Nylon 66: Performance and Sustainability

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NYLON 66: PERFORMANCE AND SUSTAINABILITY

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Topics

- RadiciGroup today
- Nylon 66 market Updates
- Nylon 66 performance for sustainability
- The Recycling issue
- Summary & Conclusions
Range of products: chemicals, engineering plastics, textiles & fibers, clothing fabrics, textile machinery, energy, hotel and real estate...

Production Sites & Branch Offices: more than 50 worldwide

OUR 2009 NUMBERS

<table>
<thead>
<tr>
<th>Sector</th>
<th>2009 Sales (US$ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base industry</td>
<td>34</td>
</tr>
<tr>
<td>Synthetic fibers</td>
<td>174</td>
</tr>
<tr>
<td>Other</td>
<td>290</td>
</tr>
</tbody>
</table>

SALES (US$ millions) of Base Industry: 34
PRODUCTION UNITS

PA 66
ADIPIC ACID
NITRIC ACID
SALT 66
HEXAMETHYLENEDIAMINE

Radici Chimica SpA
Novara - IT

ADIPIC ACID
NITRIC ACID
CYCLOHEXANOL
CYCLOHEXANONE

Radici Chimica Deutschland GMBH
Zeitz – DE
Started operation in 2001: most recent plant in Europe
Best environmental technologies applied

Radici Fil
Casnigo - IT

Radici Yarn
Villa d’Ogna - IT

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NYLON66 TRENDS IN 2010

In 2010 strong growth in overall nylon demand in most end uses and regions driven by widespread improvement in business and manufacturing activities

- Nylon 66 demand increased strongly in both engineering plastics and fibres. Support to demand also from some restocking.
- One important driver of nylon 66 demand has been the surge in light vehicles production, which, according to Pwc, should reach 21% in 2010 and so regain 2007 production levels.
- Strongest growth in automotive is taking place in Asia, where China is expected to double its production in 2010 relative to 2008.
- Nylon 66 demand in 2010 has increased in all regions, Asia is increasing market share
- China is expected to increase production by over 30% and consumption by more than 50%
- Growth in PA66 in part of 2010 was constrained by shortages in PA66 intermediates.
- This was a result of intermediates capacity cuts in Europe and US and problems with supply of specific raw materials (butadiene).

GLOBAL PA66 DEMAND END USES

- **Engineering plastics**: Strong growth in demand driven by increase in automotive, improvement in electrical /electronics and other industrial applications. Some loss of market to PA6 and other materials due to short supply and high cost;
- **Significant increase in fibre applications**:
  - buoyant demand in high tenacity yarn driven by automotive for airbags and tyres
  - Good demand for nylon 66 textile filament
  - Carpet still slow due to slow building industry and competition of Polyester in North America, the biggest world market.
NYLON 66 – A MATERIAL FOR PERFORMANCE

Nylon 66 is used for its clear technical advantages

- Excellent tensile strength
- High melting point
- Good elastic module

AND A COMBINATION OF ALL THE THREE FEATURES

This translates into technically demanding applications for:
- Fibres
- Plastics
NYLON 66 IN FIBRES

Nylon 66 in fibres:

- **Industrial yarn**: Strength - impact resistance – load extension: tyres (cap-ply, high performance), airbags.

- **Nylon textile filament**: strength, stretch, comfort, softness/ touch, lightweight, spandex compatibility, cotton compatibility.

- **Nylon 66 highest share in hosiery** wide use in intimate apparel (Moulding), circular knit due to higher melting point (220°C PA6; 265°C PA66) - Better UV resistance - Lower shrinkage.

- **Carpets**: Abrasion resistance, pile recovery.

NYLON 66 IN PLASTICS

Nylon 66 is a versatile, cost effective engineering plastic with:

- Good mechanical properties, good chemicals resistance, high fatigue resistance also under load, excellent wear, abrasion and friction behaviour, electrical insulation properties. Good flow, easy to process, freedom of design, weight reduction compared to metal.

- Specially fit for demanding high temperature applications high temperature resistance, dimensional stability at high temperatures.

- Higher share in automotive under-the-hood and powertrain applications and part of E&E applications.

- Nylon 66 fits well in the main automotive trends: reduction of weight (metal substitution) and emissions (engine downsizing)
When you talk about sustainability you certainly need to address the issue of energy requirement and emissions in the air...

And Life Cycle Assessment (LCA) is a widely used instrument...

...You also need to understand the energy requirement of a material in relation to its required performance...

... Hence you need to compare the Gross Energy Requirement (GER) of a material with its specific technical features.

### Nylon 66: Sustainability and Performance

Nylon 66 polymer performs well in terms of:

- **Elastic module**: Nylon 66 Gross Energy Requirement in relationship with average Young Module is low
  - But other polymers have a similar or better performance

- **Average Melting temperature**: Nylon 66 Gross Energy Requirement in relationship to average melting temperature is good but
  - But other polymers have a better performance
Nylon 66 polymer has an excellent performance for average tensile strength:
the Gross Energy Requirement (GER) compared to the specific tensile strength is the lowest of competitive polymers examined.

NYLON 66: SUSTAINABILITY AND PERFORMANCE-GER/AVERAGE TENSILE STRENGTH

Sustainability means controlling the whole production chain… From chemicals to textile fibres each aspect of our production chain is addressed with regard to process optimization and environmental protection…
NYLON 66 CHAIN AND RECYCLING DOWN THE VALUE CHAIN

CONCLUSIONS

- Nylon 66 market opportunities
  - In plastics: nylon 66 growth driven by automotive global and regional patterns of production/consumption and by lightweight/ sustainability trends
  - In fibres: functional approach.

- Nylon 66 Sustainability: Based on Performances

- Recycling Down the Value Chain: a Sustainable Approach to Sustainability
THANK YOU!

www.radicigroup.com