13th China International Recycled Polyester Conference & Exhibition

Supporters: Recycled Fiber Commission of China Chemical Fibers Association

China National Chemical Fiber Corp.

Organizers: China Chemical & Fiber Economic Information Network (CCFEI)

Dr. Thiele Polyester Technology

Sponsor: ZheJiang Yufeng Machinery Co., Ltd

Main Sponsor: Yangzhou Zhicheng Chemical Industry Technique Co., Ltd.

PET Flakes/Popcorn material

Chemical Regeneration Unit

» Based on years of experiences

» Focusing on polyester recycling

» Exploring for new applications

Yangzhou Zhicheng Chemical Industry Technique Co., Ltd.

Every year, millions of tons of waste polyester use ZC’s technology to manufacture various types of regenerated polyester products. ZC’s achievements have been around the world.
CCFEI International Conferences in 2018

CCFEI International Conferences Bring China Market to you.

**15th China International Polyester & Intermediates Forum**
Themes covering: PX-PTA, MEG, FGPET, BGPET, Polyester filament yarn, Polyester staple fiber, etc.
Target Audience: suppliers, users, traders and distributors of paraxylene, PTA, MEG and polyesters including FGPET, BGPET, PFY and PSF, etc.

**14th China International Recycled Polyester Conference & Exhibition**
Themes covering: Bottle flake, recycled fibers, bottle-to-bottle, new technologies for PET recycling, etc.
Target Audience: producers of bottle flakes, recycled fibers, film and plastics, etc.

**16th China International Polyamide & Intermediates Forum**
Themes covering: Benzene, cyclohexanone, CPL, adipic acid, polyamide 6/66, nylon filament, cord fabric, engineering plastics, film, etc.
Target Audience: suppliers, users and traders of caprolactam, cyclohexanone, adipic acid, nylon 6/66 polymers & fibers, and producers of nylon plastics & film, etc.

Contact: Tracy Liu
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Tel: +86-21-31276337
Website: www.ccfei.net
Notice for Conference Participants

Dear Delegate,

We extend a warm welcome to your participation. I hope you acquire your desired information in this conference and through the communication with other participants, which will be helpful to your business.

Please kindly notice the following items:

1. Conference venue: **Da Hua Pavilion, 1F in Holiday Inn Shanghai Hongqiao, China.**
2. Registration time: 14:30 -21:00, **6 Sep.**
3. Conference time: **7 Sep** (the whole day, beginning at 9:00 A.M. and 2:00 P.M.), **8 Sep** (a half day, beginning at 9:00 A.M.). Please arrive 10 minutes earlier.
4. Please wear your delegate card during the whole conference. Please be informed that you won’t be allowed to attend the conference without the card.
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6. Both Chinese and English are used during the conference and simultaneous interpretation is available. Kindly use voice acceptors and earphones on the meeting table, but please don’t take them out.
7. The presentations are provided by speakers. The points of view from the printed and oral presentations all stand for those of speakers themselves, nothing to do with the organizers China Chemical & Fiber Economic Information Network (CCFEI) and Dr. Thiele Polyester Technology.
8. Welcome to attend **CCFEI-Xuzhou Zhaoyang Night** at 18:00, **7 Sep** at **Da Hua Pavilion, 1F.**
9. Dinner is prepared at 18:00 on **6 & 7 Sep**, and lunch is prepared at 12:00 on **7 & 8 Sep**. Please keep your meal ticket properly.
10. We invite you to participate in **Sponsorship Subscription** for **14th China International Recycled Polyester Conference & Exhibition (2018)**. You may enquire our staff for details.
11. During 14:00, **6 Sep-12:00, 8 Sep**, we welcome you to visit the **Exhibition Area** on **1 Floor.**

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Contact person: Tracy Liu: +86-13816925797
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Please kindly notice the following items:

1. Exhibition venue: Da Hua Pavilion, 1F in Holiday Inn Shanghai Hongqiao, China.
2. Exhibition time: Starting in the afternoon of 6 Sep, ending at 12:00, 8 Sep.
3. Welcome to attend CCFEI-Xuzhou Zhaoyang Night at 18:00, 7 Sep at Da Hua Pavilion, 1F.
4. Dinner is prepared at 18:00 on 6 & 7 Sep, and lunch is prepared at 12:00 on 7 & 8 Sep. Please keep your meal ticket properly.
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Contact person: Tracy Liu: +86-13816925797
China Chemical & Fiber Economic Information Network (CCFEI)

Founded in 2002, CCFEI (www.ccfei.net) integrates services of online information, conferences and consultancy, covering chemicals, chemical fibers and textiles.
- More than 10-year industrial consulting experience
- Insightful professionals on chemicals, chemical fibers and textiles
- Subscribers from over 80 countries and regions

Online Info

Info Center
- Live News – Real time rolling publication
- Plant News – Real time rolling publication
- Morning Report – Morning of each working day
- Daily – 3~5 P.M. each working day
- Weekly – Friday or Monday each week
- Insight – Each month
- Price Updates – 2~5 P.M. each working day
- Industry News – From time to time
- Finance – From time to time

Data Center
- Customized
- Plant Info
  - Price
    - Contract Price
    - Price Updates
  - Price Index
    - Daily
    - Weekly
    - Monthly
- Market Index
  - Market Climate
  - Run Rate
  - Inventory
- Fundamental
  - Import
  - Export
  - Production
- Profit
  - Price Spread
  - Cash Flow
- Macro-economy
  - Domestic
  - Global
China Report

CCFEI's newsletter---China Report provides an in-depth knowledge about market dynamics and tendency for the reference of readers' strategic plan and decision.

China Report covers
- Paraxylene, PTA, MEG, Bottle Grade PET, Fiber Grade PET, Polyester Filament, Polyester Staple, Recycled PSF
- Caprolactam, Nylon Chips, Nylon Filament
- Acrylonitrile, Acrylic Fiber, Propylene/ABS
- Viscose Feedstock, Viscose Staple, Viscose Filament
- MDI/PTMEG, Spandex

Annual Report

- Polyester chain annual report
- Nylon chain annual report
- Viscose chain annual report
- Acrylic chain annual report
- Spandex chain annual report

Annual Conferences

All conference papers for following Forums are FREE to our subscribers:
- China International Polyester & Intermediates Forum
- China International Polyamide & Intermediates Forum
- China International Acrylonitrile & Acrylic Fiber Forum
- China International Recycled Polyester and PET Packaging Conference & Exhibition
- China International Textile Feedstock Market Forum
- China International Sulphur & Sulphuric Acid Conference


Full details at www.ccfei.net
### Programme

**Time** | **Presentation**
--- | ---
6 Sep | **6 Sep**
14:30-20:00 Exhibition & Registration
18:00-20:00 Dinner

7 Sep, P.M. | 14:00-16:00 Speaking
16:00-17:00 Networking drink
18:00-20:00 Dinner
CCFEI-Xuzhou Zhaoyang Night

7 Sep, A.M. | 08:30 Exhibition & Registration
09:00-10:30 Speaking
10:30-11:00 Networking drink
11:00-12:00 Speaking
12:00-13:00 Lunch

8 Sep A.M. | 08:30 Exhibition & Registration
09:00-10:30 Speaking
10:30-11:00 Networking drink
11:00-12:30 Speaking
12:30-13:30 Lunch (end of the conference)

#### Conference Time:
6-8 Sep 2017

#### Registration time:
6 Sep, 2017

#### Conference Place:
Holiday Inn Shanghai

#### Hotel Address:
No. 169 Xingzhan Road,
Minhang District, Shanghai,
China

**6 Sep**

**Topic**

*Exhibition and Registration (Da Hua Pavilion, 1F)*

*Buffet dinner (Café Pro, 1F)*

**7 Sep, A.M.**

**Da Hua Pavilion, 1F**

*Exhibition and Registration*

*Conference Chairman: Du Guoqiang, President, Ningbo Dafa Chemical Fiber*

**9:00**

*Status Quo of Recycling of Waste Textiles at home and abroad and Revelation*

Gu Mingming, Deputy Secretary-General, China Association of Circular Economy, The Technology Innovation Strategic Alliance for Waste Textiles Comprehensive Utilization Industry

**9:30**

*Status Quo and Outlook of Polyester Chemical Fiber Market*

Zhang Youding, Deputy Director General, Synthetic Fiber Division of Sinopec Chemical Products Sales Company

**10:00**

*High-efficient and High-value Recycling of Waste Polyester Fiber and Industrialization*

Wang Huaping, Vice Director of Textile Research Institute, Donghua University

**10:30**

*Networking drink in exhibition area*

**11:00**

*Polyester Fiber and Textile Recycling by the Market Leader EREMA*

Kurt Pichlmann, Sales Manager, EREMA Engineering Recycling Maschinen und Anlagen Ges.m.b.H.

**11:30**

*Dafa’s Culture——Health*

Du Guoqiang, President, Ningbo Dafa Chemical Fiber

**12:00**

*Lunch (Café Pro, 1F)*
14:00  Traceable Chemical-method High-quality Recycling of Wasted Polyester Textiles  
Yu Xinjian, Chief Engineer, Zhejiang Jiaren New Materials Co., Ltd.

14:30  LSP – Liquid State Polycondensation--A New and Proven Process for the Up/recycling of PET Fibers and Textiles  
David Hehenberger, Product Manager, Next Generation Recyclingmaschinen GmbH

15:00  The New Sorema Delabeling Solutions  
Yu Zheng, Sales Engineer, SOREMA div. of PREVIERO N. SRL

15:30  The Future Development of China Recycled Polyester Industry  
He Yanli, Vice Chairwoman, China Chemical Fibers Association

16:00  Networking drink in exhibition area

18:00  CCFEI-Xuzhou Zhaoyang Night (Da Hua Pavilion, 1F)

8 Sep  Da Hua Pavilion, 1F
A. M.
8:30  Exhibition and Registration  
Conference Chairman: Dr. Ulrich Thiele, President, Dr. Thiele Polyester Technology

9:00  Development Road of Elite Color  
Zhu Jinya, Director of Strategic Development, Elite Color Environmental Resources Science & Technology Co., Ltd.

9:30  Finish Oil: R&D and Large-scale Intelligent Manufacturing  
Ye Guanghua, General Manager, Huangshan Qiangli Chemical Co., Ltd.

10:00  Upstream Developments and the Impact on RPET  
Stewart Hardy, Global Manager - Petrochemical Market Dynamics, Nexant, Inc.

10:30  Networking drink in exhibition area

11:00  Edges of DR Circular Blowing Cooling Device of New Structure  
Liu Zhiquan, Chairman of the board, Hebei Darui Chemical Fiber Machinery Co., Ltd.

11:30  Win-win Cooperation along RPET Industry under Great Changes  
Cao Weidong, Chairman of the board, Zhejiang Huafei Recycling Resources Co., Ltd.

12:00  R-PET Market Structure under New Policies  
Cao Wenting, Product Manager, China Chemical & Fiber Economic Information Network (CCFEI)

12:30  End of conference
12:30  Lunch (Café Pro , 1F)
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High-efficient and High-value Recycling of Waste Polyester Fiber and Industrialization

Wang Huaping

Vice Director of Textile Research Institute

Donghua University
High-efficient and High-value Recycling of Waste Polyester Fiber and Industrialization

Participants:
Zhejiang Grerial Environmental Protection Co Ltd
Ningbo Dafa Chemical Fiber
Elite Color Environmental Resources Science & Technology Co Ltd
Donghua University
Zhejiang Sci-tech University
Zhongyuan University of Technology

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1. Background and Approach
2. Innovative points and key technologies
3. Major technical indexes and advancement
4. Intellectual property and third-party evaluation
5. Application & promotion, economical and social effects
6. Contributions of candidates
1. Background and approach

1.1 Background

Waste chemical fiber products in China: huge social volume, large proportion of polyester-based products, and low recycling rates.

Volume: 200 million tons.

Waste production and process: 4 million tons/year.

Waste fiber production: 3.5 million tons/year (5 years of fibre circle).

Recycling rate: < 8%

Key areas of concern in China due to high level of contamination

<table>
<thead>
<tr>
<th>Time</th>
<th>Related laws and initiatives</th>
<th>Issued by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 2011</td>
<td>'Plan' for comprehensive utilization of staple industrial solid wastes</td>
<td>Congress</td>
</tr>
<tr>
<td>Jan 2012</td>
<td>'Plan' for chemical fiber industry</td>
<td>MIT</td>
</tr>
<tr>
<td>Mar 2012</td>
<td>'Plan' for industrial cleaner production</td>
<td>MIT</td>
</tr>
<tr>
<td>May 2012</td>
<td>'Plan' for waste recycling scientific project</td>
<td>MIT</td>
</tr>
<tr>
<td>Jun 2012</td>
<td>'Plan' for energy-saving and environmental-friendly industry</td>
<td>State Council</td>
</tr>
<tr>
<td>Feb 2013</td>
<td>Guidance Catalogue for Key Products and Service of Strategic Emerging Industry</td>
<td>NDRC</td>
</tr>
<tr>
<td>Nov 2014</td>
<td>Plan of Nation to Tackle Climate Change</td>
<td>NDRC</td>
</tr>
<tr>
<td>Jul 2015</td>
<td>Standards for Recycled Chemical Fiber Industry (Polyester Fiber)</td>
<td>MIT</td>
</tr>
<tr>
<td>Mar 2016</td>
<td>12th Five Year Plan</td>
<td>Congress</td>
</tr>
</tbody>
</table>
1. Background and approach

1.1 Background

<table>
<thead>
<tr>
<th>Polyester wastes: fiber grade</th>
<th>Impurity</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastes from Polymerizing</td>
<td>Oligomer, copolymer catalyst</td>
<td>Esters, IPA, SIPA, Sn/Ti</td>
</tr>
<tr>
<td>Wastes from Spinning</td>
<td>Spin-finish oil, additives</td>
<td>Surfactant TiO₂, carbon black, BaSO₄, etc.</td>
</tr>
<tr>
<td>Wastes from weaving, dyeing and finishing, &amp; leftovers</td>
<td>Disperse dyes, auxiliary</td>
<td>AZO, anthraquinone, heterocyclic ring, levelling agent</td>
</tr>
<tr>
<td>Post-consumer textiles</td>
<td>Multi-component polymer, inorganics, ash, etc.</td>
<td>PE, PA, PU, Fe, Si, etc.</td>
</tr>
</tbody>
</table>

Standardized recycling of waste polyester fiber can hardly be realized due to complex components.

