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The Latest Size Reduction Technology For Color & Monochrome Toners

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Content

- Trends in particle characteristics of toners
- Market size and growth
- Improvement of grinding and classification processes
- New mechanical mill system for monochrome toners
- New jet mill system for color toners
- Future outlook

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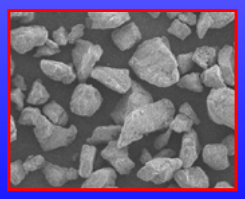
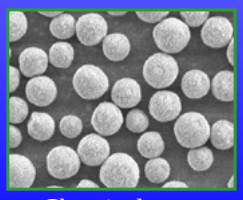
Trends in particle characteristics of toners

- **Particle size**
  - ➡ Smaller (5〜6μm)
- **Particle size distribution**
  - ➡ Narrower
    (Less fine particles & coarse particles)
- **Particle shape control**
  - ➡ Spherical or round particles



Conventional pulverized toner



Chemical toner

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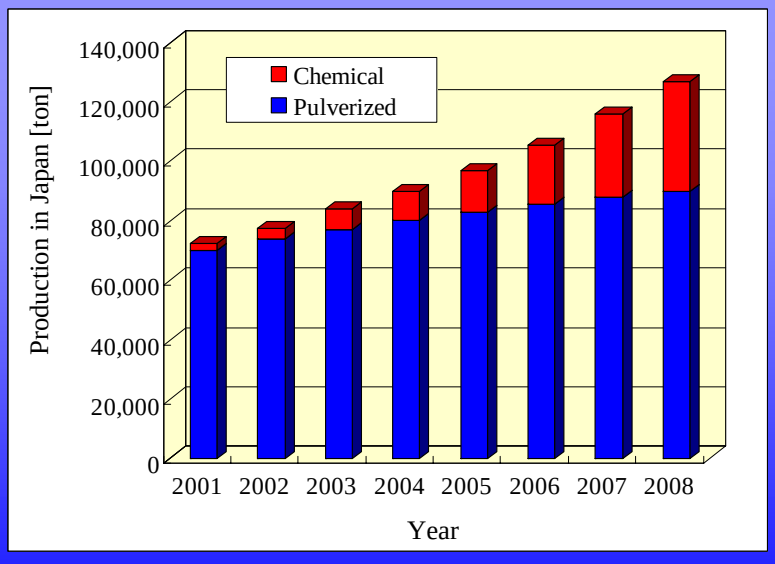

Production of chemical toner and pulverized toner in Japan

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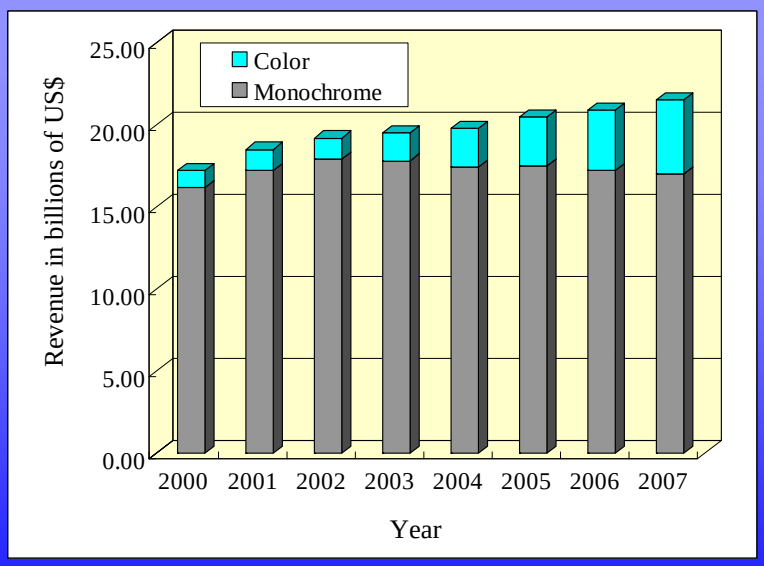

