High Performance Spin Finishes for Polyolefines

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Spin Finishes are process aids serving spinning- and related downstream processes

Main Tasks

- Adjustment of Fibre/Metal-Friction (process control)
- Adjustment of Fibre/Fibre-Friction (cohesion)
- Protection against static charging
Importance of F/M-Friction in Filament Production

**Main Tasks of Spin Finish**

**F/M too high:**

“Sawing” of the thread on godets and thread guides

- **Filament breakage**

**F/M too low:**

Slipping during stretching

- **Deficient Cristallinity**
  - **Deficient Filament strength**

- **Process adapted friction needed**!
Responsibility in Downstream Processing (PP-BCF)

Main Tasks of Spin Finishes

Requests While Spinning:
- achieving requested fibre characteristics (crimp, elongation...)
- no smoke, smell, irritation while production
- easy start up and low rate of filament breaks
- no build up of static load while high speed spinning
- no corrosion or wasting of machinery parts ...

Requests while Downstream Processing:
- suited thermostability for different heat set technologies
- no pigment solving
- supporting twisting-, weaving-, tufting, needling processes
- lattice compatibility for back-coating
- matching customer handle (crunchy- vs. soft-carpet) ...

Multitude of spinning and converting technologies in fibre production requests a multitude of process adapted spin finishes
Spin Finishes for Filaments & Tapes from Polyolefine

Product Range

Filament

BCF

Duron OF 3260
Duron SFP
Duron SFP soft
Duron OF 2199 T

CF

flat

Duron OF 3260
Duron OF 3174
Duron TX 2080

textured

Duron OF 1851
Duron OF 4013

Tape

Duron OF 3260
Duron OF 4070
Duron C 78

Lubricants*)

Duron TX 2127
Duron TX 2083

*) applied while downstream processing
Polypropylene Staple Fibre

Product Range

- short cut
  - Duron OS 3151
  - OE *)
    - Duron OS 4022
    - Duron K 3168
  - Ring*)
    - Duron OS 4022
    - Duron OS 3034

- staple
  - yarn
  - nonwoven
    - needled
      - Duron OF 1510
      - Duron OS 4022
      - Duron OS 3176
      - Duron OS 4009
      - Duron OS 3034
    - thermobonded
      - Duron OF 3850 (non permanent)
      - Duron OS 1547 (permanent)
      - Duron OS 1547 AV ***) (permanent)
      - Duron OS 4012 (permanent)
      - Duron OS 4012 AO **) (permanent)
    - hydroentgl.
      - Duron OS 3180
      - Duron K 3168
    - hydrophilic
      - Duron OF 3850 (non permanent)
      - Duron OS 1547 (permanent)
      - Duron OS 1547 AV ***) (permanent)
      - Duron OS 4012 (permanent)
      - Duron OS 4012 AO **) (permanent)
    - hydrophobic
      - Duron OS 3076
      - Duron OS 2160
      - Duron OS 2160 AV
      - Duron OS 3136 / Avistat 3 P

*) cotton and wool type
**) AO = Avocado Oil
***) AV = Aloe Vera
Methodology

Friction-, Rotorring- & Rubbingtester for detem. of F/M-, F/F-friction & tribothermal protection

Liquid strike through, wet back for hygienics

Various methods for determination of antistatic properties

High speed video camera to determine spreading properties
Selection of additional test to determine:
- gasfading of PP
- yellowing
- resilience
- scouring out properties
- godet wasting
- product & emulsion stability
- foam build up
- viscosity
- pH
dissolving pigment tendency ...

TGA, DSC, & Smoke point detector to determine thermostability of spin finishes

Lab Card and Zwick Equipment for proper process control in staple fibre processing (fibre waste and tow strength)
Methodology

- development of spin finishes is based on physicochemical measurements
- costs for test equipment sum’s up to > 500 T€ (everybody can buy, but ...)
- only experienced spin finish suppliers are able to correlate the test results with the phenomenon observed in practice
- CHT has an experience of more than 100 years in yarn lubrication processes
Measuring Principle

Test Method:
- Apply spin finish on filament
- Cross filaments around each other
- Expose filaments to rubbing stress under load