1. Background and approach

1.1 Background

Physical recycling: degradation, low quality

- Difficult to separate impurities
- Difference in viscosity, low stability of product batch
- Low utilizing rate of waste fiber

“bottle to fiber”

“fiber to filling materials”

High efficiency
High quality
1. Background and approach

1.1 Background

Chemical recycling: long process, high cost
Representative technologies: Teijin’s DMT method, Oxid’s hydrolysis method

- High quality
- Low cost performance
- Difficult to industrialize

1.2 Overall approach:

With waste PET fiber as raw materials, making research on whole process and realizing fiber to fiber

Pilot application
Develop differentiated products like monofilament-like, super-silk, coarse-denier, colored, etc.
Application in areas of apparel, shoes, carpet, automotive interior and chemical engineering

Key tech
- Granulating under hydrothermal synergy effect
- Key technology for controlling melt IV
- Key technology for full-color matching
- Composite direct spinning
- High-efficient heterogeneous alcoholysis
- Polymerization of BHET with impurity
- Direct melt spinning of recycled BHET
- Differentiated direct melt spinning with powder on-line addition

Scientific problems
- Mechanism on dirty polyester recycling
- Mechanism on depolymerizing, IV enhancing
- Physical-chemical recycling
- BHET chemical recycling
- Heterogeneous alcoholysis for dirty PET
- Controlling mechanism for polymerizing of BHET with impurities

High-efficient recycling of post-consumer PET fiber and industrialization
1. Background and approach

1.2 Overall approach:
- **Professional recycling of main components**
  - Physical chemical recycling: Homogeneous viscosity increasing
  - Chemical recycling: Alcoholsysis and repolymerization

- **Full utilization of impurities**
  - Disperse dyes, auxiliary
    - AZO, anthraquinone, heterocyclic ring, Levelling agent
  - Multi-component polymer, inorganics, dust
    - PU, PEN, PA, PE, PVC, Cellulose
  - Additive
    - TiO₂, Sb₂O₃, SiO₂, BaSO₄, Carbon black, metal

- **Removal**: Remove impurities, improve quality, and ensure stability
- **Utilization**: Reduce separation, lower energy consumption, improve efficiency, and full utilization of resources

II. Innovative points and key technologies
2. Innovative points and technologies

Main innovative points

1. Granulating under hydrothermal synergy effect and physicochemical regeneration technology
2. High-efficiency heterogeneous alcoholysis and BHET direct regeneration and polymerization technology
3. “Full color matching and online color tuning” and high-quality differentiation technology
4. Low-melting polyester producing and “New one wrapping old one” composite direct spinning technology

1. Granulating under hydrothermal synergy effect and physicochemical regeneration technology

Problem

- Sharp drop on viscosity, difficulty in drying and poor stability for different batches when granulating with waste fibers
- Low efficiency in eliminating impurity, sharp drop on viscosity and difficulty in enhancing viscosity for regenerated melt
- Poor homogeneity and stability for regenerated melt

Key technology

- Technology of granulating with waste polyester fiber under the synergistic effect of water and heat and standardization.
- High efficiency compounding ingredients based on popcorn of full polyester materials and drying technique.
- Micro alcoholysis - melting - extrusion - filtration integration technology
- “Micro alcoholysis - devolatilization polymerization” viscosity enhancing technology

Patent and standard

- Seven invention patents including “One kind of granulating unit”
- One association standard and one industrial standard for “recycled fiber grade PET popcorn”
1. Granulating under hydrothermal synergy effect and physicochemical regeneration technology

**Key 1** Technology of granulating with waste polyester fiber under the synergistic effect of water and heat and standardization.

- Study on plasticized densification and viscosity drop controlling mechanism for waste fiber.
- Waste fiber based high efficiency and low temperature granulating technology under the synergistic effect of water and heat.
- Build evaluation and classification standards for impurity content and color of popcorn.

![Graph showing the effect of temperature on viscosity](image)

*Improve the quality of popcorn by lowering the viscosity from 12% to 3% and realize resource utilization of waste polyester fiber.*

**Key 2** High-efficiency compounding ingredients based on popcorn of full polyester materials and drying technique.

- Research and development of popcorn based axial radial enhancement mixing unit.
- Development of foam material-based high efficiency uniform matching and continuous and automatic conveying technology.
- Development of popcorn based vacuum drum hot air drying technology.

![Diagram showing the mixing and conveying system](image)

*The mixing and conveying efficiency is raised by more than one time, and the water content of popcorn declines from 70ppm to 30ppm.*
1. Granulating under hydrothermal synergy effect and physicochemical regeneration technology

Key 3  Micro alcoholysis-melting-extrusion-filtration integration technology

- Study alcoholysis kinetics about polyester melts with wide molecular weight distribution
- Design high-shear gradient screw with deepened groove, and two-cylinder filtration unit
- Develop screw high-efficiency micro alcoholysis technology and high efficiency dynamic filtering technology

- Gradient deepening channel and screw
- Inlet pressure drops by 20% and pressure fluctuation falls by 15%

- Two-cylinder filtration unit
- Multi-layers in filter element is reduced by 95%
- Filter element closing time is shortened by 83%
- Leakage of impurities in filter element affected by 95%

Realize an enhanced viscosity drop and a filtration of solid impurity and raise popcorn-melting and filtering efficiency by 50%.

1. Granulating under hydrothermal synergy effect and physicochemical regeneration technology

Key 4  “Micro alcoholysis-devolatilization-polymerization” viscosity enhancing technology

- Study the controlling mechanism about devolatilization and impurity elimination of low viscosity melt as well as homogeneity and viscosity adjustment.
- Research and develop vertical falling film devolatilization and horizontal mouse cage viscosity-enhancing reactor.
- Develop high-efficiency devolatilization and impurity removing technology as well as homogeneity and viscosity enhancing technology

- Horizontal mouse cage viscosity-enhancing reactor
- Direct devolatilization and viscosity-enhancing reactor

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Index} & \text{Direct devolatilization} & \text{Direct impurity} & \text{Viscosity reduction} \\
\hline
\text{CO} & 0.04 \pm 0.03 \mu g & 0.04 \pm 0.03 \mu g & 0.05 \pm 0.05 \mu g \\
\text{TVOC} & 840 \mu g & 280 \mu g & -160 \mu g \\
\hline
\end{array}
\]

Cut down the content of vapor volatiles and TVOC, raise the homogeneity and reduce the changes on viscosity through high-efficiency viscosity enhancement.
2. High-efficiency heterogeneous alcoholysis and BHET direct regeneration and polymerization technology

Problem
- Waste polyester fibers stick with each other and are difficult to transport.
- A side reaction can happen easily during the course of alcoholysis as waste polyester products in different shapes enjoy the course at different speeds.
- The impurity has a great influence on the course and the quality of the polymerization of BHET.

Key technology
- Washing-free waste fiber pretreating technology
- Heterogeneous high-efficiency MEG depolymerizing technology
- BHET direct regeneration polymerizing technology
- Online powder adding differential directly spinning technology

Patent and standard
- Five invention patents including “one kind of polyester alcoholysis method”
- Two theses including “Use waste polyester fabrics to make low-melting point adhesive fiber through alcoholysis and regeneration”
- One industrial standard learnt as “Regenerated fiber grade PET chip”

Key 1: Washing-free waste fiber pretreating technology
- Design open-type anti-winding crusher roll and diversion high-speed rotary compression compacting device
- Develop high-efficiency waste fiber crushing and compressing technology
- Develop densification, water removal and impurity removal integration technology

- Open-type feed crushing
- High-speed rotary compression warm-up facility with diversion member

Structural sketch of anti-winding crusher roll:
- Water removal and impurity removal “combined with alcoholysis”

Improve the adaptability of raw material retention, with treatment efficiency up by more than one time and energy consumption for crushing down by 70%.
2. High-efficiency heterogeneous alcoholysis and BHET direct regeneration and polymerization technology

Key 2: Heterogeneous high efficiency depolymerizing technology

- Study heterogeneous alcoholysis kinetics for polyester products in different shapes and its impact influence mechanism.
- Develop Zinc acetate catalyzing and mother liquor recycling alcoholysis technology based on compatibilization acceleration effect.
- Design 100-level specific unit for continuous alcoholysis, filtration and separation.

- Compatibilization acceleration effect:
  - PET
  - EG
  - BHET
  - Qingyuan water

- Mother liquor recycling alcoholysis scheme:
  - Temperature: 210–230°C, catalyst: ZnAc;
  - Liquid solid ratio: (Mother liquor: EG) / PET = (3:0.2):1

Shorten the slow phase of heterogeneous depolymerization in earlier reaction period
Cut down alcoholysis cycle by 20 and ensure BHET content > 95%

Key 3: Impurity BHET direct regeneration polymerizing technology

- Study the regulation mechanism for the side reaction of regeneration and polymerization of impurity BHET mother liquor
- Develop color regulation technology for BHET regeneration and polymerization
- Develop multistage high efficiency ash content and agglomeration particle removing technology

- Color value regulation for regenerated PET by controlling temperature, pressure and oxygen supply.
- Polymersation scheme: $T_{\text{monomer}}$: 250–260°C, $T_{\text{premonomer}}$: 265–285°C, polymerizing time: 8.6 h
- Alcoholysis > Filtration > Esteriﬁcation > Filtration > Polycondensation > Filtration
  - Multistage automatic recycle type filtration and impurity removal
  - Filtration accuracy at 20μm, online washing when pressure at 0.6 bar

- Quality index for PET chip:
  - L>68, b<4, viscosity>0.68DL/g, melting point>255°C, DEG<2.03%
  - Ash content<0.15%, agglomeration particle<6μm

Set up one 100 kly/yr impurity BHET-based continuous esteriﬁcation and polymerization unit to meet the standard for polyester ﬁlament.
2. High-efficiency heterogeneous alcoholsysis and BHET direct regeneration and polymerization technology

**Key 4** Online powder cyclically adding and modifying technology

- Study two-screw melt and inorganic powder dynamic mixing system
- Build bypass online adding and modifying and precision measurement system

Realizes online direct powder addition, replacing masterbatch modification, and supports the development of colored and functional fibers.

3. “Full-color matching and online color toning” and high-quality differentiation technology

**Problem**
- The color rendering for popcorn is complicated, and there is a large error in color matching.
- Colored melt has high sensitivity on colors and heat, which can hardly be controlled.
- There is a low recycling and utilization ratio for post-consumer polyester materials mixed with macromolecule.

**Key technology**
- Primary color matching for colored popcorn and comprehensive utilization of dyed materials.
- Full-color complementary and toning technology after online addition of melts to masterbatch
- Polyester-consumer polyester materials mixed with macromolecule-based regenerated fiber producing technology

**Patent and technology**
- Four invention patents including “one kind of producing method for regenerated colored polyester staple fibers”
- Two theses including “Effect of Azo Dyes on the Thermal Degradation of Post-consumer Polyester Fabrics”
3. “Full-color matching and online color toning” and high-quality differentiation technology

Key 1

Primary color matching for colored popcorn and comprehensive utilization of dyed materials.

- Study the color changing of disperse dyes during the course of regeneration.
- Study the influence mechanism of inorganic powder against the color value of melts.
- Develop direct blending and color matching technology of colored popcorn.

Classification of colored from material
- Utilization of inorganic
  - Disperse dyes
  - Carbon black
  - TiO2
  - BaSO4

Mixing and regulation
- Regulation of colored popcorn
  - Mixing proportion
  - Resin content
  - Resistance time

Stabilization of color
- Color value adjustment
  - Representative color fiber products

Feedback and amendment
- Light brown
- Dark brown
- Grey black

Total utilization of inorganic dyes to overcome the color changes during the process of melts.
The color fastness of regenerated color silk at grade 4 to grade 5 and the color difference at grade 4 to grade 5.

Key 2

Full-color complementing and toning technology after online addition of melts to masterbatch

- Study full color matching mechanism and influencing factors of regenerated melts.
- Develop flexible online color complementing and toning system

Production of all-colored regenerated fiber

- Flexible online color adding and matching system

Build a color library for regenerated melts

Realize high efficiency full-color complementing and toning for regenerated melts.
Produce several varieties of functional colored fiber with color fastness and color difference for regenerated color fiber both at grade 4 to grade 5.
3. “Full-color matching and online color toning” and high-quality differentiation technology

<table>
<thead>
<tr>
<th>Key 3</th>
<th>Polyester-consumer polyester materials mixed with macromolecule based regenerated fiber producing technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Study the regulation mechanism of the blend phase distribution and thermal stability of hybrid polymer</td>
</tr>
<tr>
<td></td>
<td>Build a modification technology system of hybrid polymer-based regenerated polyester fiber</td>
</tr>
</tbody>
</table>

PET(polystyrene compatibility regulation mechanism)  PP(PP-g-MAH)  PU(PU thermal stability controlling mechanism)  PET(Polyester fiber modification technology system)

- **PET**
  - PE 10%
  - PP 10%
  - PEN 15%
  - PU 5%

Fully bring the features of impurity polymer into play and realize a direct mixing modification of regenerated polyester fiber through physicochemical method.

4. Low melting polyester producing and “New one wrapping old one” composite direct spinning technology

- **Problem**
  - Difficulties in controlling the quality and cost of low melting PET
  - Great changes in raw materials and poor stability in compounding and moulding
  - Low production efficiency for low melting composite fiber

- **Key technology**
  - Dual effect synergy-based low melting point co-polyester producing technology
  - “New one wrapping old one” sheath-core composite high-density high-pressure spinning technology
  - Low melting PET/PE sheath-core composite spinning and intensified cooling technology
  - Low melting PET/R-PET sheath-core composite fiber after spinning technology

- **Patent and standard**
  - Four invention patents including “one kind of producing method for low melting regenerated co-polyester”
  - Two thesis including “Study on rheological property of low-melting co-polyester and its sheath-core composite spinning”
4. Low melting polyester producing and "New one wrapping old one" composite direct spinning technology

**Key 1**

- Dual effect synergy-based low melting point co-polyester producing technology
  - Study the rules of lophosphate acid and diethylene glycol influencing the melting point of co-polyester
  - Equation and polymerization process for line and cohesive force-based optimized low melting co-polyester

Dual effect synergy based low melting point changing rules

Regulations on line and cohesive force of co-polyester

Notable result of coordinated reduction on melting point, which is stable and regulable at 110–180°C.