Worldwide bulk toner revenue

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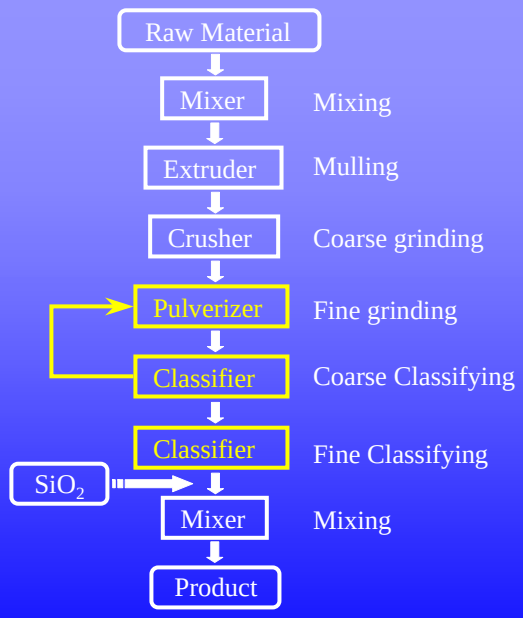

Process flow of grinding toners

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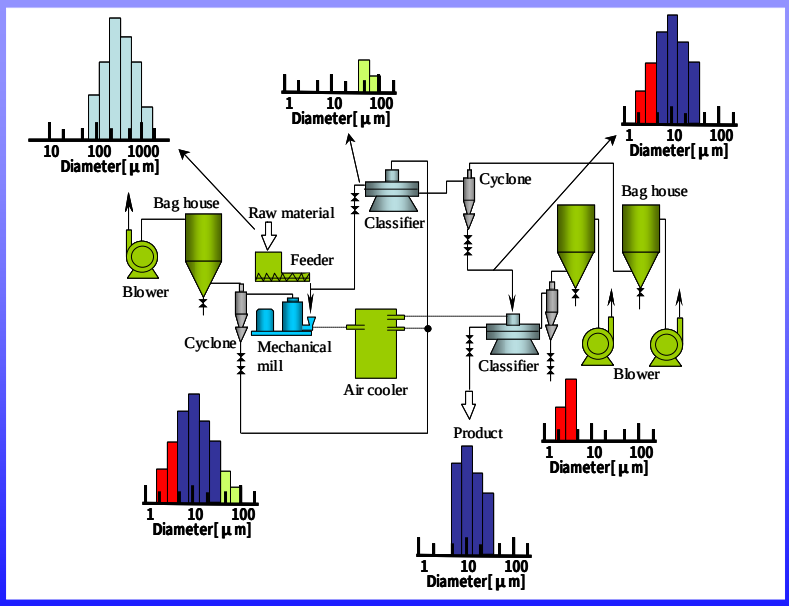

Flowsheet of grinding and classifying process for toner

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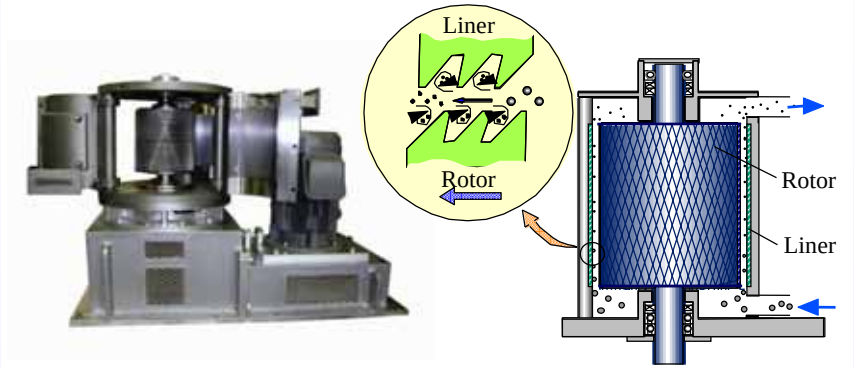

Mechanical mill; Super Rotor SR-25

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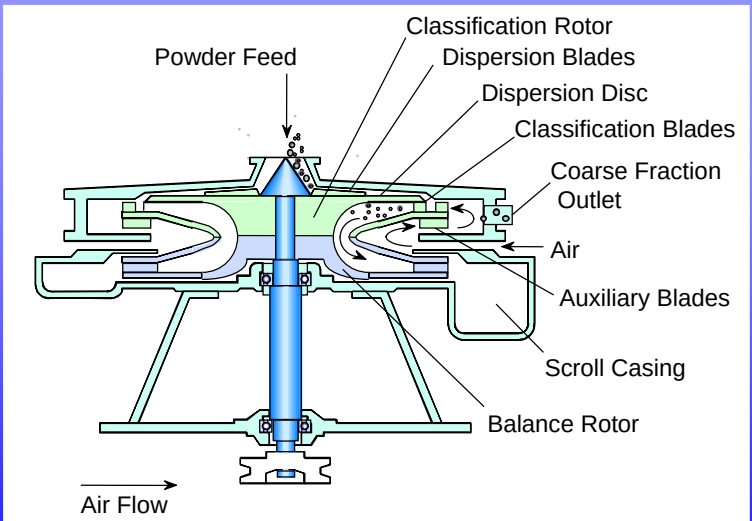

