Introduction to Rilsan HT

ARKEMA

1

Rilsan® HT New class of flexible PPA

Flexible Thermoplastic Solution

Metal / Rubber Solution

220-200° C

110-120° C

250° C

Metal & Rubber

Complex solutions (i.e. reinforced rubber / KRM)

no solution

220-200° C

150° C

110-120° C

Metal / Rubber Solution

A Breakthrough in Metal Replacement

What makes Rilsan® HT so different?

Process flow of high performance PA

ARKEMA

Aminoundecanoic acid

Sebacic acid

Decanediamine

H₂N-(CH₂)₁₀COOH

H₂CO-(CH₂)₁₀COOH

H₂N(CH₂)₁₀CH₂NH₂

Castor plant

Castor seed

Castor oil

Petroleum base

45-100%

45-100%

Up to 70%

Up to 53%

Up to 95%

Up to 95%

Up to 50%

Up to 50%

Up to 95%

Up to 95%

Mid-chain PA PA612

Mid-chain PA PA610, 1010, 1012

Mid-chain PA PA11

Long chain PA PA11

High heat resistance PA

PA12

PEBA

C110-120

C250

C150

Castor oil

Mid&long chain PA

Flexible Thermoplastic Solution

Metal / Rubber Solution

Cooling:

PA11

HPPA, MLT solution

PA12 Special Grade

Air Intake

TEEE, PA6, PA6-Alloy, Rubber

Processability:

no solution

Rilsan® XB

Rilsan® HT

PEBAX

HIPROLON

Rilsan® XD

PA (Aliphatic PA

Solution

PA elastomer

PEBA

Rilsan® HT creates opportunities to replace metal in tubing that were previously unthinkable!

High Temperature Resistance.... PLUS:

- Flexibility
- Processability:
  - processing similar to aliphatic polyamides
  - no need for special heating & cooling system
  - excellent thermoforming and fitting insertion
- Long term heat resistance
  - (thermooxidation) and chemical resistance at high temperature
- Integrity of mechanical properties
  - at high temperature
- Spin-welding
- Low density
- Low moisture uptake
- Biobased

Rilsan® HT.....

- is the first flexible PPA to replace metal in tubing for high temperature applications
- can be easily manufactured on standard processing equipment
- offers cost-efficient manufacturing and system cost reduction
- features high design flexibility
- surpasses other high-temperature thermoplastics with superior long-term resistance to thermo-oxidative and chemical aging at high temperatures
- is the only PPA being spin-weldable on aliphatic PA
- is a light-weight PPA resin
- offers exceptional dimensional stability
- naturally fits into eco-design concepts

Rilsan® HT - The First Flexible PPA Confidential Arkema Property - Duplication prohibited
Rilsan® HT – The First Flexible PPA

**Rilsan® PA11**

- **Classical PPA resins**
  - **Limitations**
    - Temperature resistance up to 150° C
  - **Limitations**
    - Only available as injection grades due to intrinsic brittleness / stiffness of material
    - Poorer Long-Term Aging Resistance
    - Difficult overall processing

**Key Points:**
- Flexibility
- Excellent Long-Term Aging
- Resistance
- Ease of processing
- Bio-based

**Rilsan® HT – The optimum synergy of both**

**Rilsan® HT – Unprecedented Flexibility**

- Flexural modulus of Rilsan® HT compared to classic HT polymers – a breakthrough amongst HT materials

<table>
<thead>
<tr>
<th>Melting point (°C)</th>
<th>Rigid</th>
<th>Flexible</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA 6</td>
<td></td>
<td>Rilsan® HT</td>
</tr>
<tr>
<td>66/6T</td>
<td></td>
<td>Rilsan® HT extrusion grades</td>
</tr>
</tbody>
</table>

**Rilsan® HT:** is the only PPA to combine the high-temperature resistance of conventional PPA grades with flexibility

**Weight reduction by Rilsan® HT**

- Weight savings, through Metal replacement and substitution of rubber & other polymeric materials
  - **Environmental**
    - Low density

**Density of Rilsan® HT compared to metal, rubber and other polymeric materials**

**Rilsan® HT:***
- lowers total system weight by min. 50% (factor 2 to 3 vs Al, 6 to 8 vs steel)
- is a light-weight PPA resin
- helps to reduce emissions and fuel consumption