**Key 2**

- "New one wrapping old one" high-density high-pressure spinning technology
  - Study the rheological property of low melting PET/RE PET melts
  - Develop high density sheath core composite spinneret plate and high pressure spinning technology
  - Design main and auxiliary boxes with high temperature difference

Rheological property

Spinning section

Main and auxiliary boxes with high temperature difference

Dynamic balance for component pressure (L2-22 MPa)

- `Φ405mm/2060孔`

Solve the problems related to the deviation on the bonding surface and coagulation, so as to improve the production efficiency and quality.

Molding degree of cross section sheath core >99.5%, Line density deviation: ±5%, Component cycle picked up from 3-5 days to 12 days.
4. Low melting polyester producing and “New one wrapping old one” composite direct spinning technology

**Key 3**
Low-melting PET/R-PET sheath-core composite spinning and intensified cooling technology

- Develop multi-layer and multi-orifice spunther plate combined low-damping ring blowing device
- Develop low-temperature large air volume ring blowing cooling and waved-path vertical intensified cooling technology
- Develop low-temperature multi-orifice oiling technology

Lift up the use cycle of cooling unit (< 90 days), easy to wash
Solve the problem of contamination in winding, with yield rate > 90%

**Key 4**
Low-melting PET/R-PET polyester sheath-core composite fiber after-spinning technology

- Study the low-temperature drafting and setting crimping mechanism of sheath-core composite fiber
- Develop low-temperature long-distance drafting technology
- Research and develop special draft roller for chilled water circulation as well as crimping and setting system,

The draft ratio between the first roller and the second roller at 9:1,
the distance shortened by 25% and the temperature at 55~65 °C

Uniform heat conduction through chilled water and high-efficiency release of latent heat
Solve the problem related to after treatment silk doubling

Good quality for “New one wrapping old one” low-melting polyester composite fiber
Defect < 30mg/100g, high yield rate (96%), production cost cut down by 25%
## 3. Major technical indexes and advancement

### 3.1 Major technical indexes

<table>
<thead>
<tr>
<th>Term</th>
<th>Domestic</th>
<th>International</th>
<th>This project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granulation from waste fiber by physical/mechanical method</td>
<td>Physical method mainly friction, granulation &amp; direct melt recycling</td>
<td>Vacuum screw extrusion chain-extrusion viscosity enhancing</td>
<td>Granulating under hydrothermal energy effect reaction, dissolving polymerization* homogenization viscosity enhancing</td>
</tr>
<tr>
<td>Production: <del>5% high impurity IV after recycling: 0.85</del>0.90 g/L</td>
<td>IV reduction: ~3%</td>
<td>IV after recycling: <del>0.85</del>0.90 g/L</td>
<td>IV reduction: ~3%</td>
</tr>
<tr>
<td>Cost: 200,000 Yuan/ton</td>
<td>Cost: 300,000 Yuan/ton</td>
<td>Cost: 300,000~500,000 Yuan/ton</td>
<td></td>
</tr>
<tr>
<td>BMYE regeneration, polymerization and spinning by chemical method</td>
<td>No like industrialized technique yet</td>
<td>Teijin’s DMT chemical method</td>
<td>Homogeneous alcoholysis and BMYE direct regeneration polymerization</td>
</tr>
<tr>
<td>Production of recycled recycled polyester fiber</td>
<td>Low tenacity, homogeneity and large color difference fiber</td>
<td>Limited functional recycled high cost</td>
<td>Fiber tenacity up with that produced by virgin PET; all color matching, color difference &amp; fastness grade 4~5</td>
</tr>
<tr>
<td>Only for technical filling application</td>
<td>Only for technical filling application</td>
<td>Multi-functions, including automotive trim, civil engineering, etc.</td>
<td></td>
</tr>
<tr>
<td>“Newspaper-wrappedate”/“tissue-papered” spinning technology</td>
<td>All for virgin materials Limited specs</td>
<td>All for virgin materials Limited specs</td>
<td>Containing 20% recycled materials Cost reduction of 25%</td>
</tr>
</tbody>
</table>
### 3.2 Advancement

Realize high-efficient and comprehensive recycling of waste polyester fiber

<table>
<thead>
<tr>
<th>Polyester wastes: fiber grade</th>
<th>Impurity</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastes from Polymerizing</td>
<td>Oligomer, copolymer catalyst</td>
<td>IPA, SIPA Sb/Ti</td>
</tr>
<tr>
<td>Wastes from Spinning</td>
<td>Spin finish oil, additives</td>
<td>Surfactant TiO₂, carbon black, BaSO₄, etc.</td>
</tr>
<tr>
<td>Wastes from weaving, dyeing, and finishing, &amp; leftover</td>
<td>Disperse dyes, auxiliary</td>
<td>AZO, anthraquinone, heterocyclic ring, levelling agent</td>
</tr>
<tr>
<td>Post-consumer textiles</td>
<td>Multi-component polymer, inorganics, ash, etc.</td>
<td>PE, PA, PU Fe, Si, etc.</td>
</tr>
</tbody>
</table>

### 3.2 Advancement

Establishment of high-efficient & high-value recycling system based on physicochemical method and BHET chemical method for waste fiber

<table>
<thead>
<tr>
<th>Grade</th>
<th>Technique</th>
<th>Mechanism</th>
<th>Characteristics</th>
<th>Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low end</td>
<td>Easy opening and screening</td>
<td>Physical form change</td>
<td>Unstable component, performance and quality</td>
<td>Wuxi, Dongguan, etc.</td>
</tr>
<tr>
<td>Gradual</td>
<td>Physical method</td>
<td>Micromolecular scale degradation</td>
<td>Unidirectional degradation of performance and quality</td>
<td>Widely located in Jiangsu, Zhejiang, Shandong, Guangdong, Fujian, India and Pakistan</td>
</tr>
<tr>
<td>High end</td>
<td>Chemical method</td>
<td>Micromolecular scale purification</td>
<td>Stable quality, Bidirectional control of performance and function</td>
<td>Teghio, Cidu</td>
</tr>
<tr>
<td>Professional</td>
<td>Physicochemical method</td>
<td>Comprehensive utility</td>
<td>Complementary utility, Process enhancement &amp; homogenization</td>
<td>Stable quality, Bidirectional control of performance and function</td>
</tr>
</tbody>
</table>

Upgrade of recycling technology realizes the unification of resource, environmental protection and economy.
3.2 Advancement

Recycling of waste polyester fiber by physicochemical method

✓ Appraised by experts: Process internationally leading. Overall internationally advanced

3.2 Advancement

BHET chemical-method recycling for waste polyester fiber

✓ Appraised by experts: Overall internationally advanced
3.2 Advancement

Physicalchemical method 450 ktyr, low melt point compounding 75 ktyr

Largest capacity and production, strong adaption

BHET chemical method recycling
Filament spinning line 100ktyr

Largest capacity worldwide economical and efficient

3.2 Advancement

Clean production in whole process, with emission up to standards
Waste water: COD<sub>e</sub><400 mg/L, removal rate>80%
Waste gas: Non-methane hydrocarbon removal rate>90%, Acetaldehyde removal rate>94%, Gas and oil contamination removal rate at 90%

Anaerobic/aerobic method combined biotreatment for waste water
Collecting unit for waste gas from polymerization

Microbiological treatment for waste gas
Collecting unit for waste gas from decolorization and viscosity enhancing
High-efficient and High-value Recycling of Waste Polyester Fiber and Industrialization

4. Intellectual property and third-party evaluation

4.1 Authorized patents and industrial standards

- Authorized invention patents: 20
- Authorized practical new-type patents: 37
- Industrial and association standards: 3

Form a proprietary intellectual property rights system integrating high-efficient pretreatment technology for polyester wastes, “micro alkoholysis–devolatilization-polymerization” physicochemical regeneration technology, BHET direct polymerizing low-cost chemical regeneration, high-efficient & high-value differentiated recycled polyester fiber production, and low-carbon & emission-reduction.
4.2 Third party evaluation

Intertek certification of 100% recyclable component / certification of negative carbon footprint

First “negative carbon footprint” series of chemical fiber products made of fiber wastes in China

4.2 Third party evaluation

Grerial, Dafa and Elite Color are corporations that first received green certificate in the industry, and they were firstly added to MIIT list of standard manufacturers producing recycled chemical fiber (polyester). The high-efficiency large-scale production of 10+ series of recycled polyester fiber has realized. The products, having passed the tests of prestigious institutions such as SGS and national quality supervision center for textiles and apparel, meet the requirements as automobile interior, civil engineering, apparel, household decorations.
5. Application & promotion, economical and social effects

5.1 Application & promotion

Stable performance, high quality and successful application in automobile interior, civil engineering, apparel, home textile and footwear.

- Break strength ≥12.5 kN/m
  CBR bursting strength ≥2.1 kN
  (GB/T 17638-1998)

- Bursting strength ≥250 N
  Colorfastness: Color change ≤5/4, Stain
  Pilling ≤4 (FZ/T 73024-2014)

- Bond strength ≥25 N, tuft withdrawal force ≥20 N
  (GB/T 11746-2008)

- Colorfastness: <5/4
  Color: level 4 (GB/T 3903.42-2008)
  Bursting strength ≥20 kPa (GB/T 199)
5.1 Application & promotion

Designated supplier to international brands such as BMW, IKEA and NIKE and successful application in major projects such as Sanjiangyuan Project and South-to-North Water Transfer Project.

5.2 Economical and social effects

Turnover and Profits in 2014-2016

- Turnover: 6,641 million yuan
- Profits: 294 million yuan
- Tax: 234 million yuan
5.2 Economical and social effects

Products represent 2017-2018 China fiber fashion trend

“Fiber Dynamics • Green Pioneer”

Higher-quality products enhance international image and reputation of China R-fiber industry

6. Contributions of candidates
6. Contributions made by prize candidates

Wang Huaping, Donghua University

- Person in charge of project techniques: project techniques and program design & coordination
- Contributing greatly to all four innovations
6. Contributions of candidates

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wang Shaobo</td>
<td>Zhongyuan University of Technology</td>
<td>✓ Contributing greatly to innovation 2, 3 and 4</td>
</tr>
<tr>
<td>Chen Ye</td>
<td>Donghua University</td>
<td>✓ Contributing greatly to innovation 1, 3 and 4</td>
</tr>
<tr>
<td>Shi Jiaxue</td>
<td>Greelal</td>
<td>✓ Contributing greatly to innovation 2</td>
</tr>
<tr>
<td>Xing Xiqian</td>
<td>Dafa</td>
<td>✓ Contributing greatly to innovation 1, 3 and 4</td>
</tr>
<tr>
<td>Wang Xueli</td>
<td>Donghua University</td>
<td>✓ Contributing greatly to innovation 4</td>
</tr>
<tr>
<td>Dai Mengqian</td>
<td>Elite color</td>
<td>✓ Contributing greatly to innovation 1 and 3</td>
</tr>
<tr>
<td>Yao Qiang</td>
<td>Greelal</td>
<td>✓ Contributing greatly to innovation 2</td>
</tr>
<tr>
<td>Wang Fanghe</td>
<td>Dafa</td>
<td>✓ Contributing greatly to innovation 1, 3 and 4</td>
</tr>
<tr>
<td>Wang Zhaozhong</td>
<td>Donghua University</td>
<td>✓ Contributing greatly to innovation 1 and 4</td>
</tr>
<tr>
<td>Zhang Xuzhen</td>
<td>Zhejiang Sci-tech University</td>
<td>✓ Contributing greatly to innovation 2</td>
</tr>
</tbody>
</table>

---

**Thank you!**

- 2004: Cooperation between Donghua and Dafa
- 2005: Chemical Fibre Recycling Industry Alliance
- 2009: Ultimate achievements in technical innovation
- 2014: Final report on research projects
- 2015: Key R&D plan under the 13th Five-year Plan
- 2016: Strategic R&D projects
- 2017: Results of comprehensive evaluation of cooperative projects and promotion of technical innovation

Put recycling into practice and push forward industrial development
Polyester Fiber and Textile Recycling by the Market Leader EREMA

Kurt Pichlmann

Sales Manager

EREKA Engineering Recycling Maschinen und Anlagen Ges.m.b.H.
Kurt Pichlmann
Avon Sales Manager China

EREEMA. The Number One.
Some Facts.

- More than 500 employees worldwide
- 10 subsidiaries worldwide
- More than 5,000 Erema Systems in use around the globe produce approx. 20 million tons of top quality plastic pellets every year
Number One in the world...

More than 5000 Worldwide.
EREMA is the global market leader in plastic recycling systems.

Number One costumers...

EREMA PLASTIC RECYCLING SYSTEMS
EREMA. The global Number One

- EREMA total centres with 15 systems in total for test runs
- 10 regional service centres for on-site technical support
- Over 50 EREMA representatives

Costumer Center EREMA
EREMA research and development

Production
EREMA. The Number One. In China!

- Since 1984 is Erema in the Chinese market
- Founded in the year 2001 in Shanghai Pudong
- More than 300 machines in China
- Market leader in the BOPET and BOPA recycling
- International service team
- Chief Representative: James Qiu

Where you can find EREMA?

Mechanical Recycling Quote from Plastic Packaging:
- Germany 2016: 35%
- EU 2020: 60%

Production

In house waste

Converting Waste (Colour, Laminate,...)
... and in PET Application!

Production:
- EREMA Backflush Filter: Fiber and Sheet
- Intarema Inline: POY Production waste
- Vacurema Inline: Fiber, Stamping, Sheet and Preform

Worldwide Recycling quote of Rothe flakes:
Approximately 50% (20% food and 80% technical application)

In-house Waste: BOPET 10%
In-house Waste: Fiber 2%

---

Recycling in the textile industry?

<table>
<thead>
<tr>
<th>Process</th>
<th>Melt</th>
<th>Fiber</th>
<th>Yarn</th>
<th>Raw Fabric</th>
<th>Garment</th>
<th>Apparel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polycrystallization</td>
<td>&gt;2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiber production</td>
<td></td>
<td>&gt;2%</td>
<td></td>
<td>&gt;2%</td>
<td></td>
<td>&gt;30%</td>
</tr>
<tr>
<td>Spinning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;20%</td>
<td>&gt;100%</td>
</tr>
<tr>
<td>Textile Processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textile Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apparel Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Sold Apparel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apparel End of life</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Challenges in PET fibre/textile recycling

- Water: 0.5 – 15%
- Spinning Oil: 0.1 – 5%
- Weight and form of the fibre: 10 – 200 g/l

Water in the melt destroys IV!

