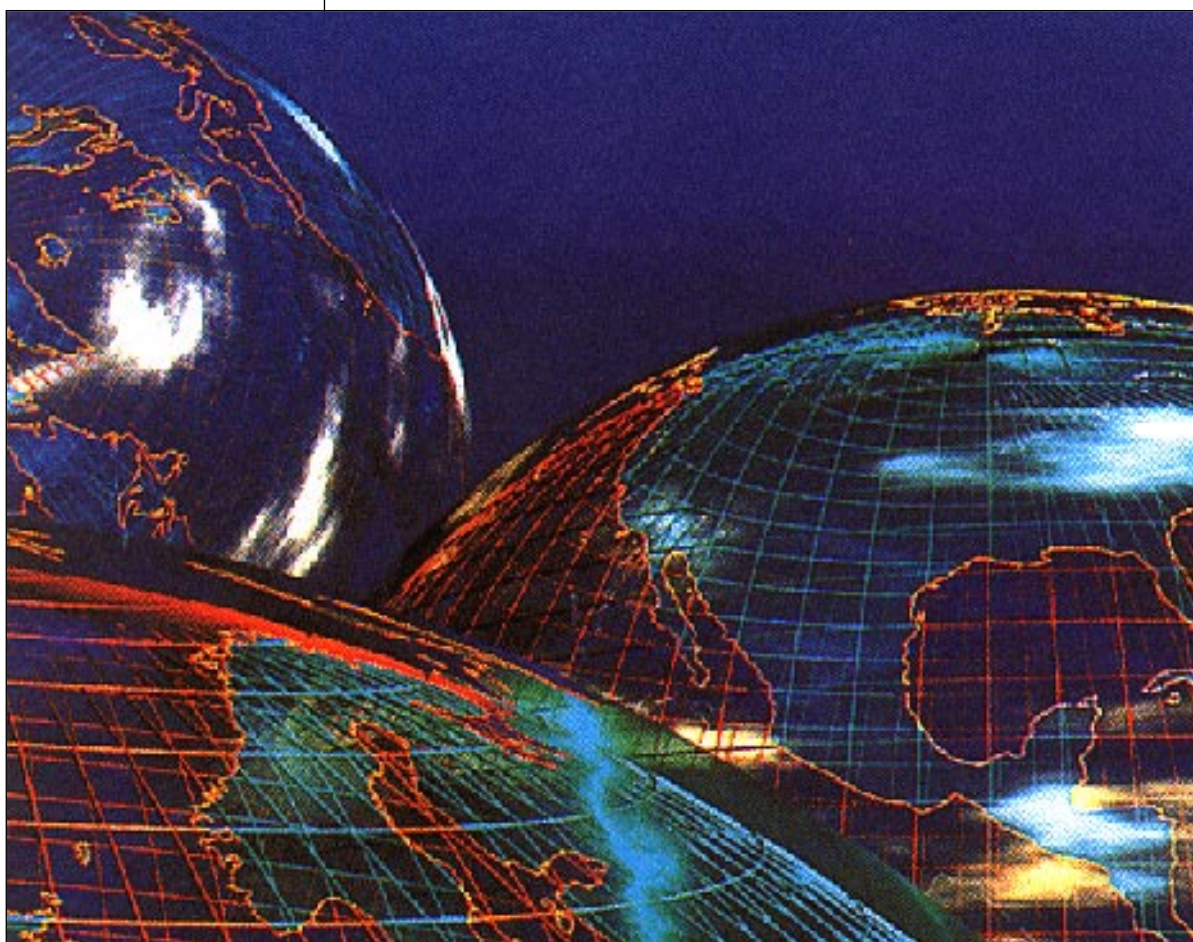
Food Industry

- Beverage tubing
- Corn starch separator

Powder Coatings

- Dishwasher baskets
- Furniture
- Shopping carts
- Paint additives
- File rods
- Mechanical parts

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