Status quo of R-PET industry and design of industry admittance standards

Lin Shidong

Secretary General

Recycled Fiber Commission of China Chemical Fibers Association
Status quo of R-PET industry and design of industry admittance standards

Lin Shidong
Secretary General, Recycled Fiber Commission of China Chemical Fibers Association

Contents:

I Status quo of R-PET fiber industry
II Status quo of R-PET fiber technology & facility
III Status quo of environment-protection of R-PET industry
IV The necessity of industry admittance threshold
V Principle and design of R-PET industry admittance threshold
I Status quo of R-PET industry

1. Status quo

1983-1989: mainly small lines introduced from Chinese Taiwan and South Korea, single screw for single position, feeding on popcorns, 10 tons/day capacity, mainly producing 2D-6D used in low-end needle-punched non-woven and glove yarns.

1996-1999: lines mainly feeding on bottle flakes, assisted with popcorns, generally two screws for 12 positions, 7.5kt/yr capacity, much higher product quality, can produce 1.5D virgin-like regular fibers and 2-D-crimped hollow fibers.

2000 till now: stage of fast development, with remarkable progress in technology. PET flakes of high cleanliness to produce 3-D-crimped hollow fiber (3D-15D), H-T L-S cotton-type (virgin-like), R-PFY (POY, DTY, FDY, BCF), regular industrial yarn, etc. Scale production of above-mentioned products enabled R-PET fibers to substitute virgin fibers in many applications.

2. Capacity & Production

R-PET industry had been developing fast in both capacity and technology progress since 2002, thanks to low feedstock costs and lucrative profit, which encouraged producers to produce in large-scale and increase product varieties. In 2005, R-PET fiber capacity of China reached 3.5 million t/a, and 8 million t/a in 2012, making China the largest R-PET fiber producer in the world.

3. Distribution

In China, R-PET capacities mainly locate in southeast coast, with the capacities in Jiangsu and Zhejiang provinces accounting for nearly 63.8% of the country’s total, those in Guangdong and Fujian provinces accounting for 15%, and those in other regions merely 21.2%. In recent years, capacities in Jiangsu and Zhejiang are taking a shrinking share due to higher costs in environment-production, land resources and labor resources, while those in Fujian, Guangdong, Hubei, Shandong, Hebei and Jiangxi were taking increasing shares.
I Status quo of R-PET industry

4. Capacity concentration

By end of H1 2013, R-PET fiber capacity of China totaled around 8.3 million t/a. Among it, there are 11 R-PET fiber producers whose capacity is above 100kt/yr, with total capacity of the 11 at 2.06 million t/a, accounting for 25.1% of the nation’s total; there are 33 producers whose capacity is above 50kt/yr, with total capacity of the 33 at 1.97 million t/a, accounting for 23.7% of the nation’s total; there are 61 producers whose capacity is above 30kt/yr, with total capacity of the 61 at 2.01 million t/a, accounting for 24.2% of the nation’s total.

5. Varieties of R-PET products

R-PET products mainly include R-PSF and R-PFY. R-PSF includes cotton type, wool type and medium-length, mainly used to substitute cotton and wool, and to produce fiberfill and non-woven fabrics. R-PFY mainly includes POY, DTY, FDY, BCF, and industrial yarn, etc.

Cotton type R-PSF is still the dominant variety, accounting for more than 50% among all varieties. Non-woven and fiberfill ranged second, while R-PFY and fine denier fibers take comparatively small share. In Jiangsu province, products are mainly cotton type for non-woven, while recyclers in Zhejiang focus on R-PFY and fiberfill, and those in Guangdong and Fujian mainly produce fiberfill and cotton type fibers.

II Status quo of R-PET technology & facility

There are two main sources of raw materials for recycled polyester fiber: ① industrial wastes, startup lumps and waste fibers from virgin fiber producing plants, offcut from nonwoven plants, and waste apparels, being sorted, washed, cut and granulated. In 1991, a popcorn machine produced 1.5 tons of popcorn, and nowadays the daily output has increased to 12 tons of popcorn and 25 tons of waste PET material after friction. ② postconsumer Coca Cola bottles/flakes. In early 1990s, a single washing line could process 4-5 tons of postconsumer bottles each day through small-scale grinding and simple washing. Today a single line can process 80-150 tons a day, through a lot of proceedings such as classifying, sorting, grinding, hot washing, water-recycling, wasted heat recovering and innocent treatment, etc.
II Status quo of R-PET technology & facility