- Water: 0.5 – 15% = 5,000 - 150,000 ppm
- Or
- 1,200 kg/h PET waste + 1,020 kg/h PET (85%) + 180 l/h water (15%)

180 l water = 306,000 l of Steam! ⇒ too much for a vacuum pump!
Different water content in the input: creates different IV in the melt (IV stability)!

Solution: predrying is a must, before extrusion!

Troublemaker: Oil!
Spinning oil = mineral oil (=>120°C) + synthetic oil (=>300°C)

Spinning oil destroys colour
Influence IV
Makes troubles in reprocessing in the extruder, spinning line or in LSP
Makes Gels and blackspots in the end product
...
Is washing a solution* — to solve the oil problem?

After washing, the material has
Up to 30% water!

Centrifuges can be a solution, but still water problem (up to 15% moisture, depends on the form)

Thermal dryer is too expensive
(approx. 0.2 - 0.3 kWh/kg)

Still water problem — like before!

* Where goes the oil/water waste from the washing plant?

Form and weight → machine feeding

Different Form (POY, DTY, FTY, Non Woven, Woven, Yarn,...)
Different IV/tensacity
Different length
Different bulk density
...
EREMA Solution:
Precondition unit – Extruder!

Temperature, H\textsuperscript{2}O and IV are linked!
Inline solution (0.15 - 3 t/h) for PET fibre / textile (Shredder / Precondition unit / Extruder)!

Conclusion: fibre / textile recycling

Challenge: Form (Fibre, Non-woven, yarn, woven,...); Contamination (Moister, Oil, soiled,...) and physical quality (IV, strength,...)

1. Efficient and perfect Preparation
   (no agglomeration, no washing,...)
   Water removing, good homogenisation and stable material feeding

2. Perfect Extrusion
   → Stable and high IV
   → Automatic processing and monitoring
   → High filtration fineness
   → Low energy consumption

Fibre to fibre recycling (without additional processing step)!
NO environmental pollution!
Preparation and extrusion for PET bottle: VACUREMA - the most convenient recycling way!

Preparation and extrusion for food application: VACUREMA®
Shorter processing time → less energy and more flexibility!

CONVENTIONAL PET PROCESS

CLEAN, FOOD CONTACT COMPLIANT PET PELLETS AFTER AROUND 11 HOURS

CLEAN, FOOD CONTACT COMPLIANT PET PELLETS AFTER AROUND 3 HOURS

Stabil IV after decontamination!

Example: carbonated soft drink bottles - thick flakes - high starting IV value, low IV value growth rate

Example: water - thin flakes - low starting IV value, high IV value growth rate
Filtration

Backflush screen changer (RTF)

High number of screens with small screen area:
- Big Filter surface (like candle filter):
  - No influence on IV*
  - Filtration up to 18µm / 700 mesh
- High pressure stability (downstream):
  - Backflush has no influence
- Self cleaning system:
  - Long processing time and no contamination influence on the melt (short contamination resting time)

*High Pressure destroys IV and soft contamination moves through the screens
Conclusion –
In PET Recycling is important:

✓ Preparation
✓ Extrusion
✓ Filtration

Only one company in the world has build more than 500 PET recycling units...

... choose the number one!

DI Kurt Pichmann, Area Sales Manager China
Dafa’s Culture——Health

Du Guoqiang

President

Ningbo Dafa Chemical Fiber
Dafa’s Culture
—— Health

Ningbo Dafa Chemical Fiber Co., Ltd.

Introduction

Founded in 1998, Ningbo Dafa Chemical Fiber is a private enterprise that is engaged in the production of recycled polyester staple fiber via post-consumer bottles.

In 2003, the company introduced three major international management systems, namely ISO9001, ISO14001 and OHSMS18001.
**Introduction**

In terms of technical innovation, we have declared a total of 259 patents in recent years, with 230 authorized, and undertaken 5 National Torch Plan projects, 3 National Key New Product projects and 1 National 863 Plan project.

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**Introduction**

Our main product is recycled hollow PSF, which is mainly applied in the fields including nonwoven, filling, home textiles, home decoration and automotive trim. Output value is expected to reach 2 billion yuan this year.

Besides, major economic indicators including production, quality, variety, brand and performance all take the leading position among the fellows worldwide.
Culture

Vision: We have been pursuing the concept of earning money while keeping healthy, trying to meet with the needs of material, spirit and health of our staff to the full extent, with employee satisfaction reaching above 98%. Besides, we will create green products that comprehensively utilize resources, with high quality and practical benefits.

Targets:
1. Sustainable development
2. Keep leading edge worldwide
3. Be health-featured enterprise in the world

Culture

Mutual benefit
Conscientiousness
Health
Culture  Mutual benefit

1. Enterprise
2. Staff
3. Nation
4. Society
5. Partner

While obeying the law, we always bind ourselves with high moral standard.
Culture

Health

✓ Not only make money, but also keep healthy
✓ Better life after joining in Dafa
✓ Main purpose of life is to be healthy and happy, and all the activities will directly or indirectly serve for health and happiness.

1000000

Health measures

1. Free annual health examination for 12 consecutive years for all staff
Expense standards: 400 yuan each time for ordinary employees; 1,000 yuan each time for administrative and canteen employees, employees with working age over 10 tens, and grass-roots cadres; 2,000 yuan each time, twice, for factory manager, section chief, and deputy general manager. Everyone's health examination results have been input into health management system so as to carry out dynamic management.
Health measures

2 Health Award
15 indicators are established, including 10 indicators for health examination (40 points), BMI measurement (20 points), study on health (10 points), psychological health (10 points), sports (10 points) and personal hygiene (10 points). Monthly check with a full score of 100 points, and reward of 400 yuan each month, with the premise that one must sign a commitment of smoking cessation. No smoking cessation, no reward, even if the body is well.

3 Everyone will be provided with a box of best yoghurt (or raw walnut, organic red dates, etc. of equal value) in the local market each month.

4 Each employee will be provided with an electric toothbrush worth over 400 yuan.

5 Health lecture around once each month, with multiple ways for propaganda of health education, such as special column of enterprise newspaper, propaganda column, message, related wechat platforms and so on.
Health measures

6. Special post at first production line

Equip every employee with labor protection appliances, and make good health management, in strict accordance with the labor protection requirement; environmental monitoring at regular intervals, work shift at regular intervals, and one more occupational health examination each year.

7. High-temperature production areas

Add ventilation equipments in the workshops, set up operation observation room, and equip air conditioner to improve working environment.

Health measures

8. Issue self-compiled health brochures four times, with over 10 thousand brochures published. Buy related health books for all the staff to study, or give them to related staff as a present. Subscribe for related newspaper for all teams, groups and departments.
Health measures

9. Invite doctors and experts for a visit every week, involving all departments (internal department, surgical department, gynaecology, orthopedic department, acupuncture and tuina department, etc.), free of charge and prescribing on spot.

10. Establish health consulting room, to resolve the doubts and measures height, weight and blood pressure for employees at ordinary times.

Health measures

11. Forest-like office

Over ten pots of green plants are put in each office, and two air purifiers are placed as well, with one for internal circulation and the other to infuse fresh air from the outside to maintain sufficient oxygen. PM2.5 is kept below 20, neglecting the level outside. Besides, artificial waterfall is placed in the general manager's office, with negative oxygen ion density at over 1,500/cm³, indicating international superior level.
Health measures

12 Canteen controls the per capita dosage of cooking oil and salt, and issues statistical statements every month.

13 Deep-fried, salted, smoked, toasted, finished and mouldy food are all forbidden, while all kinds of grains and brown rice are advocated, with aginomoto also unused.

Health measures

14 Secondary filtering is adopted for water use in the canteen, and a specially-assigned person comes to detect the electric conductivity every Monday morning, with that for the water used to make food below 5 (the numbers for qualified tap water is around 500, while the national standard is below 1,000).

15 Vegetables for canteen are supplied by two designated farms, and olive oil, camellia oil and sea salt are adopted during the cooking. Public chopsticks and spoons are provided, with individual serving.
**Health measures**

16 **Dafa Healthy Team with general manager as the leader**

- Set up health commissioner;
- Employ archiaters and China Health Managers with over 30 years of experience in health care as health consultants (4 in total);
- Employ doctors and professors who have studied in the US to give lectures, guide health maintenance and purchase healthy food in the world.

宁波大发化纤有限公司

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17 **Various sports equipments are provided, totally over 60 sets in over 20 varies, including 10 table tennis tables. Sports meet is held once every year, coupled with physical fitness test and match. 15-minute sports time is provided in the each half day for administrative staff.**

宁波大发化纤有限公司
18. To reduce mobile phone radiation, we have changed the mobile phone card from China Mobile to China Telecom, ensuring everyone can use low-radiation mobile phone. Besides the free mobile phones for every employee, two years of mobile phone bills are also given.

19. Pessometer, massage comb and radiation-protection sticker are provided for every administrative staff and medium/senior cadres. Besides, foot massage device and electric-heating foot tub are allocated for senior cadres.
Health measures

20 All kinds of test instrument

- Air related: PM2.5, PM10, negative oxygen ion, formaldehyde, general volatile matter, oxygen content, chlorine-containing ratio
- Body related: Muscle-containing ratio, blood pressure, heart rate, height, weight, BMI
- Diet related: Electric conductivity, pesticide residue
- Others: Electromagnetic radiation, etc.

21 In the dormitory, two-layer hollow glass windows are installed for sound proofing and heat preservation, with dark double-deck curtains to enhance the sleep quality. Two-layer hollow glass windows are also installed in all the office, while four-layer such windows are installed in the office for general manager.
Health measures

22 From April 2015, we have taken advantage of health education to guide weight reduction via comprehensive intervention on dietary structure and lifestyle. Following over one month of training, we carried out a new round of physical examination, and compared the results with the year-ago period. Hereinto, the involved 51 employees totally reduced 258.8 kg of weight, with indicators mostly at normal levels.

23 From July 2016, we have taken advantage of the meetings before and after the office hours, to arrange health commissioners to communicate with staff for about 5-10 minutes, and such small-scale study meeting has been held for over 300 times by June 2017.
Health measures

24. Set up Dafa’s health club, including table tennis, basketball, football, badminton, snooker, running and fitness dance, with over 100 employees attending. With special funds allocated, the interests of employees will be combined with health campaign.

Three words to help you keep healthy: Awareness, method and persistency.

Awareness refers to that you should actually want to keep healthy, instead of just a talk; and then you will try to find the method. With the method, you should persist, and in turn health will be there.
Effect of health management

In recent years, we have spent around 6 million yuan every year in health management, and have enjoyed good results, despite the high expenditure.

Effect of health management

1. Growing health consciousness of staff

Health consciousness of over 1,000 employees have been generally reinforced, with their family members also influenced greatly. All kinds of unhealthy life modes have been improved to different degrees.
Effect of health management

2 Smoking-cessation rate of staff increases

No smoking rate has risen from 35% before the release of health reward (in 2011) to 93.6% now. The rest employees are also smoking less cigarette, down from over 10 every day to below 5 now. Then, a lot of money spent on cigarette has been saved, the harm from passive smoking has been greatly reduce, and unhygienic conditions and fire risk stemming from smoking have been significantly cut as well.

Effect of health management

3 Low employee turnover rate

Health project satisfies employees’ rigid needs, which makes them feel at ease when working in DaFa, and the annual employee turnover rate has fallen from 20% six years ago to below 10% in 2016, with no core persons leaving.
Effect of health management

Higher employee satisfaction

Employees will feel happier and be aware of company’s care for them with healthy body, and in turn the employee satisfaction will reach over 95%, which will be converted into more devotion, stronger initiative and continuous innovations towards their positions. As such, the company’s benefit will grow steadily.

Dafa in steady and healthy development

Currently, Dafa retains the leading position among the fellows worldwide in terms of competitiveness. In the past eight years, we have never suspended production during the Spring Festival, and our scale is always expanding, which is rare in the world.
**Effect of health management**

6 Sustainable & healthy development

With good profits, Dafa is able to take out some funds to do health and charity affairs. And as a positive cycle has been forged, health has been one of the core competitiveness, with the knowledge of ‘National Enterprise Health Management Sample’ by the media. According to related evaluation, around 90% staff think that they will enjoy a better and longer life.

---

**Initiate new health programme**

1. At least 2 new health measures each year
2. To realize zero smoking rate by the end of 2018
3. To be health-featured enterprise in the world
Initiate new health programme

It is just a starting point to initiate a health-featured enterprise, while the final goal is to implement the strategy of Health China. With 'China Enterprise Health Management Promotion Alliance' as the supporter, we have proposed several suggestions including preventive treatment of disease and smoking control via mainstream media for many times, and invited members of the national committee of CPPCC and related specialists to discuss for several times. And in the two sessions of 2015, 2016 and 2017, these suggestions have been illustrated as the joint suggestion of over 10 members of the national committee of CPPCC, and acquired good effects.
Traceable Chemical-method
High-quality Recycling of Wasted Polyester Textiles

Yu Xinjian

Chief Engineer

Zhejiang Jiaren New Materials Co., Ltd.
Traceable Chemical-method High-quality Recycling of Wasted Polyester Textiles

Yu Xinjian
Chief Engineer
Zhejiang Jiaren New Materials Co., Ltd.

I. Features of chemical-method recycling

II. Technology

III. Product

IV. Members and cooperators of ECO CIRCLE™
We pursue a permanently closed circle of garment to garment, with the ECO CIRCLE™ solution of Teijin.

**Recycling-repeatable**

Compared with other chemical fibers for one-off recycling, products made with Jaren’s fibers can be recycled repeatedly to produce high-quality products through chemical decomposition process.

- We cooperate with ECO CIRCLE™ members to promote R&D, commercialization and recycling of products.

**2. Mechanism**

Polyester products decomposed to molecule level, with colors and miniature impurities, which are difficult to handle with other methods, removed, just leaving polyester of the same quality of virgin product.
3. Comparison between processes

Features of fibers recycled with chemical method:
- Quality equal to virgin PET
- Excellent performance in function and texture
- Long durability

There is hardly any defect with recycled fibers that may reduce acceptance among consumers compared with original fibers, regarding aspects such as fashion and function, etc.