**System Cost reduction by Rilsan® HT**

- **Economical**

**Component / system cost**

- Assembly
- Processing (Extrusion, Thermoforming)
- Material

**Rilsan® HT:*** generates up to 50% cost savings vs. metal tubing assemblies

- EGR vacuum tubing @ PSA
- Blow-by @ VW
- TOC @ Hyundai
Rilsan® HT product line up

**Extrusion grade**
- Rilsan® HT CESV P010TL
- Rilsan® HT CESV Bk P010TL HP
- Rilsan® HT CESV Bk P223TL
- Rilsan® HT CESV P123TL

**Injection grade**
- Rilsan® HT CMNO TL
- Rilsan® HT CMNO TL
- Rilsan® HT CMFO
- Rilsan® HT CZM30 Bk TLD
- Rilsan® HT CSR13

**feature (flexural modulus)**
- Standard (820MPa)
- High pressure (1530MPa)
- Flexible (520MPa)
- Improved hydrolysis (820MPa)
- Standard, non-filled (1800MPa)
- Standard, non-filled (1370MPa)
- High flowability, non-filled (1800MPa)
- GF30% (7300MPa)
- Conductive (7600MPa)

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Rilsan® HT – ...
... already been selected by many OEM

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Rilsan® HT – with best fit ....
... to Euro 6 & key powertrain technologies

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Rilsan® HT Tubing
Case: Aggressive M. / Blow By

**Grade:**
- Rilsan® HT CESV P010TL

**Case study:**
- Powertrain - Aggressive Media Management
- Blow By Line

**Replaced:**
- Aluminium tubing / HPFA with heat shield

**Status:**
- Approved and in series prod. since Q3 2010
  at VW (PV 3936) / AUDI / SEAT / Porsche / Bentley / Daimler, Mahindra, Ferrari / Maserati
  / Alfa Romeo, Chrysler

**Models:**
- Volkswagen: all diesel engines (having a diesel particle filter, due to new Euro 5/6 regulation),
  models/platforms starting with 2.0l & 1.6l engines, eg. Golf, Passat, Tiguan, A3, Skoda, ...
- all new 12 cyl. gasoline engines (e.g. A8, Phaeton, Bentley)
- Fiat group: eg. for new V6 engines of Ferrari & Chrysler for Maserati, Alfa Romeo, Chrysler

**Example:**
- Rilsan® HT CESV P010TL
  - Blow By tubing
  - 2 temp. classes: 
    - 160° C
    - 180° C
Rilsan® HT Tubing  
**Case: Air Mngt. / Air Intake**

- **Grades:**
  - Rilsan® HT CESV P010TL
  - Rilsan® HT CESVO P223TL ("ultra-flexible")

- **Case study:**
  - Powertrain – Air / Pressure Management
  - Air intake

- **Replaced:**
  - Metal, Rubber

- **Status:**
  - Under development

- **Example:**

Rilsan® HT Tubing  
**Case: Oil Mngt. / TOC**

- **Grades:**
  - Rilsan® HT CESV P010-HP TL (tubing)
  - Rilsan® HT GF reinforced (QC)

- **Case study:**
  - Powertrain - Oil Mngt. / Transport
  - TOC (Transmission Oil Cooling)

- **Replaced:**
  - Metal, Rubber Tubing

- **Status:**
  - Approved at BMW, Greatwall

- **Models:**
  - will be in series for new platforms

- **Example:**

Rilsan® HT Tubing  
**Case: Cooling**

- **Grades:**
  - Rilsan® HT CESV P010 TL (medium temp.)
  - Rilsan® HT CESV black P123 TL (high temp.)

- **Case study:**
  - Powertrain - Aqueous Media Mngt.
  - Cooling lines

- **Replaced:**
  - Aluminium tubing / Rubber

- **Status:**
  - Current grade: CESV P010 TL
  - New grade: CESV black P123 TL

  - Under evaluations

  - (technical feedback from customer to pass VW specification)

Rilsan® HT Tubing  
**Case: Industrial Tubing**

- **Grades:**
  - Rilsan® HT CESVO P223 TL – "ultra-flexible" Rilsan® HT Grade

- **Case study:**
  - Industrial Applications – Air / Vacuum Management
    - e.g. High Temperature Pneumatic Tubing

- **Replaced:**
  - Metal, ETFE, PTFE

- **Status:**
  - Under evaluation at customer / OEM

- **Example:**

Temperature class: > 150° C

Key Benefits:
- Flexibility (520MPa)!
- "ultra-flexible" Rilsan® HT Grade