Production of R-PET fiber has high requirements in technology and delicacy management, given diversified sources and varied performances of raw materials. In 1979, R-PET fiber production was in its primary stage, when VD402 could produce 1.5 tons per day with 4 spinning positions. Later, the VD403 could produce 2.5 tons per day, followed by VD404, VD405, VD406 and large scale units with similar proceeding of Toyobo. After more than 30 years of development, batch drum dryer/continuous dryer are adopted, and the diameter of spinneret have increased from φ160 to φ220, and then φ328, φ410 and φ500. Refrigerator + ring quenching and out-ward quenching are applied for cross air quenching. Development of melt-filter has experienced stages of single-tube (1980), multi-tube (1985), on-line switchable one-stage double-cylinder filter (1991), and the latest double-stage four-cylinder filter. The take-up speed of spinning section has increased to 1,600 m/min from the 500 m/min in 1979. The total denier for tow in drawing section can now reach 5 million compared with 600 thousand in early stage. The speed of drawing-crimping section has risen to 280 m/min from 120 m/min, and with tension-setting being introduced in 2005, a single line can produce 50-120 tons per day.

II Status quo of R-PET technology & facility

Currently in China, around 30% of recycling capacities are built in 1990s, with urgent requirement of retrofit. After the fast development of integrated equipments during the periods of 11th and 12th Five Year Plan periods, China’s recycling technologies and facilities have gained leading edge in the world. For example, in 2009 Shanghai Pacific Textile Complete Equipment’s HT-LS R-PSF production line brought daily output to 40 tons, and in 2012 Shaoyang Textile Machinery’s 120 tons/day HT-LS cotton type R-PSF production line passed inspection of administering institutions.
II Status quo of R-PET technology & facility

Equipment level of China’s R-PET fiber industry

<table>
<thead>
<tr>
<th>No.</th>
<th>Process</th>
<th>Level</th>
<th>Equipment supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>R-PFY (POY, DTY, FDY, PIF)</td>
<td>World</td>
<td>advanced</td>
</tr>
</tbody>
</table>

III Status quo of environment-protection of R-PET industry

In 2010, comprehensive energy consumption of R-PSF production had fallen to 197 kgce/t from the 232 kgce/t in 2005, down by 15.09%, and the comprehensive energy consumption of R-PFY production in 2010 was 167 kgce/t.

Material consumption during baled bottles processing also decrease fast thanks to advanced washing facilities introduced from Europe and the US. The unit consumption index for baled bottles processing had fallen by 8.00% during the period of 11th Five Year Plan, while power consumption of other staple fibers had fallen by 0~3.6%.

Water consumption also saw significant decrease due to technology development, particularly during the raw material treatment, which fell by 37.50% during the period of 11th Five Year Plan.

In 2010, wastewater discharged during the processes of dirty flake to clean flake, and clean flake to R-PSF had fallen by 35.71% and 35.19% respectively compared with in 2005, while COD emission during the two processes had fallen by 27.27% and 27.78% respectively.
III Status quo of environment-protection of R-PET industry

The achievements in energy saving and emission deduction during the period of 11th Five Year Plan are attributed to technology progress:

1. Equipment retrofit to increase controllability and yield, while reducing energy consumption by 10%, water consumption by 5%.
2. Retrofit to steam drain system, saving steam by 1%～3%.
3. Conduction oil used in thermal setting, saving energy by 5%.
4. Frequency electricity control system to save power by 10%.
5. Utilizing of the afterheat from thermal setting and boiler to shorten drying time, reducing energy consumption by 10%.
6. Recycling of alkali liquor from alkali boiling, with evaporation loss10%.

III Status quo of environment-protection of R-PET industry

7. Recycling of condensate water, saving desalted water treatment fee by 1.20 yuan/ton, with part of the water recycled to steam generator, and part used as domestic water (bath for example).
8. Recycling and filtering of wastewater from finish oil bath in post-processing line, reducing wastewater discharge by 1.5kg/t or 90%.
9. The application of flash evaporation technology can save one ton of low-pressure steam per hour (based on a 70 ton line with a consumption of 3-ton medium-pressure steam per hour), and save water treatment fee by 4,000 yuan/day with condensed water directly recycled into the boiler.
10. Twin filter technology prolongs life span of a spin-pack by 3 times, saving spin-pack cost by 140 yuan/week and reducing waste fiber by 30kg/week per spinning position.
IV The necessity of industry admittance threshold

1. Status quo
   As a major R-PET fiber producer in the world, China's capacity and production account for more than 75% of world total. However, more than 40% of flake, the main raw material, is imported. As the industry has developed for 30 years, equipments and technologies of many R-PET fiber producers are outdated. With technologies experiencing rapid development in latest 10 years, the level of equipment, product, unit consumption and waste treatment are quite unbalanced among different enterprises.

