Polyamide 6&66: Performance and Sustainability Opportunities

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POLYAMIDE 6 & 66
Performance & Sustainability Opportunities

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9th China International Polyamide & Intermediates Forum
Shangai, 1-2 December 2011

Topics

- RadiciGroup’s Profile
- Global Polyamide Overview
- Polyamide Performance
- Sustainability & Performance
- Issues and Opportunities
- Conclusions
**RADICIGROUP: Our Vision & Mission**

**VISION, MISSION AND VALUES**

1. **Service**
   - To provide a high quality and comprehensive group of innovative and premium products that are integrated to provide better service.

2. **Service**
   - To improve the development of the company that is innovative and enhances value creation.

**VALUES**

1. **People are at the center of our business.**
   - We value our employees in order to achieve the highest of productivity and efficiency.

2. **Efficiency and effectiveness of our management system to support our values.**
   - We practice and maintain the management system to support our values.

3. **Responsibility and transparency of our management system to accomplish our objectives.**
   - We practice and maintain the management system to accomplish our objectives.

**RADICIGROUP: Our Numbers in 2010**

- **Consolidated Sales**
  - Euros: €1,165

- **Personnel**
  - 3,500

- **Consolidated Sales (Millions of Euros)**
  - Chemicals, Plastics, Synthetic Fibers, Textiles
  - 533

- **2010**
  - Personnel: 3,500
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Nylon 6 & 66 Global Demand Overview

<table>
<thead>
<tr>
<th>Type</th>
<th>2010-2000</th>
<th>2015-2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA6 FIBRES</td>
<td>-3.2%</td>
<td>2.5%</td>
</tr>
<tr>
<td>PA6 PLASTICS</td>
<td>3.1%</td>
<td>5.1%</td>
</tr>
<tr>
<td>PA6 FIBRES</td>
<td>0.1%</td>
<td>1.9%</td>
</tr>
<tr>
<td>PA6 PLASTICS</td>
<td>4.8%</td>
<td>5.3%</td>
</tr>
<tr>
<td>PA FIBRES</td>
<td>-1.1%</td>
<td>2.1%</td>
</tr>
<tr>
<td>PA PLASTICS</td>
<td>4.1%</td>
<td>5.2%</td>
</tr>
</tbody>
</table>

Source: PCI

Annual Metric Tonne

- 2015: 2,354 1,381 2,770 1,274 7,772
- 2010: 1,818 1,079 2,527 1,125 6,548
- 2009: 1,504 872 2,317 948 5,641
- 2008: 1,619 1,043 2,235 1,188 5,086

Source: PCI
PA Fibres: Demand Trends

<table>
<thead>
<tr>
<th>Source</th>
<th>2000/10</th>
<th>2010/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI</td>
<td>-0.7%</td>
<td>2.9%</td>
</tr>
<tr>
<td>PA Textile Filament</td>
<td>-3.0%</td>
<td>1.9%</td>
</tr>
<tr>
<td>PA Staple Fibre</td>
<td>-11.2%</td>
<td>-7.8%</td>
</tr>
<tr>
<td>PA Industrial Filament</td>
<td>3.1%</td>
<td>2.1%</td>
</tr>
<tr>
<td>TOTAL PA FIBRES</td>
<td>-1.1%</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

Polyamide 6&6 Fibres by Region

Polyamide Fibre Demand

Thousands of Metric Tonnes

Source: RadiciGroup on PCI
PA 6&66 in Plastics by Region

Polyamide Demand in Plastics Incl. Film

Thousands of Metric Tonnes

Source: RadiciGroup on PCI

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An Example: PA6 & PA66 in APPAREL

PA66: highest share in HOSIERY (Intimate Apparel)
PA6: highest share in WARP KNIT (Weaving/Circular Knit)

Market Complexity
- differences in PA6/66 share between areas due to:
  - end use
  - history
  - competition strength

PA 6&66 Performance in Fibres

Applications requiring:
- Technical advantages
- Comfort, Functional, Aesthetic benefits

In every application:
- Complexity
- Cost – Expensive

Industrial Yarn
Carpet
Textile Filament

PA 6&66 in Fibres
Issues & Opportunities

Critical Issues
- Raw Material: High Price
- CARPET: Worldwide Trend

Opportunities
- Competition with Polyester in commodity end uses
- More Hard Flooring
- Industrial Yarn: growth in Tyres, Airbags
- Textile Filament: Trend Toward Functional Fabrics

Freshness: Thermal Regulation
Warm Retention
Comfort: Lightweight, stretch, Easy dye
Strength
Durability

Functional Approach to New Product/Application Development
**PA 6&66 Performance in Plastics**

**A versatile and Cost – Effective Engineering Plastic**

Applications Required:
- Versatility
- Cost-effective

**Examples:**

**PA6 in FILM:** Excellent combination of mechanical, optical and barrier properties

**PA6 in Engineering Plastics:** good mechanical performance, resistance to vibration, Surface Appearance, lower production costs

**PA66 in Demanding High Temperature Applications:**
Higher temperature resistance and dimensional stability due to higher melting point

**PA6 & 66 in Plastics Issues and Opportunities**

**CRITICAL ISSUES**

- Competition by different polymers (mainly for PA6)
- PP e PBT mainly for pricing

**Growth in Automotive:** Lightweighting
Metal Substitution in North America and emerging countries
New Applications development

**Emerging Economies (Asian):** to foster PA growth in
- Electrical, Electronic and Industrial Applications

Opportunity to GAIN MARKET SHARE from more specialist polymers
Through performance improvement

**Recycling:** the recyclate plastics maintains
good mechanical performance, good “mouldability”
Recycled content could be up to 100%
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PA 6&66 Performance and Sustainability

Sustainability Parameters vs. Performance

Global Energy Requirement (GER) and Mechanical Properties

Polyamide shows the Best Performance

Source:
- PA6 and PA66: Radici Group
- Others Polymer: Plastics Europe
PA 6&66 Performance and Sustainability

Sustainability Parameters vs. Performance

Global Warming Potential (GWP) Mechanical Properties

Global Energy Requirement (GER) and Elastic/Tenacity Properties

Polyamide shows good Performance

Source: PA6 and PA66: Radici Group Others Polymer: Plastic Europe
PA 6&66 Performance and Sustainability

Sustainability Parameters vs. Performance

Global Warming Potential (GWP) and Elastic/Tenacity Properties

Some Criticality for PA

Source: PA6 and PA66: Radici Group
Others Polymer: Plastic Europe

PA 6 & 66 Performance and Sustainability

Continuing efforts to reduce environmental impact

Source: Radici Group
**Issues and Opportunities**

- Continued growth of Demand in Plastics.
- Trend to lightweighting and engine downsizing
- Strong growth in Asia and emerging countries
- New applications development to support trend

**Fibres opportunities**
- Strong growth in technical yarns
- Positive trend of demand in nylon core end uses of Textile filament
  in both Western developed and emerging countries

**Raw material pricing:** an issue in commodity fibre business
(competition with polyester) and specific plastics applications
(competition of PP)

**Sustainability**
- Environmental performance in relation to functionality deployed
- Recycling into the plastics business
Conclusions

Sustainability in PA6 & 66:
- Need to clarify industry stance and efforts
- Opportunities based on combination of PA6 & 66 technical features versus environmental performance

TO CATCH THESE OPPORTUNITIES

Higher degree of cooperation along the global polyamide chain from chemical & polymer producers, to compounders/moulders to spinners-textile/apparel customers

IS NEEDED
to enhance technology/product innovation and application development to support the new challenges

Thank You!

www.radicigroup.com