4. Quality

Equal in quality

Recycled PET

Virgin PET
5. Traceability

1. DMT process: $-\text{CH}_3$
   PTA process: $-\text{COOH}$

2. Special catalyst applied during chemical reaction: 60-90ppm/PET according to element detection

3. Standard to identify recycled polyester fiber came into effect on 1 Mar, 2016

6. LCA Evaluation

- CO$_2$ emission reduced by 52\%
- Energy saved by 38\%

Compared with those making from virgin polyester fiber
7. Environmental certification and hang-tags

Certificate of Conformity

Recycle fiber Recycle fiber

II. Technology

1. Process
4. DMT purification

Purity of the raw material DMT is a key factor that decides the quality of recycled polyester chip. After the steps of rectification and distill to remove impurities and EG, DTM of 99.99% purity is collected, with the remaining to go through rectification again.

III. Products

1. Chip

- SD-R Chip
- FD-R Chip
- BB-R Chip

Can be used to produce fine denier and super fine denier FDY, POY and DTY of the same quality of virgin PET chip. Good spinning performance.
<table>
<thead>
<tr>
<th>Index</th>
<th>GB/T 14108-2015 FDPET chip Bright, semi-dull AA grade</th>
<th>Recycled FDPET chip made with chemical method AA grade (Jieren)</th>
<th>FZ/T 51013-2015 Recycled FDPET chip Grade A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intrinsic viscosity (dL/g)</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 0.010</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 0.012</td>
</tr>
<tr>
<td>2</td>
<td>Melting point/°C</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 2</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 3</td>
</tr>
<tr>
<td>3</td>
<td>Over-length chip/ (mass fraction) %</td>
<td>≤ 0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>4</td>
<td>Ash content/ (mass fraction) %</td>
<td>≤ 0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>CTCDD (ppm)</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 4</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 4</td>
</tr>
<tr>
<td>6</td>
<td>Chroma</td>
<td>L-value</td>
<td>Report value</td>
</tr>
<tr>
<td></td>
<td>B-value</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 2.0</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 2.0</td>
</tr>
<tr>
<td>7</td>
<td>Moisture/ (mass fraction) %</td>
<td>≤ 0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>8</td>
<td>Agglutinated particle (mg)</td>
<td>≤ 3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>9</td>
<td>Dicyclop (mass fraction) %</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 0.15</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 0.15</td>
</tr>
<tr>
<td>10</td>
<td>Iron (mg/kg)</td>
<td>≤ 2</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Powder/mg/kg</td>
<td>≤ 100</td>
<td>100</td>
</tr>
<tr>
<td>12</td>
<td>Titanium dioxide (mass fraction) %</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 0.03</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 0.03</td>
</tr>
<tr>
<td>13</td>
<td>End methyl (moi)</td>
<td>--</td>
<td>M_M&lt;sub&gt;N&lt;/sub&gt; ± 3</td>
</tr>
</tbody>
</table>

### 2. Filament

**FDY**

- Fine Denier: 20D/12F20D/24F30D/24F30D/72F50D/72F, etc.
- Conventional: 75D/36F75D/72F100D/48F100D/36F150D/48F150D/36F etc.
- Differentiated WAVERON: 40D/36F75D/50F(anti-UV, window-proof, water-proof, unidirectional transparent)

Stable production with high evenness and the same quality with virgin fiber. Dyeing grade above 4.5, 8.0kg in weight as maximum depending on customer's requirement. Sustainable supply.
DTY

Fine denier:
20D/12F30D/24F30D/36F50D/72F50D/144F65D/192F

Conventional:
75D/6F75D/72F100D/86F100D/96F150D/48F150D/144F
300D/90F及150D/288F300D/576F

Special varieties: CALCULO cross profiled
75D/12F100D/12F150D/144F（S+Z）（sweat-absorbing and light）

Stable production, with the same quality with virgin fiber.
Dyeing grade above 4.5. Fixed length and weight (generally 5kg).

With the same quality as original chips, our recycled FG PET chips can be used to produce differentiated fibers upon customers’ requirements.

Such as:
① Colored yarn (Black, red, blue, grey, etc.)
② Full dull/Super bright
③ TTY
④ Conjugated yarn (CDP, ITY, sea-island, etc.)
⑤ Profilled yarn
⑥ Functional yarn
etc.
Recycling saves our earth!

Thank you!
LSP – Liquid State Polycondensation—
A New and Proven Process for the
Up/recycling of PET Fibers and Textiles

David Hehenberger

Product Manager

Next Generation Recyclingmaschinen GmbH
LSP - Liquid State Polycondensation:
A new and proven process for the up/recycling of PET fibers and textiles

CONTENTS

- NGR in brief
- The LSP Process (Liquid State Polycondensation)
  - PI-REACT – basic functions and handling of the PI-reactor
  - Process simulation
    - PET process components
  - LSP advantages
  - iPET – melt direct conversion
    - Sheet applications
    - Fiber applications
  - Summary and conclusion
INNOVATIVE PLASTIC RECYCLING SOLUTIONS

Next Generation Recyclingmaschinen GmbH
HQ, Production & Customer Care Center Europe
4031 Feldkirchen, Austria

www.ngr.at

Number of Employees: (NEXT GENERATION GROUP): 250
Annual Sales: ~100 Mio. €
PET UPCYCLING

WITH

LSP PROCESS
(LIQUID STATE POLYCONDENSATION)
### PET PROCESS COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>SSP (Solid State Polycondensation)</th>
<th>LSP (Liquid State Polycondensation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode of Work</td>
<td>Rössel (crystallization)</td>
<td>Lyophil (melt)</td>
</tr>
<tr>
<td>Environment</td>
<td>Hot gas or vacuum</td>
<td>Vacuum</td>
</tr>
<tr>
<td>Typical Temperature</td>
<td>(360-365) °C</td>
<td>(270-280) °C</td>
</tr>
<tr>
<td>End Product</td>
<td>Pellet crystallized</td>
<td>Pellet crystallized / amorphous</td>
</tr>
<tr>
<td>IV</td>
<td>Front, through the long residence time and controllable</td>
<td>Adjust- and controllable</td>
</tr>
<tr>
<td>IV - Lift - Speed</td>
<td>(0.31 - 0.32) g/hour (Paddle)</td>
<td>(0.07) g/hour</td>
</tr>
</tbody>
</table>

### LSP PROCESS - ADVANTAGES

- Continuous process - no batch-related problems
- IV-Increase within minutes and automatic control of IV-level
- Extremely good decontamination performance
- No color degradation in the LSP reactor
- High energy efficiency
- FDA and EFSA approved for 2004 food contact
- Small footprint
- Flexible in melt application
DIRECT FIBER PRODUCTION
UPCYCLING UNIT FOR THE PRODUCTION OF HIGH-QUALITY PET-FIBER OUT OF PET-SCRAP

DIRECT FIBER PRODUCTION
BOTTLE FLAKES TO DIRECT SPINNING

- Only 3 filament breaks per minute on a three yarn line
- Stabilized IV from various input flakes
- One-step process
- Energy and space efficient because of direct converting
DIRECT FIBER PRODUCTION
BOTTLE FLAKE TO DIRECT SPINNING

P: SHEET
UPCYCLING UNIT FOR THE PRODUCTION OF HIGH-QUALITY PET-SHEETS OUT OF PET-SCRAP
P:SHEET
UPCYCLING UNIT FOR THE PRODUCTION OF HIGH-QUALITY PET-SHEETS OUT OF PET-SCRAP

P:REACT with PET-sheet flat film unit

KUMME PET sheet winde

Current Sheet Production

<table>
<thead>
<tr>
<th></th>
<th>Virgin</th>
<th>Skeletons</th>
<th>Bottle Flakes</th>
<th>Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Skeletons</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Sheet</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Sheet Production with LSP

<table>
<thead>
<tr>
<th></th>
<th>Virgin</th>
<th>Skeletons</th>
<th>Bottle Flakes</th>
<th>Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Skeletons</td>
<td>40%</td>
<td>50%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Sheet</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
SUMMERY LSP DIRECT CONVERSION

- Saves energy by eliminating one step of reheating and cooling down
- P-REACT ensures lowest value of IV-fluctuation
- IV-level can be adjusted due to the requirements of the finished product (very stable)
- 100% food-grade allows for highest flexibility (fluores cleared prior to processing)
- Small footprint
- No inventory required for pellets
- High quality products out of low cost PET-scrap as material source
Experience the Next Generation of S.M.A.R.T. plastic recycling innovations
The New Sorema Delabeling Solutions

Yu Zheng

Sales Engineer

SOREMA div. of PREVIERO N. SRL
THE NEW SOREMA DELABELING SOLUTIONS

«Hot/cold bottles pre-washing with integrated labels separator»

Yu Zheng
Assistant to Sales Department

6 - 8 September, 2017
CORPORATE IDENTITY

Fact and figures

More than 200 recycling systems installed Worldwide

More than 1.5 Million ton/year plastics waste recycled with SOREMA washing Technology

Next challenge

- From technology supplier to integrated service supplier.
- Engineering, machineries and management services.
- Projects in plastics recycling are moving to larger scale with high-END applications.
  Market requires full turn key project with management support during first 1 or 2 years of production.
PREVIERO / SOREMA ACTIVITY

Business Units

PLASTICS SIZE REDUCTION

RUBBER GRINDING SYSTEM

WASHING LINE AND MODULES

TURN KEY SYSTEM

SOREMA ACTIVITY

Leader in recycling technology for packaging and other post consumer materials

Wide range of complete solutions ranging from complete turn key projects to single modules

More than 40 years experience in the construction and installation of plastics recycling plants, grant to Sorema a leading position in the market
PREVIERO ACTIVITY

More than 60 years experience in machinery construction.

Market leader in the production of rubber grinding and storage plants.

Complete and customised solutions for size reduction, transport of plastic and cellulose products.

PREVIERO / SOREMA ACTIVITY

To provide global technical solution

1. Research - Analysis of process conditions
2. Engineering and technical assistance
3. Manufacturing and pre-assembling
4. Onsite installation (turnkey or supervisor)
5. After sales and production support
6. Management service
THE NEW SOREMA DELABELING SOLUTIONS

- **Commercialization**
  - Several machines installed in Europe, Asia and USA.
  - Excellent results on PS, PVC and other labels removal.
  - Strong surface decontamination.
THE NEW SOREMA DELABELING SOLUTIONS

Advantages

- Special compact layout design
- Very limited loss of bottle necks
- Sleeves labels separation
- Efficiency in the separation of both contaminations and labels
- High % of labels removed
- Low loss of bottle necks
- High flexibility

THE NEW SOREMA DELABELING SOLUTIONS

Advantages

- Cost effective
  - Designed machine with anti-wear parts
  - Any additional chemical is required
  - Isolates/minimizes wear
  - Affordable replacement parts
  - Low thermal energy consumption
  - Due to the low water temperature it can be installed a physical chemical treatment which reduces the consumption of water to one-third of the nominal one
  - High efficiency motor
  - Easy maintenance operations
  - Low maintenance costs
THE NEW SOREMA DELABELING SOLUTIONS

The New Delabeling, pre-washing system

WET PROCESS

THE NEW DELABELING PRE-WASHING SYSTEM

Main characteristics

New Sorema “Delabeling / Pre-washing” system, designed for PET bottles washing lines, ensures:
• the highest quality of pre-washing and all labels separation (PVC, PS, PETG…) with a single module in wet conditions
• Possibility to wash at HOT / COLD conditions in accordance to the input material characteristics and contaminations
• Associated with a ballistic separator ensures a high efficiency in separation of labels from bottles
THE NEW DELABELING PRE-WASHING SYSTEM

The Sorema sleeve labels removing system with ballistic separator

Technical specifications

- Bottles characteristics:
  - Average weight: 35 g
  - Volume: 100-5000 cc
- Labels: paper, polyolefin, PETG, PVC glued and or sleeves
- Maximum input capacity: variable according to the type of machine model
- Labels separation: high efficiency
- Reduced water consumption: coming and recirculated from upstream washing modules
- Possibility to work with HOT and COLD water flow
THE NEW DELABELING PRE-WASHING SYSTEM

► Models available

<table>
<thead>
<tr>
<th>PREWASHING DELABLER</th>
<th>Type 3000</th>
<th>Type 6000</th>
<th>Type 9000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation capable TMS</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Water cleaning process available</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Dry labels separation process available</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>MAX Production Kg/h</td>
<td>3,000 - 4,500 Kg/h</td>
<td>5,000 - 7,000 Kg/h</td>
<td>7,000 - 10,000 Kg/h</td>
</tr>
</tbody>
</table>

THE NEW DELABELING PRE-WASHING SYSTEM

► Examples of material processed

- Input Material: Shredded labels, PET/PE terephthalate
- Bottles and shredded labels after Delabeling Action
- Printed Labels

95
THE NEW SOREMA DELABELING SOLUTIONS

The Sorema Dry Delabeler

DRY PROCESS

THE SOREMA DRY DELABELER

- The Sorema sleeve labels removing system with aerodynamic label separator or ballistic separator

INPUT MATERIAL: Sleeves, Labels, PET bottles from Post consumer Bales

REMOVED CONTAMINANTS: Plastic labels and light contaminants

OUTPUT MATERIAL: High purity of PET bottles without labels
THE SOREMA DRY DELABELER

Examples of material processed
DRY TREATMENT

Input Material
Attraction-Prevent Stitches

Output Stitches

Removed Labels

THE SOREMA DRY DELABELER

System composition
DRY TREATMENT

Label Separation/Seperation System

Rinse Floater/Center

Delabeler
THE SOREMA DRY DELABELER

System composition
DRY TREATMENT

Labels belt/brick separation system

Delabeler

WHERE TO INSTALL A DELABELER

Full stream

BALE BREAKING → DRY SORTING → PREWASH → OPTICAL SORTING → MANUAL SORTING → WET GRINDING

ADVANTAGES:

- Easier installation on small lines
- High labels removal for full stream
- Optimization in pre-washing and in downstream sorting steps
WHERE TO INSTALL A DELABELER

- Side stream

ADVANTAGES:
- Easier installation on large lines
- Minimized material loss

THANK YOU FOR YOUR ATTENTION
Development Road of Elite Color

Zhu Jinya

Director of Strategic Development

Elite Color Environmental Resources Science & Technology Co., Ltd.
Elite Color Environmental Resources Science & Technology Co., Ltd

Add: 29 Huanxi Road, Zhutang Town, Jiangyin City
Tel: 0510-86380700

Content

- Organizational Based View (OBV)
- Market Based View (MBV)
- Resource Based View (RBV)
- International Strategy Analysis
- Corporate Social Responsibility
1.1. Profile

Elite Color Environmental Resources Science & Technology Co., Ltd (ECER) is a “National Recycled Colored Fiber New Materials R&D and Production Base” and a “Green Fiber” R&D Base officially certified by China Chemical Fibers Association. Our company seeks development through innovation and strengthens industry-college-institution cooperation so as to highlight the characters learnt as recycling and dope dyeing. With waste textile products as raw materials, we can produce four categories of fiber products that are used in engineering industry, civil carpets, auto interior decoration and high-end clothing respectively, covering nonwoven fabric, functional compound special fiber, auto interior decoration, environment-friendly new decorative materials and high-end clothing fabric. We have seized the top position in this industry based on our product development capability, processing technology and product and service quality.