Cross-sectional view of Turbo Classifier

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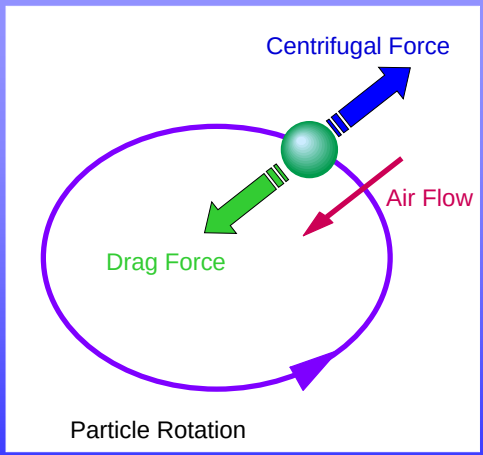


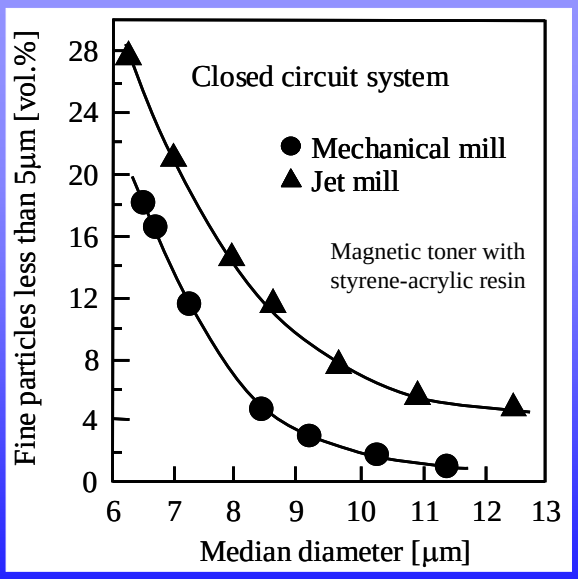
Large Particles

Centrifugal Force > Drag Force

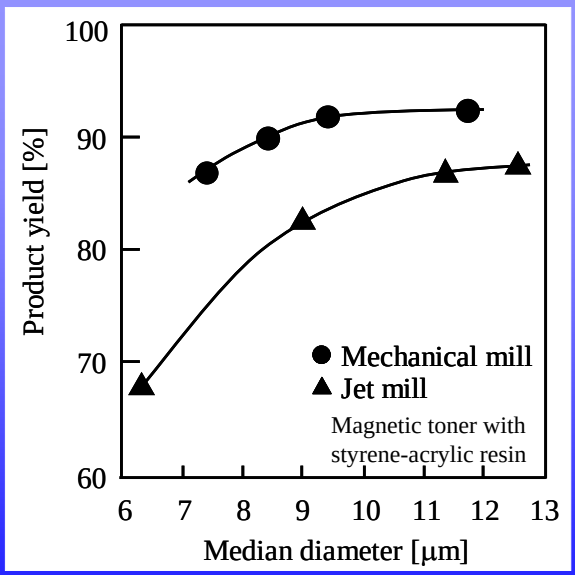
Small Particles

Centrifugal Force < Drag Force

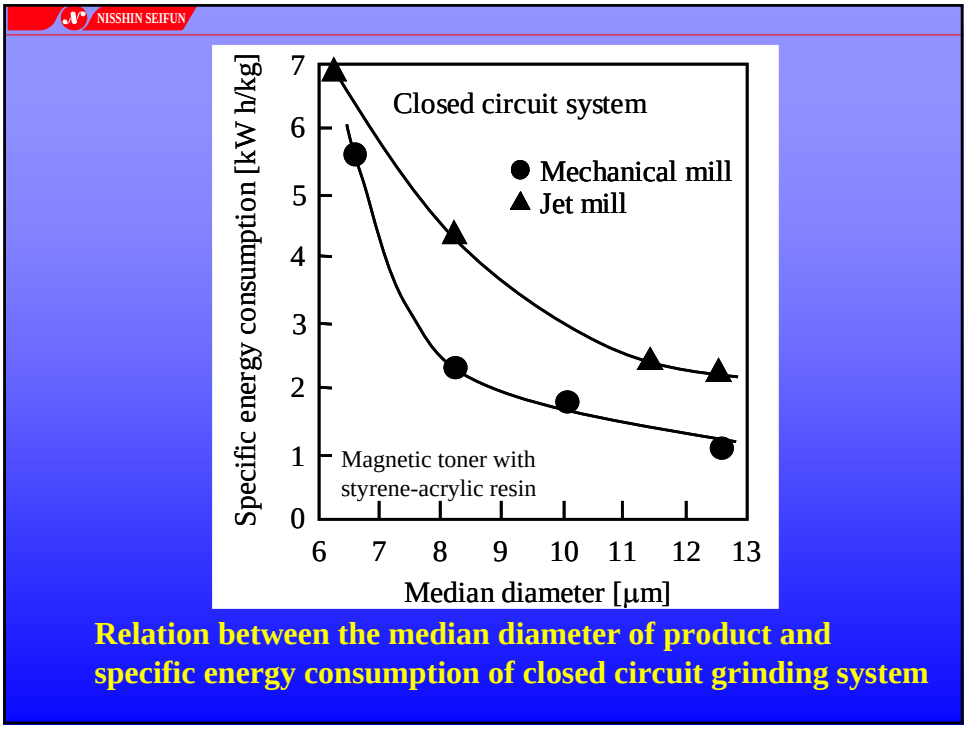
Principle of air classification (centrifugal force classification)