Amount of cycles until yarn breaks indicates fibre protection by spin finish
## Results from Practice

### Rubbing Tester and Fibre Protection

<table>
<thead>
<tr>
<th>Product</th>
<th>Rubbing Cycles</th>
<th>opu needed</th>
<th>Dust formation while production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin Finish 1</td>
<td>283</td>
<td>1,05</td>
<td>Benchmark</td>
</tr>
<tr>
<td>Spin Finish 2</td>
<td>390</td>
<td>1,00</td>
<td>-12%</td>
</tr>
<tr>
<td>Spin Finish 3</td>
<td>3075</td>
<td>0,85</td>
<td>-33%</td>
</tr>
<tr>
<td>Spin Finish 4</td>
<td>5000</td>
<td>0,65</td>
<td>-39%</td>
</tr>
</tbody>
</table>

**Confirmation of Lab-Results:**

As higher the rubbing cycles as higher the fibre protection!
Cost / Performance of Spin Finishes

- use of high performance spin finishes allows production of better valued - high quality yarns (low dust formation)

- high performance spin finishes needs less opu on fibre than low quality spin finishes (saving of ~ 40%)

- therefore cost of a spin finish has not to be determined by calculating costs for 1 kg of spin finish but calculating the costs of spin finish needed for 1 kg of filament produced!

- in any case the spin finish contributes less than 1% to total costs of fibre or filament production
Determination of F/F friction

Correlation of Friction Measurement and Softness
Softness of PP BCF Carpet Yarns
- Approach to measure -

**Factors influencing softness**

- **Amplitude** = $F_{2_{\text{max}}} - F_{2_{\text{min}}}$
  - high = scroopy

- $N = \text{Number of Peaks} / 900 \text{ s}$
  - high = soft
PP-BCF Spin Finishes
Adjustement of Handle

- Duron OF 3260
  scroopy

- Duron SFP
  medium soft

- Duron SFP soft
  soft

- Duron OF 2199 T
  soft and **dry** touch
Possible Reasons for Stickiness of Carpets

- Additives within the spin finish
- Migration of polymer additives (e.g. calcium stearate) to the fibre surface while heat set processes
- Type of backcoating polymer
- Quality of jute yarns used in weaving construction
Mineral Oil on Jute / BCF yarn

Gaschromatography and Stickiness

<table>
<thead>
<tr>
<th>Specimen</th>
<th>105 °C over night [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jute yarn</td>
<td>4,6</td>
</tr>
<tr>
<td>Jute yarn</td>
<td>4,0</td>
</tr>
<tr>
<td>PP-BCF yarn after extrusion</td>
<td>0</td>
</tr>
<tr>
<td>PP-BCF yarn shaved from carpet</td>
<td>1,0</td>
</tr>
</tbody>
</table>

Observation/Interpretation:
- high content of mineral oil on jute yarn detected (~4%)
- no weight loss observed for PP-BCF heat set yarns by this method
- but markedly weight loss observed for PP-BCF yarn shaved from carpet

Strong hince of migration of mineral oil from jute to pile yarn
Gaschromatographic Investigation

Gaschromatography and Stickiness

Gaschromatographic Investigation

Mineral Oil

Jute 1

Jute 2

BCF yarn before carpet processing

BCF yarn shaved from carpet

mineral oil peaks

migration of mineral oil into pile confirmed by gaschromatographic investigation!
Effects of Mineral Oil on PP

PP foil treated with Duron Spin Finish remains unaffected

PP foil with mineral oil starts to form “bubbles” and loose its shape

Mineral oil starts to solve polypropylene and supports the migration of polymer additives onto the fibre surface

Stickiness and lack in fibre strength!
Conclusion

- Spin finishes are no commodities but high sophisticated process aids serving spinning and downstream processes.

- Development of high performance spin finishes is based on physicochemical measurements and the experience of its correlation to the phenomenon observed in practice.

- CHT is a well equipped and experienced supplier of high performance spin finishes:
  - Saving money by low opu and dust formation (rubbing test)
  - Fine tuning of yarn handle (F/F friction measurement)
  - Analysis of influence of mineral oils on stickiness of carpets (gaschromatography / raster electronic microscopy)

- Not the cheapest spin finish is the best valued spin finish.