ECER has obtained the honors such as “High-Tech Enterprises in Jiangsu Province” and “Scientific and Technological Enterprise in Jiangsu Province” for many consecutive years. Our company adheres to the concept of “Win-win development and client first”, actively cooperates with our clients in the development of new products and seeks to find solutions to high-speed and high-efficiency colored fiber and functional fiber, so as to realize common development with our clients.
1.2. Structure

Material management (Logistics)  
Financial resource management (Fund flow)  
Human resource management (People)  
Information resource management (Information flow)

ERP system

1.3. Theory of business

Technology
1. Focus on R&D and manufacturing of regenerated polyester raw materials
3. Make contribution to global green and low-carbon economy.

Turning waste into treasure innovative development

Assets
1. “Internet plus” cooperation and combination between strong enterprises
2. Finish stock reform, introduce private equity (PE), and plan to list on A share market

Market
1. Customer oriented
2. Bring convenience and warmth to customers and shift focus from product selling to service.
1.3. Theory of business

New resources
- New technologies
- New products

Efficient application
- Functional facility
- High-valued products

1.4. Honors of ECER

Recycled chemical fiber
1. With regenerated resources as raw materials and without pollution during the course of production.
2. Up to energy-saving and emission-cutting standard of green fiber during the course of production.
3. Up to safety and environmental protection standard of green fiber.

Dope-dyed chemical fiber
1.4. Honors of ECER

An advanced enterprise with the largest social responsibility in China's chemical fiber industry during the 12th five-year plan period.
An industrial contribution award in China's chemical fiber industry during the 12th five-year plan period.
National Recycled Colored Fiber New Materials R&D and Production Base
A standing director unit of China Chemical Fiber Association
One of the first batches of enterprises receiving Green Fiber State certification
High-Tech Enterprises in Jiangsu Province
Pharmaceutical Scientific and Technological Enterprise in Jiangsu Province
An enterprise postgraduate workstation in Jiangsu Province
An internship base for postgraduates of East China University

1.5. Media reports

Variety
- Produce personalized variety and develop new products with more efforts

Quality
- Continue to improve quality based on science and technology

Brand
- Emphasize green and environmental protection concepts and promote brand development
2. Market Based View (MBV)

2.1. Patented products

- **Regenerated night-vision fiber**
  - Good evenness, launderability and stable property after long-term use, with little influence on the environment during the course of production.

- **Special-purpose fibers for artificial turf**
  - Filtering fiber for the transformation during the course of vortex spinning.

- **Compound electro-conductive fiber**
  - An important raw material for static-free, electromagnetic shielding fabric.

- **Super course demer hollow fiber**
  - Study and durable, wrinkle-resistant, easy to dry after washing, acid and alkali resistant, not afraid of mildew and moth eaten, widely used in artificial turf and cleaning appliances.
2.1. Functional products

- **High-tensile colored re-PSF**: One of green and energy-saving chemical fiber products with the largest demand, and resistant to color fading and losing.

- **Flame-retardant re-PSF for auto interior decoration**: With good compositionality, high tear strength, easy-wash property, fine resilience and wrinkle resistance, take up more than 90% of the consumption in auto decoration fabric.

- **Colored flat anti-bacterial polyester fiber**: Widely used in household textiles, underwear, sport shirts and so on, particularly suitable to clothing of old people, pregnant women, babies and children. With long-term efficacy against bacterial and launderability.

- **Compound modified PSF**: Able to change physical properties by combining smaller-than-aute-sized solid with fibers through compound machines with patent, and provide special function to fiber products that can meet the requirement of clients.

2.2. R&D procedure

1. Feasibility study
2. Implement development plan
3. Perfection and mass production
4. Make development plan
5. Trial sale and feedback
2.2. Application fields

- Engineering industry
- Civil carpets
- Auto interior decoration
- Functional clothing

2.2. Engineering industry

Our engineering fibers are mainly used in seepage prevention for major engineering projects, and our company is one of suppliers for key engineer projects like South-to-North Water Diversion Project and Beijing-Shanghai Bullet Train.
2.2. Civil carpets

Such kind of special-purpose fibers are used in great exhibitions, celebration activities, and household decoration, and civil carpets made from such fibers are applied as flooring materials in China's military parade, World Expo and newly built guesthouse and hotels.

2.2. Auto interior decoration

Such kind of fibers are mainly used as auxiliary products of auto interior decoration for brand automobiles like BMW, Benz, General Motors, Hyundai Motor.
2.2. Functional clothing

Our functional component fibers are mainly used in special clothing and garments characterized as environment friendly, safe and healthy.

2.4. Development goal

Rank the first in the industry
Leading enterprise with sustainable vitality
2.4. Future development

- Change existing knowledge about regenerated fiber and popularize the concept of recycling and green economy.
- Set up an industrial benchmark and implement modular management and development.
- Work out a three-year plan to bring our company from domestic market to international market.

2.4. Corporate culture

- Team construction:
  - Specialized research and development institution
  - Introduce middle and high-end talents
  - Attach importance to personnel training
  - Social insurance for all employees

- Guarantee mechanism:
  - Create opportunities for employees
  - Share incentive mechanism
3. Resource Based View (RBV)

3.1. HR advantages

**Industry alliance**
Strengthen industry-college-institution cooperation and explore new ways for large-scaled spreading of innovative products.

**Capital cooperation**
Pay attention to the combination between tradition and innovation, and talk about the cooperation with "Internet plus" enterprise.

**Endogenous growth**
Train our employees and technicians and provide more favorable policies to high-quality talents.
4. International Strategy Analysis

4. International Strategy

Into the National team

- Dominate or participate in the work of setting standards, industry-college-institute cooperation and the application and transformation during the research and development of the science and technology items of national strategic projects.

Go global

- Perfect existing business management mechanism so as to realize an intelligent manufacturing module management.

- Seize niche market and make global distribution based on the industrial characters.

- Relying on internet plus global supply and marketing system, our foreign trade team joins in the global distribution framework.
5. Corporate Social Responsibility

5.1. Green enterprise

First group of certified Green Fiber enterprise

On 13 March 2016, China Fibre Textile Trends Release Conference made an authoritative announcement about the “Green Fiber” logo which is a symbol of health, environmental protection, and sustainability. Eight enterprises including ECER were the first group of enterprises obtaining the honor of officially certified "Green Fiber" producers.

ECER advocates green development and environmental protection, and is focused on the R&D and production of dope dried PSF with regenerated polyester frits as raw materials, so that the printing and dying process with high energy consumption and high pollution can be removed. To become an environment-friendly enterprise, ECER strictly implements 5 development ideas including innovation, coordination, green development, opening up and sharing which is put forward in the 13th five-year plan.
5.2. Contribution to the society

We grow up together with our customers and build a good reputation among them.

我们和客人
一起成长，建立
良好的口碑

优彩
Thank You!

优彩环保资源科技股份有限公司

The Core Environmental Resources Science & Technology Co., Ltd.
Finish Oil: R&D and Large-scale Intelligent Manufacturing

Ye Guanghua

General Manager

Huangshan Qiangli Chemical Co., Ltd.
Huangshan Qiangli Chemical Co., Ltd.

We produce spin finish oil, silicone oil, antistatic agent, synthetic ester, lube, high-purity lyoamme, etc.

Finish Oil: R&D and Large-scale Intelligent Manufacturing

Huangshan Qiangli Chemical Co., Ltd.
Ye Guanghua

E-mail:ygh@hsqlhg.cn
I. Overview of chemical fiber and finish oil development

Global chemical fiber production:
Rapid increase in the last decade, to 311.6 million ton in 2016 from the 151.34 million ton in 2007, with annual growth rate averaged at 10.59%. However, the growth rate averaged at -1.85% in latest three years, indicating huge over-capacity.

Global finish oil production:
Rapid increase in the last decade, to 2.93 million tons in 2016 from the 1.97 million tons in 2007, with annual growth rate averaged at 4.89%. Growth of finish oil production is slower than that of chemical fiber, because of rising oil quality, as well as improving processes and management of chemical fiber producers.
I. Overview of chemical fiber and finish oil development

Chemical fiber production in China

Similar to growth in world scope, the production rose to 49.44 million tons in 2016, from the 24.14 million tons in 2007, with annual growth rate averaged at 3.84%. Never the less, production in 2016 was 5.11 million tons higher than that in 2014, indicating that the industry in China still had strength.

Finish oil production in China (foreign funded included)

China’s domestic finish oil production rose to 464.7kt in 2016, from 313.8kt in 2007, with annual growth rate averaged at 5.45%, higher than global average thanks to fast economic development of the country.
I. Overview of chemical fiber and finish oil development

Polyester fiber production in China

China’s domestic polyester fiber production rose to 39.74 million tons in 2016, from the 25.13 million tons in 2010, with annual growth rate averaged 8.30%. However, in 2013 production posed merely a 0.74% increase year on year.

I. Overview of chemical fiber and finish oil development

Operating rate of China’s domestic polyester fiber plants:

During the period between Apr 2013 to Mar 2017, overall run rate of domestic PSF plants was below 70%, while that of PFO was below 80%, indicating heavy over-capacity.
### I. Overview of chemical fiber and finish oil development

#### Spin finish oil demand in China’s polyester industry:

The demand had picked up to 347.3kt in 2016, from 224.7kt in 2010, with annual growth rate averaged at 7.79.

<table>
<thead>
<tr>
<th>Year</th>
<th>Demand (kt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>224.7</td>
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<tr>
<td>2011</td>
<td>247.6</td>
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<td>262.5</td>
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<tr>
<td>2015</td>
<td>315.5</td>
</tr>
<tr>
<td>2016</td>
<td>347.3</td>
</tr>
</tbody>
</table>

#### Strategy and targets of China’s chemical fiber industry

- Average annual growth to be adjusted to 3.6% from the 9.2% during 12th Five-Year Period
- Merge between enterprises is encouraged, and development of industrial fiber should be a priority
- The whole industry is expected to make joint efforts to promote innovative applications
- In the 5 years to come, high-end fiber products will gain further development, with high-performance, differentiated and bio-chemical fibers going more popular in frontier fields such as new energy, environment protection, aviation and aerospace, etc.
- Emission of main pollutions to be reduced by 10% by the year of 2020
- With central government pushing forward the supply-side structural reform, many outdated fiber capacities will be eliminated, thus to optimize the industry structure.
I. Overview of chemical fiber and finish oil development

Importance and perspective of China’s finish oil industry:
- Finish oil plays an essential role in the development of the chemical fiber industry and is a key factor in determining fiber quality.
- Finish oil is of special importance to chemical fiber production in China.
- R&D of new finishing oil is gaining increasing importance, given expanding domestic fiber capacity, increasing varieties, advancing technologies, and raising speed of spinning.
- According to statistics, currently China’s domestic annual output of finish oil totaled over 200 kt, foreign-funded production included, and the country had to import around 40% of its total finish oil consumption.
- High-performance, differentiated, functional, and environment-friendly oils will be the trend.

II. R&D of new finish oil

Common finish oils:
① Primary functions: smoothing, antistatic, emulsifier
② Subsidiary functions: wetting, softening, adding-cohesive, levelling, antioxidant, detergent, penetrating, PH-adjusting, viscosity-improving, stabilizing, defoaming, bactericide, preservative, balance-control
II. R&D of new finish oil

2. 1 Smoothing agent

- Which can reduce friction between fiber and fiber/other materials, and make fibers more soft, smooth and shining

II. R&D of new finish oil

2. 1.1 Varieties of smoothing agents

- Mineral oil, HEES and organosilicon
- Mineral oil includes white oil and saxoline
- HEES includes aliphatic ester, polyhydric alcohols, acid esters and lipidations of polyatomic acid and alcohols, etc.
- Synthetic ether includes AEO, FMEE, polyoxyethylene ether, polyoxypropylene ether, etc.
II. R&D of new finish oil

- Organosilicon
- Non-functional
- Functional

2.1.2 Performance comparison

Smoothing:
Organosilicon oil > HEO/Synthetic ether > mineral oil

Heat-resisting:
Organosilicon oil > HEO/Synthetic ether > mineral oil

Volvility:
Mineral oil > HEO/Synthetic ether > organosilicon

It leads to the conclusion that organosilicon has better performance than other varieties in many aspects
II. R&D of new finish oil

2. 1.3 R&D of new organosilicon smoothing oil

Molecular formula:

\[
\text{CH}_3 \quad \text{Si} \quad \text{O} \quad \text{CH}_3 \\
\text{CH}_3 \quad (\text{CH}_2\text{Si(O)}_n \quad (\text{CH}_3\text{CHD})_m \quad \text{Si} \\
\text{CH}_3 \quad \text{OH} \quad \text{CH}_3\text{CHD} \quad \text{OH} \quad \text{CH}_3
\]

II. R&D of new finish oil

2. 1.3 R&D of new organosilicon smoothing oil

New series of high quality acquired by adjusting structure and molar ratio. Could be applied in PSF and PFY production.

Including:
QL-9688 used in auto nonwovens
QL-6178 used in 3-D-crimped fiber
QL-7378 used in down-like fiber
II. R&D of new finish oil

2. 1.4 Non-solvent process of HEES/Synthetic ether smoothing oil
- R&D of non-solvent process has been a high-light in world smoothing oil territory.
- The R&D team of Qiangli Chemical, after years of work, had finally achieved the non-solvent process, based on which we have developed various finish oils that are of high quality and environment-friendly.