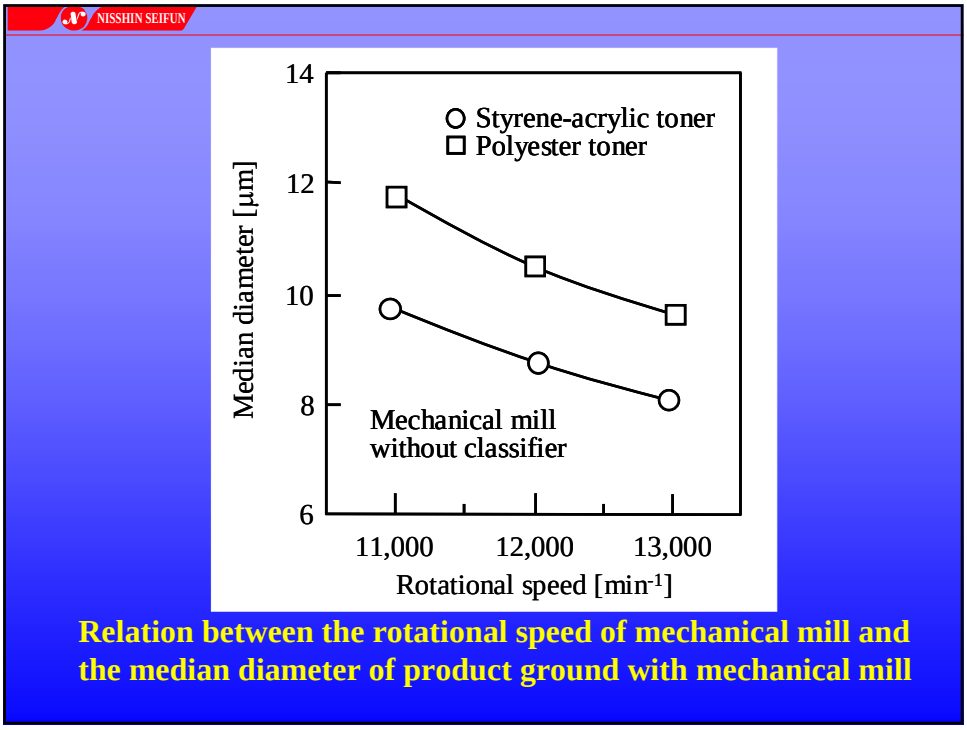
Relation between the median diameter of product and the volume percentage of fine particles less than 5μm



Relation between the median diameter and product yield in grinding and classifying process



Relation between the median diameter of product and specific energy consumption of closed circuit grinding system