2. Necessity to keep the total capacity in balance
   New R-PET projects shall increase their industrial concentration, enhance integrated competitiveness through merger and acquisition, thus to eliminate outdated capacities and produce new materials such as differentiated, functional and high-performance products.

3. Reason for scale control
   Scale production helps to control costs, reduce unit consumption and reduce pollution. Regional governments schedule the distribution of capacities according to central government’s requirements on environment and with local environment conditions taken into consideration.

4. Necessity of equipment, technology and process standards
   Currently, China ranked high in the world regarding the level of its R-PFY and R-PSF equipments, with capacity of a single line at around 10-40 kt/yr, and the performances in unit consumption and product quality are also world-advanced. However, in China, capacity of world-advanced equipments accounts for merely 1/3 of the state's total, while most domestic capacities need up-grading.

5. Necessity of energy consumption standard
   Energy consumption standard is a key part to rule R-PET fiber industry. The standard is formulated to reflect the energy-consumption level of relatively advanced capacities of the industry, and is expected to be raised in the future to mirror progresses in technology, equipment and process.
IV The necessity of industry admittance threshold

6. Necessity of Three Wastes standards
Standards for emission and treatment of Three Wastes (waste water, waste gas, industrial residue) are formulated according to relevant state laws and regulations and industrial policy, to reflect the level of relatively advanced capacities of the industry, in the purpose of facilitating healthy and sustainable development of R-PET fiber industry. New, rebuilding and expanding projects shall strictly implement the standards. Existing enterprises which do not meet the standards have to complete rectification in three years.

7. How to supervise
In the purpose of facilitating healthy and sustainable development of the industry, functions and responsibilities of relevant administering departments, industry associations and local governments are stipulated in the Standards, for them to effectively supervise and administrate the industry.

V Principle and design of R-PET industry admittance threshold

Principle:
According to the relevant state laws and regulations and industrial policies, with the principles of optimizing the distribution, adjusting the structure, saving energy, reducing unit consumption, environment protection and safety production, the R-PET Fiber Industry Admittance Threshold Standards is hereby formulated with the purpose of inhibiting the industry duplication and excess capacity, encouraging comprehensive utilizing of waste textiles, sourcing new raw materials, and guiding the healthy development of the R-PET fiber industry.
V Principle and design of R-PET industry admittance threshold

(1) Production capacity distribution

1. Local governments should schedule for the development of local R-PET fiber industry according to conditions of local environment, energy, resource and demand. New, rebuilding and expanding projects shall meet the national industrial policy, industry development plan, and environmental & land utilization policies. New R-PET projects shall not be approved in principle in eastern China. Enterprises shall be encouraged to build their production units in R-PET industrial parks. New R-PET enterprises shall not be encouraged in central and western China. Integrated R-PET enterprises must build their production units in R-PET industrial parks.

2. No new R-PET projects shall be allowed around the lawfully established natural preservation areas, scenic spot, cultural heritage, source water protection area and resident’s clusters, medicine, food and precision instrument production bases which demand high environmental conditions, or within the sensitive area of key ecological functional areas planned by the country and the local. According to the regional relevant plans and laws, the R-PET projects in the above areas which have been put into operation shall phase out by the ways of relocation, changing products or closing the production, etc. Development of R-PET industry in regions, which have difficulties to afford it ecologically, should be limited.

3. New R-PET projects should be encouraged to increase their industrial concentration, enhance integrated competitiveness through merger and acquisition, thus to eliminate outdated capacities and produce new materials such as differentiated, functional and high-performance products.

4. Rebuilding and expanding projects should utilize resources with efficiency through clean production and recycling. Existing enterprises shall be encouraged to upgrade technology and eliminate outdated capacities. Leading enterprises should enhance industrial concentration and integrated competitiveness through merger and acquisition.

5. R-PET enterprises and R&D institutes shall be allowed to build an experimental or pilot production line with capacity below 1 kt, and differentiation rate above 90% for the purpose of R&D.
V Principle and design of R-PET industry admittance threshold

(2) Process and equipment standards

1. New, rebuilding and expanding projects shall comply with the requirements of Catalogue for Guiding the Industrial Restructuring, and adopt processes and equipments of low pollution intensity, energy saving and environmental protection. Differentiated, functional, high-performance, environment-friendly and low-carbon products shall be encouraged.