II. R&D of new finish oil

- 2.2 Antistatic oil
- Which helps to reduce friction of fibers by increasing fibers’ electric conductivity. Antistatic oils applied in chemical fiber production are mainly surfactants.
II. R&D of new finish oil

- 2.2.1 Varieties and performance of antistatic agent:

- The most common way to classify antistatic oil is to classify by chemical structure (non-ion, anion, cation and amphoteric-ion) and application form (outer/inner). Antistatic oils used in chemical fiber are usually outer type.

- 2.2.1 Varieties and performance of antistatic oil:

- Anion-type: Of good heat-resistant and antistatic performance. Qiangli Chemical has recently developed the QL-1895 anion-type alkyl ether phosphate antistatic oil.
II. R&D of new finish oil

- Cation-type antistatic oils mainly include quaternium and imidazoline oils. Quaternium, as the most commonly applied, such as SN, are highly adhesive with high polymer materials, and present excellent antistatic performance, while are less heat-stable, and contains relatively high proportion of VOC and solvents, which give them strong smell and make them toxic or stimulating.

II. R&D of new finish oil

- Research on new cation-type antistatic oil mainly focuses on high purity quaternium of more than 99% purity, with VOC and solvents removed. Though Gemini quaternium and quaternium polymers may have better heat stability, they are rarely applied in chemical production due to high costs.
II. R&D of new finish oil

□ Antistatic performance of amphoteric-ion oils is not as good as that of ionic antistatic oil. However, they have better heat stability, and do less damage to high polymer materials. Most of them are low-toxic or non-toxic, and are easy to process.

II. R&D of new finish oil

□ 2.2.2 What is an ideal antistatic oil?

□ An ideal antistatic oil for PSF is supposed to be:
  ① Of effective and endurable performance
  ② Able to maintain stability in temperature above 200°C
  ③ Of adequate compatibility with polyester fiber, to ensure the oil layer playing well with its antistatic function
  ④ No damage to fiber’s performance (such as dyeability, heat-sealing and mechanical property, etc.)
  ⑤ No conflict with other auxiliaries
  ⑥ No smell, no taste, VOC-free, non-toxic
  ⑦ Of low cost
II. R&D of new finish oil

-  2. 3  emulsifier
  - Which enhances surface tension between ingredients in emulsion, thus to make ingredients scattering homogenously and stably.

II. R&D of new finish oil

- Type of emulsifiers
  - Emulsifiers are generally classified into anion-type, cation-type and amphoteric-ion by chemical structure and character; natral emulsifier and synthetic emulsifier by source; surfactant, viscosity enhancer and solid adsorbent by function; oleophylc and hydrophilic.
II. R&D of new finish oil

- Factors that influence stability of oil emulsion
- Many factors influence the performances, including emulsifying method, structure and variety of emulsifier, phase volume, temperature, with the most from structure and variety of emulsifier.

II. R&D of new finish oil

- Choice of emulsifier
- Proper emulsifier helps to facilitate forming of emulsion, and decide the type of emulsion, thus to serve to quality control of emulsion oil.
II. R&D of new finish oil

- Huangshan Qiangli Chemical, with more than 20 years’ experience in oil emulsifying, provides emulsion oil of high stability and quality, and can meet the requirement of uniform oil painting, with outstanding performance of oil slick.

II. R&D of new finish oil

- **2.4 Oil formula and blending**
  - Formula design is to carry out qualitative and quantitative analysis on effective constituent of a oil, and conduct mixture regression according to the data acquired from experiment.
II. R&D of new finish oil

- Through experiments, we may understand the relationship between constituent proportion and oil performance.

II. R&D of new finish oil

- **2.5 Performance test**
  - Object: Polyester staple fibers of varied kinds, steeped in oil, with oil content at 0.1% ~ 0.4%.
  - **PH value test**: to test the PH value of 1% aqueous solution, with a Lei-ci PHS—25.
II. R&D of new finish oil

- **Solid content test:**
  - Sample of around 5g put in a 50mm*30mm vessel, with the vessel dried in a moisture meter, and then read the solid value.

II. R&D of new finish oil

- **Stability test:**
  - Centrifugal stability test: Sample oil put in a centrifuge tube, which is to be placed in a high speed centrifuge. The oil is regarded as centrifugally stable if no layer or floating oil is observed after centrifuged for 30 min at 3000 r/min.
II. R&D of new finish oil

- **Mechanical stability test:**
  - Filtered oil sample stirred for 5-10 min in a high-speed shear agitator at 1500-3000 r/min. Again filter the oil and weigh the remaining on the filter screen. The oil is regarded as of good mechanical stability if no residue remains.

II. R&D of new finish oil

- **Heat stability test:**
  - Sample oil in an assay flask, which is closely sealed and placed in a drying oven at the temperature of 50°C. To test the viscosity at fixed interval. Oil of good heat stability reveals little viscosity change.
II. R&D of new finish oil

- Freeze-thaw stability:
  - Sample oil placed in a cryostat for 24 hours at temperature of -20°C~40°C, and then at indoor temperature for 8 hours. After 5 rounds of such operation, oil of good freeze-thaw stability shows no demulsification.

II. R&D of new finish oil

- Specific resistivity test:
  - Parallel test with sample fiber of 5g in a YG321 tester, at 25 °C temperature and 65% relative humidity.
II. R&D of new finish oil

- Friction coefficient test:
  - Test of \( \mu_k \) between fiber and ceramic with a Y151 tester, at 250 m/min, wrap angle at 180°.

II. R&D of new finish oil

- Cohesive force test:
  - Cohesive force test with a TM tester, to fiber sample without applying oil.
II. R&D of new finish oil

- **Touching test**
  - 50g polyester staple fiber dipped in 1% oil solution for 20 min. Dehydrated for 1 min. Placed in a drying oven of 150°C for 20 min. Touch evaluation in 20 hours after taken out from the oven.

II. R&D of new finish oil

- **Green oil certification**
- **VOC test:**
  - Water extraction. Analysis with a HPLC.
  - Contents to be tested: formaldehyde, acetaldehyde and acraldehyde.
II. R&D of new finish oil

- Green oil certification
- VOC test
- Analysis with HS-GC/MS
- Contents to be tested: benzene, methylbenzene, ethylbenzene and styrene

II. R&D of new finish oil

- Green oil certification
- AP and APEO test:
  - Analysis with LC-MS, based on standard of ISO18254-1:2016
  - Contents to be tested: NP, OP, NPEO and OPEO
II. R&D of new finish oil

- Green oil certification: test report 1

- Green oil certification: test report 2
3 Large-scale intelligent manufacturing

- Intelligent manufacturing is a high light of technology progressing in 21st Century.

3 Large-scale intelligent manufacturing

- Through cooperation with SUPCON in 2014, we have upgraded traditional oil manufacturing process, and commissioned the automatic DCS system, which is highly integrated and intelligent.
3 Large-scale intelligent manufacturing

- DCS has displayed high accuracy and flexibility in both automatic raw material production and oil blending since it started operation half-year ago. It fits well in our strategy of large-scale and cost-efficient production, as well as quick response to market demand.

Welcome to visit us!

Thank you!
Upstream Developments and the Impact on RPET

Stewart Hardy

Global Manager - Petrochemical Market Dynamics

Nexant, Inc
Upstream Developments and the effect on RPET
Stewart Hardy

Prepared for:
CCFEI 13th RePET Conference

September 2017

Agenda

- Introduction to Nexant
- Upstream issues
  - Aromatics
  - MEG
- Effect on PET/RPET
- Conclusions
Upstream Developments and the effect on RPET

INTRODUCTION TO NEXANT

Nexant Thinking provides expertise across the energy value chain

Energy
- Electric Power
  - Grid Management
  - Dispatch Software
  - Energy Efficiency
  - Demand Side Management

Gas
- Gas Market Analysis
  - Market Forecasts
  - Gas monetization

Downstream Oil
- Petrochemicals
  - Product Market Forecasts
  - Gas to Liquids
  - Gas to Liquid

Chemicals and Clean-tech
- Specialty Chemicals
  - Advanced Materials
- Synthetic Fuels
- Alcohols
- Aromatics
- Biorefinery from Biomass, Agro, Wastes, and Agricultural Sources

Greener Chemicals
- Syngas
- Biopolymers
- Olefins
- Aromatics

Renewable Energy
- Biomass
- Geothermal
- Solar (Photovoltaics & CPV)
- Wind Power
- Waste
- Carbon Capture and Storage
- Fuel Cells & Hydrotreated Gas

In-depth knowledge from Nexant Thinking
Nexant Thinking provides global knowledge and regional expertise

Our assignments provide support to management and investors in the chemical industry

PRODUCTS (MULTI-CLIENT)
- Strategic Business Analysis
- Market Dynamics
- Price Forecasts
- Competitiveness
- Technology
- Training

CONSULTING (SINGLE CLIENT)
- National and Regional Masterplans
- Corporate Strategy Development
- Merger & Acquisition: Industry Adviser Support
- Independent Technical and Commercial Due Diligence (to support financial transactions)
- Process, Business and Cluster Benchmarking
- Project Planning/Screening Studies
- Feasibility Studies/Technology Evaluations
- Market Evaluations (including addressable market appraisal)
Nexant has a strong track record as Lenders’ Independent Market, Technical and Environmental Advisor

- Active as Lenders Independent Advisor since 1977
- Team of Highly Qualified Experts with extensive experience advising on investments
- Long Term Experience and Credibility advising on Market, Technical and Environmental issues in the Energy and Chemicals sectors
- Fully familiar with project implementation from initiation of Financing through to monitoring project performance during construction and operation
- Known and trusted by ECAs for their Market, Technical and Environmental due diligence

Nexant's record includes acting as advisor in over $100 billion worth of successfully financed engagements

Upstream Developments and the effect on RPET

UPSTREAM ISSUES - AROMATICS
China's role in the global PX market

- China's imports accounted for 30 percent of global demand in 2016.
- Most recent overseas projects have targeted demand growth in China, but this is no longer an option.
- The lack of demand growth in other regions makes Middle East aromatics developments more challenging.

China's import requirement will remain a significant element of demand, but does not leave room for new exporters in other regions.

Firm PX capacity developments in China

The proposed build is enormous, but proportionally less than what occurred on PTA.
Global PX capacity development

- Reliance 2.3m tons/yr plant at Jamnagar, and the 0.7m tons/yr NghI Son plant in Vietnam account for most growth in Asia.
- ExxonMobil now owns JAC
- Abyrau refinery in Eastern Europe not producing much PX.
- Developments in the Middle East are slowing. Projects in Bahrain and UAE have lost traction. Other refineries are progressing, but are not including aromatics in the first phase, and may instead export naphtha.

The scale of the build in China is stifling developments in other regions.

TDP economics have frequently been unattractive in recent years

- TDP has become less attractive since the fall in oil prices.
- High octane values have kept toluene valuation high.
- Benzene values have been strong, supporting TDP economics.
- Transalkylation is impacted by PX prices and toluene blend values in gasoline, but does not produce benzene.

All new PX complexes include toluene conversion.
Chinese coke production is stabilising

Growth in coke exports to India offsets declining consumption in China. The benzene supply outlook from benzoic is stable, and will not decline further in the coming years.

New liquids crackers will provide sharp growth in benzene supply

After a period of ethylene capacity development dominated by MTO, several new very large scale naphtha/liquids crackers are being built. As with PX, some private companies are driving the capacity growth. There is less interest in new gas crackers, although some liquids crackers are now processing some propane.
What happened with PTA?

- The capacity surge in China caused the closure of older plants totaling around one third of the new capacity.
- Some idled plants in China have been restarted, but those in other regions stayed closed.
- Some of the new market entrants went bankrupt.
- Operating rates have been lowest in China, but rates in other regions also dropped.
- The build continues long after China became oversupplied, and more closures will occur.

China became the most challenging PTA market, and saw the greatest volume of closures.

What will happen with PX?

- New investments will create a "land of the giants."
- As consumers back-integrate, merchant PX sellers have less market to address.
- The Chinese refining industry is slow to reform. Teapot refineries remain in operation despite competition and legislation.
- Delay to some major projects likely a bigger influence than the closure of old units.
- Older extraction plants will run intermittently, keeping pressure on extraction margins.

The scope for rationalisation looks relatively low.
The weight of capacity addition in China will stall growth in other regions

<table>
<thead>
<tr>
<th>Year</th>
<th>Middle East</th>
<th>Europe</th>
<th>Americas</th>
<th>South Asia</th>
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<td>700</td>
<td>1000</td>
<td>1200</td>
</tr>
</tbody>
</table>

- As naphtha is easily transportable, production costs are relatively even in all regions, and Chinese low fixed costs are an advantage.
- Very few consumers outside China have the scale necessary to invest upstream in PX refining.
- The closures in the US and Indonesia in 2015 were more due to local considerations than rationalisation.

Crude-to-Paraxylene is a new concept

- The developments by Hengli and Zhejiang Petrochemical represent a new kind of investment, where PX is the primary activity of the refinery rather than a small value-adding unit.
- The projects both focus heavily on PX, producing a much higher ratio of aromatics to crude distillation capacity.
- By diverting most of the naphtha into aromatics, and some of the hydrocracker output into steam cracking, the projects maximise chemical production and reduce exposure to fuels markets.
- These configurations includes choices which are not normally optimal for refiners, and can impact on the profitability of refinery.