Relation between the rotational speed of mechanical mill and the median diameter of product ground with mechanical mill

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Temperature control for mechanical mill

Methods

Inlet air temperature: from +5 to -40 degree C
(from 41 to -40 degree F)
Cooling rotor: water

Conditions

Feed Material: Non-magneticToner with Polyester Resin, D_{50}=500μm
Grinding Mill : Mechanical Mill
Product Diameter: 8 μm
Temp. of Mill Outlet: 50 degree C (122 degree F)

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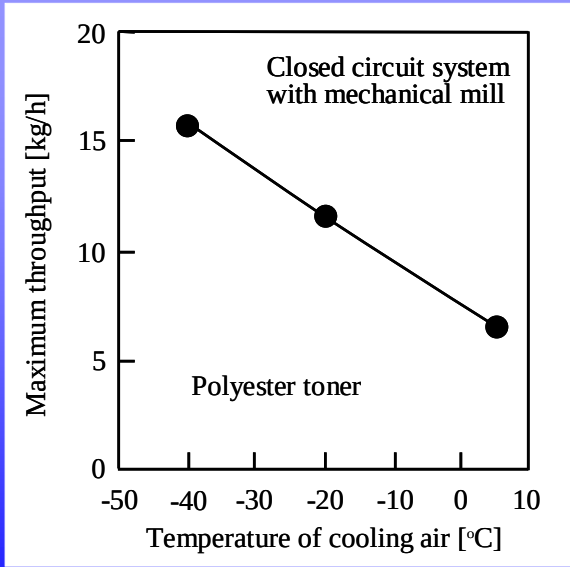
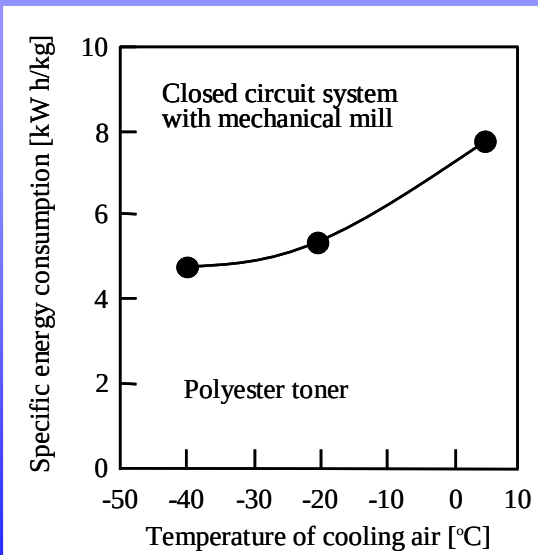
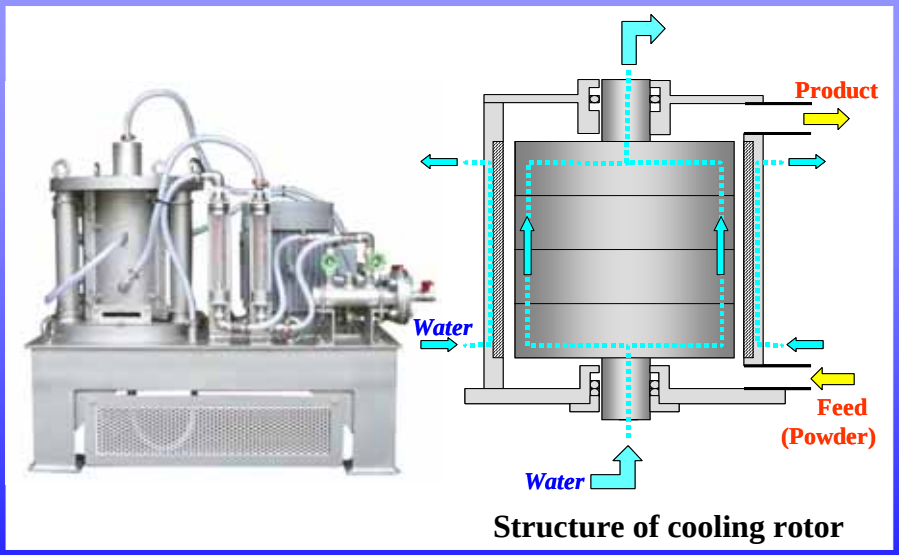