2. Capacity standards for rebuilding and expanding projects:
   - Raw material processing $\geq 30$kt/yr, or fiber output $\geq 30$kt/yr
   - popcorn (single machine) $\geq 12$ tons/day;
   - friction material (single machine) $\geq 25$ tons/day;
   - flake/bottle wash (single line) $\geq 20$ kt/yr;
   - R-PFY (single line) $\geq 10$ kt/yr;
   - colored R-PSF (single line) $\geq 10$ kt/yr;
   - other R-PSF (single line) $\geq 20$ kt/yr; differentiation rate $>30\%$.


   Capacity standards for new projects:
   - Raw material processing $\geq 50$kt/yr, or fiber output $\geq 50$kt/yr
   - popcorn (single line) $\geq 12$ tons/day;
   - friction material (single line) $\geq 25$ tons/day;
   - flake/bottle washing (single line) $\geq 40$ kt/yr;
   - R-PFY (single line) $\geq 20$ kt/yr;
   - colored R-PSF (single line) $\geq 15$ kt/yr;
   - other R-PSF (single line) $\geq 25$ kt/yr; differentiation rate $>50\%$. 
V Principle and design of R-PET industry admittance threshold

Basic requirements for main equipments:

**Motor**: High-efficient motor and frequency-variable motor listed in Catalogue for Promoting the National Key Energy-saving Technologies.

**Screw extruder**: EMP heating to utilize thermal energy more efficiently, high-precision screw to reduce melt returning, screw’s lifespan > 2 years; Diameter of screw for R-PFY units ranging between 160mm-200mm; Diameter of screw for differentiated, functional and high-performance R-PSF ≥ 90mm, and for others ≥ 160mm.

**Spin-pack**: Self-sealing pack. Spinneret for producing differentiated, functional and high-performance R-PSF ≥ 220mm, and for other products ≥ 328mm; diameter of spinneret for R-PFY between 80mm-110mm.

V Principle and design of R-PET industry admittance threshold

**Taking-up (staple fibre)**: Spinning tunnel suction device to reduce the quantity of waste fiber and splashing of finish oil, to protect the health of workers.

**Taking-up (filament yarn)**: Automatic multi-end (8-16 bobbins) winders to raise efficiency.

**Canning (staple fibre)**: Equipped with four-direction traversing device controlled by PRC system, with length or time metering device to reduce repieces and waste fiber.

**Drawing**: R-PSF post-processing lines equipped with distributed control systems (DCS), and safeguard system for drawing process (mandatory)

**Oven**: Conduction oil as heating medium to produce R-PSF, with automatic temperature control system to save energy.
V Principle and design of R-PET industry admittance threshold

4. To phase out or retrofit outdated equipments: popcorn (single machine) ≤ 12 tons/day; friction material (single machine) ≤ 25 tons/day; Flake/bottle washing (single line) ≤ 20 kt/yr; R-PFY (single line) ≤ 10 kt/yr; colored R-PSF ≤ 10 kt/yr; other R-PSF ≤ 20 kt/yr; To encourage enterprises to build R-PET fiber production lines of differentiated, functional and high-performance products, with proportion of these products accounting to more than 30% of total varieties.

V Principle and design of R-PET industry admittance threshold

(3) Product Quality and management

1. R-PET enterprises shall be encouraged to adopt information systems such as ERP, DCS and DMS to enhance informatization, optimize management, reduce costs and improve product quality.
2. R-PET enterprises shall establish a sound and complete management system for quality inspection, actively develop products of low consumption, low pollution and high added-value. R-PET products shall meet the quality requirements of national and industry standards. The proportion of grade-A products shall be no less than 95% with R-PFY, and no less than 98% with R-PSF.
3. R-PET enterprises shall implement third class of energy measurement and water consumption measurement, by assigning special department or personnel to supervise energy consumption, water utilization and waste emission, and establishing inspecting and data statistic systems.
V Principle and design of R-PET industry admittance threshold

(4) Resource consumption standards for new, rebuilding and expanding projects

1. Resource consumption standards for rebuilding and expanding projects
   1) Water consumption: fresh water recharge per ton (flake) ≤ 1.5 tons, fresh water recharge per ton (bottle) ≤ 2 tons, fresh water recharge per ton (R-PET fiber) ≤ 0.6 tons, reuse rate of production water ≥ 85%.
   2) Comprehensive energy consumption: raw material per ton ≤ 45 kgce/t, R-PSF per ton ≤ 170 kgce/t, R-PFY per ton ≤ 165 kgce/t (in the case of 300D).