The new crude-to-PX complexes will still need to succeed in the refining/fuels business.
Chinese PX Supply/Demand

- Projection assumes actual capacity will be 4m tons/year lower than announced by 2022
- Refinery/chemical developments not exposed to naphtha or condensate markets
- So far no firm major methanol-to- aromatics
- Operational and margin risk will restrict OR at new plants
- Possibility for some closure of smaller plants, but small volume affected
- Import volume will remain substantial

Operating rates and margins will drop to levels not previously experienced in China

Global PX supply/demand

- The Chinese capacity build will impact all regions
- Margin pressure will force the closure of high-cost producers
- Refiners will leave MX in the gasoline pool
- Least integrated producers likely to suffer most
- TDP also likely to be loss-making at times, reducing PX output at modern complexes as well as old
- New Chinese plants will be relatively competitive due to refinery integration and captive demand

Global operating rates are set to decline to unprecedented lows
Upstream Developments and the effect on RPET

UPSTREAM ISSUES - MEG

Chinese MEG Supply/Demand

- Operating rates to increase over the next 2-3 years
- Improving quality and operability of coal/oxygenate MEG has driven a reduction in imports
- Coal price recovery and crude oil price drop has slowed investment in coal/oxygenate MEG
- New conventional EO/MEG plants expected along with the refinery/chemical projects of Hengli and Zhejiang Petrochemical (Rongsheng etc)

Operating rates and margin outlook on MEG is relatively healthy despite the planned new plants
Global MEG supply/demand

- Minimal supply growth in the Middle East, Iran the only country with firm plans
- Several large scale plants under construction in the United States
- Aside from China, both India and Malaysia have major new plants in planning
- China coal-based capacity is a major element of new supply

Asia and US have replaced the drop in new capacity growth in the Middle East

The US has replaced China as the major source of export growth

The economic turmoil in South America and Eastern Europe has postponed ethylene and MEG developments
- Formosa Plastics, Lotte Chemical, MEGlobal and Sasol have projects underway in the USG
- Reliance and Petronas are the key Asian developers outside China
China coal-based production is now significant on the global scale

Global MEG Capacity (Million tons per year)

- Most new capacity around new ethane-based steam crackers in the United States
- Chinese EO/MEG developments include some supply based on MTO
- Improvements in catalysts have allowed operating rates and product quality at coal-based plants to surge since 2016, supporting ongoing supply growth

Coal prices have soared since 2016, while oil prices remained low

Feedstock Pricing

- Coal-based MEG has remained viable despite the price increase
- Well integrated coal-to-olefins producers remain competitive despite the higher prices
- Coalfield utility prices are still much lower than in coastal areas
- Much of the coal demand into CTO/MEG is captive, and coal miners continue to face production quotas

Coal chemicals as still competitive, but the incentive to invest has declined
Upstream Developments and the effect on RPET

EFFECT ON PET/RPET

The slowdown in China and developing Asian countries impacts on the growth outlook

Global PET Growth by Region (percent Volume Growth)

<table>
<thead>
<tr>
<th>Region</th>
<th>2016-2020</th>
<th>2000-2016</th>
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</thead>
<tbody>
<tr>
<td>Other Asia</td>
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<tr>
<td>Middle East &amp; Africa</td>
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<td></td>
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<tr>
<td>Europe</td>
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</tbody>
</table>

Regional PET Demand, 2016 (volume = 22.5 million tons)

- China: 19%
- South America: 7%
- Europe: 22%
- North America: 19%
- Other Asia: 21%
- Middle East & Africa: 12%
Developing Asian nations are now driving growth

**Global PET Growth by Region (thousand tons)**

- Other Asia
- China
- Middle East & Africa
- Europe
- North America
- South America

**Regional PET Demand Growth, 2016-2021 (percent)**

- North America: 11%
- Europe: 13%
- China: 20%
- Middle East & Africa: 17%
- South America: 6%
- Other Asia: 33%
**RPET Trade Drivers**

- PET market growth has returned to Europe and North America
- Western MRFs are investing to improve sorting and bale quality
- Several recyclers closed since 2014 oil price drop
- Better quality RPET bales offered to export market
- B-2-B recycling hit hardest in Europe
- Growth markets in Asia and Africa do not have deposit schemes, but some have good manual sorting

*Lower prices give Asian consumers greater advantage over European/US operations*

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**The value of PET bales declines with virgin PET prices**

- Chinese PET producers achieved low but positive margins in 2016
- Depending on quality, 1.3-1.4 tons of PCR bottles are required per ton of flake, and 1.05-1.1 tons of flake per ton food grade pellet.
- The value of PCR PET bales into b-2-b was around $400/ton in 2016

*Bottle-to-bottle is difficult to work without legislative support*
**RPET availability will remain constrained**

- Import restrictions such as “Green Fence” and “National Sword” will continue to restrict availability.
- Draft legislation suggests raw PET waste (bale) imports may be outlawed altogether.
- Clampdown on recyclers without adequate water treatment etc pushes up the cost of RPET flake in China.
- The lack of Chinese buying interest pushes down RPET bale prices in Europe, Japan, the US etc, supporting local demand.
- Growth in the Chinese PET market, and therefore domestic RPET supply has slowed. Lower PX costs will support PET selection against other materials, but growth in the beverage market will remain slow.

**RPET availability will remain short in China**

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**If PX operating rates drop below 70 percent, margins may disappear for a period**

<table>
<thead>
<tr>
<th>Potential Outcomes For PET Chain Cash Cost Margins (Cash cost margin, dollars per ton)</th>
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<tbody>
<tr>
<td>![Graph showing cash cost margins for PET chain]</td>
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- Leader cash cost margins have averaged around $400 per ton for PX integrated to naphtha
- PTA and PET margins may be able to recover some margin if PX costs drop
- As PX margins plunge, PTA and PET margins may recover slightly

The loss of margin on PX could drop production costs by around $250 per ton PET
Operating rates and margins on ethylene are set to decline sharply over the next five years

- Ethylene margins have been extremely high since 2015, but are expected to fall towards 2021
- MEG margins on market-price ethylene remain low and have little scope to fall
- Coal-based MEG in China will contribute to pressure on global MEG prices, and provide an increasing supply for local PET producers

The loss of margin on ethylene is likely to drop MEG costs by around $100 per ton PET

The lower costs of PET polymer and fibre will maintain pressure on RPET margins

- PET capacity additions have resumed, while domestic demand growth is low. Virgin polymer margins show little scope for long term increase.
- PTA margins have stabilised, but capacity additions continue. Operating rates will increase, partly due to more advantaged PX.
- PET/fibre producers will have difficulty retaining any more margin

The loss of margin on PX and ethylene could result in a drop of around $350 per ton in PET costs by 2021
Upstream Developments and the effect on RPET

CONCLUSIONS

Conclusions

Upstream
- PX operating rates and margins may be moving into uncharted territory. Potential weakness in benzene could undermine TDP
- Ethylene margins to weaken, reducing MEG costs into PET
- New market entrants will need to succeed in the refining/fuels business to provide a platform for their aromatics businesses
- New project development in other regions is very low, leaving Chinese consumers the main beneficiaries of the supply growth

RPET
- Ongoing pressure on prices as loss of PX and ethylene margin feeds through PTA and MEG to virgin fibre
- Raw bale prices supported by restrictions on imports, slow growth in domestic PET market
- Revival of interest in garment production in developed regions (Zara etc) could stimulate flake demand for RPET in other regions to support “closed loop” initiatives in the West

The RPET industry will need to adapt to a further significant drop in virgin polymer prices
Upstream Developments and the effect on RPET

Thank you!

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Edges of DR Circular Blowing Cooling Device of New Structure

Liu Zhiqian
Chairman of the board
Hebei Darui Chemical Fiber Machinery Co., Ltd.
Edges of DR Circular Blowing Cooling Device of New Structure

Darui’s patent, 2017

Hebei Darui Chemical Fiber Machinery Co., Ltd.

Introduction

After two years of R&D works, Darui has developed a circular blowing cooling device of new structure and design, which vary from traditional ones that had been adopted decades ago in China, and existing for almost one hundred years in the world. The DR Circular Blowing Cooling Device is easy to install and operate, energy-saving, while ensures stable operation and product quality. With the device, Darui company acquired totally 5 patents of utility modal and design.

Hebei Darui Chemical Fiber Machinery Co., Ltd.
Features and Performance

- Comparison between the DR device and conventional cart-type blowing device:

Hebei Darui Chemical Fiber Machinery Co., Ltd.

Structure

- Structure of cart-type blowing device:
  - Mainly comprises five parts:
  - 1. Blowing chamber
  - 2. Rack
  - 3. Air-inlet tube
  - 4. Circular blowing rectifier
  - 5. Upper gland

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**Structure**

- **Steps to replace a rectifier:**
  1) To lower blowing chamber to the bottom by pressing a certain button on the cylinder
  2) Remove 16/8 bolts (M8×20) on upper gland
  3) Remove upper gland (around 20kg)
  4) Replace used rectifier with a new one
  5) Return upper gland
  6) Screw up bolts
  7) Press another button to raise blowing chamber to working position

- The whole process generally takes 7 min and 10 sec (430 sec) for device with 16-bolt gland, and 4 min (240 sec) for that with 8-bolt gland.

*Hebei Darui Chemical Fiber Machinery Co., Ltd.*
**Structure**

- **Steps to replace a rectifier:**
  1. To lower blowing chamber to the bottom by pressing a certain button on the cylinder
  2. Turn the wheel to disconnect the tray from the chamber
  3. Press another button to raise blowing chamber
  4. Replace used rectifier with a new one
  5. Lower the chamber, and then turn the wheel to lock the tray with the chamber
  6. Raise the chamber to working position

Note: The whole process generally takes 4500s in total.
Summary

1) Time needed for rectifier replacement
Rectifier replacement of DR’s circular blowing device takes merely one tenth-one fifth of the time needed to replace that of a traditional one.

2) Burden for operator
Traditional structure: The upper gland weighs around 20kg, and is placed at 1.3 meters height. It is a quite demanding work to handle the gland as well as rectifier, regarding to worker’s physical strength, and may cause harm when removed from such a high position.

DR structure: No need to remove upper gland, and the rectifier can be taken out from one side of the device. The whole operation requires merely 1/10-1/6 physical effort compared with that of a traditional one, and is easy to operate for a male as well as for a female.

Hebei Darui Chemical Fiber Machinery Co., Ltd.

Summary

3) Optimized appearance design
The arc shape enables the air blowing more smoothly, equally and stably. It raises production efficiency while makes the device more pleasant to the eye.

4) The upper gland
Upper gland in a DR structure is stamping-formed from metal plate. Hollow inside, it is light but firm, and the hollow internal is helpful to insulate heat. With such a gland, the device is more stable in structure, and prolonged in life.

Hebei Darui Chemical Fiber Machinery Co., Ltd.
Summary

5) Fixed structure

Thanks to the new appearance design and light upper gland, the new device can adopt a fixed structure, which makes centering more easy and ensures stable spinning quality, while solves the problem of leak with inlet tube.

We pursue better products and services!

Thank you!
R-PET Market Structure under New Policies

Cao Wenting

Product Manager

China Chemical & Fiber Economic Information Network (CCFEI)
R-PET Market Structure under New Policies

Cao Wenting
CCFEI
Great changes in policies for R-PET industry

On 18 July, the Ministry of environmental protection of China put forward new rules to WTO, requiring an emergent adjustment on the list of imported solid waste. According to the list, China will ban imports of 24 types of solid waste by the end of 2017, covering waste plastics, unsorted scrap paper, discarded textiles, various metal slag and other kinds of waste.

Changes in import policies

Rumors are bubbling with noises, changing from a ban on imports of post-consumer bottles to a ban on all solid wastes.

On 7 February, China’s General Administration of Customs held a meeting in Beijing, announcing to launch the one-year anti-smuggling campaign, known as “National Sword 2017”, which mainly targets the smuggling of foreign waste, agricultural products, resource products, tax-related goods, drugs and guns.

On 18 April in Beijing, passing “the Implementation Plan for Prohibiting the Entry of Foreign Garbage and Advancing the Reform of the Imported Solid Waste Management System”.

Import of living waste plastics prohibited before the end of 2017

“Sharp Sword of National Gates” 2017

Imported Waste Management Directory
**Environmental inspection**

1. The central environmental protection supervision has been established since 2015, and the fourth round of supervision activity has started completely.

2. A special campaign to crack down on pollution in imported waste processing launched in July 2017.


5. A general inspection on safe production, a battle of 100 days for administration, and law enforcement. A special inspection supervision at the provincial level on the prevention and control of air pollution in Shandong.

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**Supply-side Structural Reform**

1. Definition: The supply-side structural reform aims to adjust the economic structure so as to realize an optimum allocation and an improvement in the quality and quantity of economic growth.

2. Background: The efforts on the protection capacity and the transformation of the industrial structure made by overcapacity industries as well as the supply-side reforms in major policies spread, which has the same result as the changes in E-RF industry.

3. Common ground: Huge changes on import policies and stricter environmental inspection are both coming down in one continuous line with the supply-side reform.
Changes over prices of feedstock and R-PET products

Capacity, production and import volume of R-PET

With the expanding of R-PET capacity, the import volume of waste PET went up year by year, and grew from 1,100 kt in 2007 to 2,556 kt by 2016, an increase of 130%. In 2016, the import volume of waste PET accounted for 20% of the capacity of R-PET and 39% of the production of R-PET.
Prices of PET bottle flakes and R-PSF and R-PFY

Cash flow margin of PET bottle flakes
Analysis of price difference

The price difference between semi dull PET chips and cleaned flakers to spin virgin-like R-PSF has dropped from 3,500 yuan/ton to about 700 yuan/ton, and the average price difference in 2017 is at 1,384 yuan/ton.

The price difference between virgin PSF and high-tenacity virgin-like R-PSF has fallen from 2,000 yuan/ton to about 500 yuan/ton, and the average price difference in 2017 is at 798 yuan/ton.
Analysis of price difference

The price difference between semi dull PET chips and cleaned flakes to spin R-PPF has declined from 2,600 yuan/ton to 450 yuan/ton, and the average price difference in 2017 is at 967 yuan/ton.

The price difference between polyester POY and R-POY has slid from 2,600 yuan/ton to 450 yuan/ton, and the average price difference in 2017 is at 967 yuan/ton.

Analysis of price difference

The price difference between semi dull PET chip and clear flakes to spin 3-D-crimped R-PSF has dwindled gradually from 3,250 yuan/ton to 650 yuan/ton, and the average price difference in 2017 is at 1,290 yuan/ton.

The price difference between virgin PSF and 3-D-crimped hollow R-PSF has shrunk from 3,200 yuan/ton to 1,100 yuan/ton, and the average price difference in 2017 is at 2,118 yuan/ton.
Run rate and inventory

Weekly average inventory since the beginning of 2017

Changes in the thinking of R-PET enterprises
Changes in the thinking

01 Clarify the policy context
Clarify the policy context and comply with policy trends so as to re-define the development prospect of enterprises.

02 Dangers coexist with opportunities
The word "Crisis" means dangers coexist with opportunities. Grasp policies and opportunities to realize a bright future in the development.

03 Price difference or added value
Pay more attention to differential products and high-value-added products instead of caring too much about price differences, and walk along a path of industrial upgrading.

Pattern and direction of R-PET
Thank you!
Yangzhou Zhicheng Chemical Industry Technique Co., Ltd.

Every year, millions of tons of waste polyester use ZC’s technology to manufacture various types of regenerated polyester products, ZC’s achievements have been around the world.

PET Flakes /Popcorn material Chemical Regeneration Unit

- Based on years of experiences
- Focusing on polyester recycling

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