Existing R-PET fiber producers must meet above mentioned standards in 3-5 years.

2. Resource consumption standards for new projects
   1) Water consumption: fresh water recharge per ton (flake) ≤ 1.0 ton, fresh water recharge per ton (bottle) ≤ 1.5 tons, fresh water recharge per ton (R-PET fiber) ≤ 0.6 ton, reuse rate of production water ≥ 90%.
   2) Comprehensive energy consumption: raw material per ton ≤ 40 kgce/t, R-PSF per ton ≤ 160 kgce/t, R-PFY per ton ≤ 150 kgce/t (in the case of 300D).

V Principle and design of R-PET industry admittance threshold

(5) Environmental Protection

1. R-PET enterprises shall actively adopt clean production technologies of low energy consumption, high efficiency and low/non pollution. Enterprises shall implement regular clean production audit and energy audit.
2. Wastewater discharge of new, rebuilding and expanding projects shall conform to the state’s processing system or public standards of water pollutants, after treated by enterprise or industrial wastewater treatment center. Industrial wastewater is not allowed to be discharged into urban sewage treatment system, unless permission and Urban Drainage License are acquired from local wastewater treatment administration. Wastewater discharged by R-PET enterprises must meet relevant requirements of the country and the local. Efficient and eco-friendly sludge treatment process and innocent treatment for the sludge must be adopted.
3. Waste gas emission of R-PET enterprises shall meet the requirements of state and local governments. Emissions parts shall be equipped with absorption devices.
4. Factory boundary noise shall comply with the requirements of < Emission Standard for Industrial Enterprises Noise at Boundary> (GB12348-2008) and local government.
V Principle and design of R-PET industry admittance threshold

(6) Safety, health and social responsibility

1. New, rebuilding and expanding projects shall have risk pre-assessment and completion inspection to their safety facilities according to relevant regulations and requirements of the country, and ensure that safety facilities are designed, constructed and put into use at the same time of the main works. Enterprises shall establish sound safety responsibility system according to relevant requirements on occupational health and safe production.
2. R-PET enterprises shall be encouraged to perform social responsibilities according to requirements of China Social Compliance 9000 for Textile & Apparel Industry (CSC9000-T), and acquire certificate of environment management system and occupational health and safety management system.

V Principle and design of R-PET industry admittance threshold

(7) Supervision and Administration

1. Applications for registration from new, rebuilding and expanding projects, who do not meet requirements of the Standards, shall not be accepted by provincial investment or industry administrations. All administrative and financial procedures for R-PET project shall be handled complying to the admittance requirements. Provincial industry administration shall put forward preliminary examination opinions on environmental impact assessment report to provincial environment administration to examine and approve.
2. The investment management department shall not approve and record, the departments of land and resources administration, environmental protection, and safety supervision shall not handle relevant formalities, financial institutions shall not provide loans and other forms of credit support for the R-PET projects that could not conform to the requirements of the Standards. Enterprises should obtain required licenses before operation. Administering departments shall punish the enterprises, who breach rules, according to applying laws and rules, and order it for rectification.
3. Industry administrations of all levels must urge existing enterprises to accelerate update equipments and optimizing management. After enterprises' situation verified by provincial industry administration upon application submitted by the enterprises, national industry administration shall regularly announce the list of R-PET fiber producers, which meet the admittance requirements.
4. Relevant industry associations shall assist the enterprises in admittance requirements implementation, self-discipline and technology progress, while help government in supervising.
V Principle and design of R-PET industry admittance threshold

(8) Supplementary

1. The term R-PET fiber in the Standards refers to new/rebuilding/expanding projects that produce R-PET fiber through melt-spinning process, with recycled flake, popcorn, etc., as raw material.

2. The term bottle in the Standards refers to post-consumer PET bottle, collected, processed and baled as raw material of R-PET fiber.

3. The term flake in the Standards refers to flake of collected and processed PET bottle, ready for spinning.

4. The term popcorn in the Standards refers to product made by popcorn machine from waste polyester textiles.

5. The term friction material in the Standards refers to product made by friction material machine from waste polyester textiles.

6. The Standards are applicable to all types of R-PET fiber enterprises within P.R.China, with the exceptions of Taiwan, Hong Kong and Macao.

7. Should the laws and regulations, national standards and industrial policies involved in the Standards be revised, revised provisions shall be executed.
Thank you!

Contact: Lin Shidong
Tel: 86-13810178742 (Beijing)
    86-15336591330 (Hangzhou)
Email: shidonglin@sina.com
      shidonglin@sohu.com