Relation between the temperature of cooling air and the maximum throughput of the mechanical grinding system



Relation between temperature of cooling air and specific energy consumption of closed mechanical grinding system



Structure of cooling rotor

Super Rotor using cooling rotor

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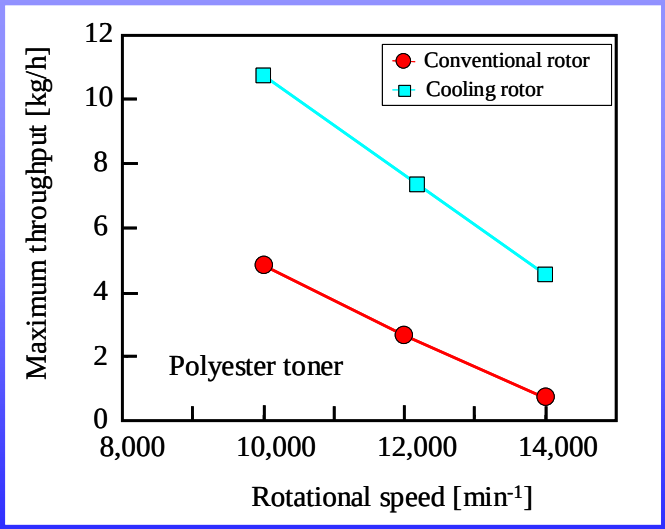

Effect of cooling rotor on throughput of mechanical mill

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Particle shape measurement

Particle shape analyzer

Malvern ; FPIA-2000
(Flow Particle Image Analyzer)

Definition of shape factor

Circularity index **(C.I .)** $= \dfrac{\sqrt{(4\pi * \text{Area})}}{\text{Perimeter}}$

≦ 1

Smooth & round surface shape ⟹ 1 (Spherical shape)

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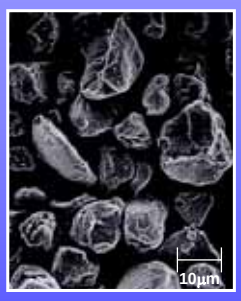
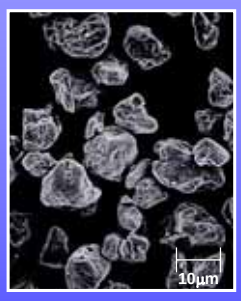


C.I. = 0.93

(a) Target jet mill



C.I. = 0.93

(b) Pancake jet mill

C.I. = 0.94

(c) Mechanical mill

Effect of type of mills on particle shape of monochrome toners

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Toner manufacturing plant using the mechanical mill

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New jet mill; Super Jet mill for color toners

Features

- Narrow particle size distribution,
  less fine particles & coarse particles
- Simple inner structure without moving parts
  less powder accumulation and adhesion
- Easy maintenance and cleaning

Super Jet mill SJ-10K

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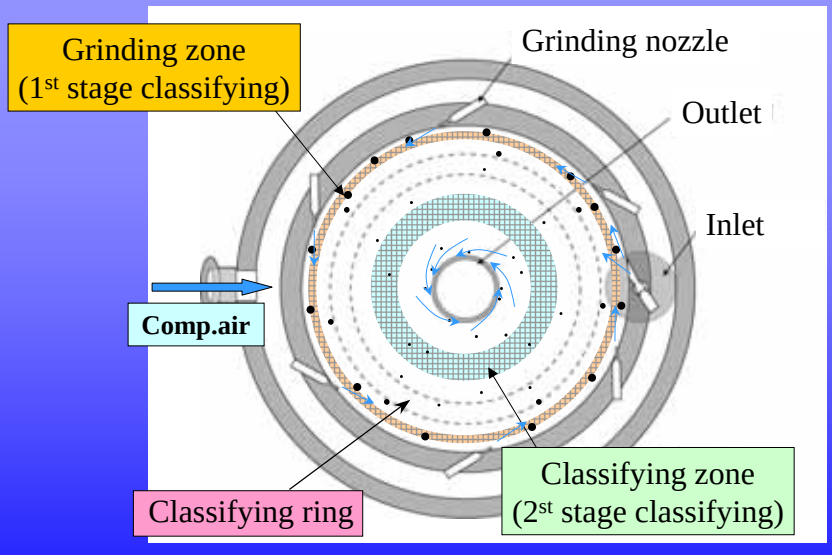

Structure of Super Jet Mill

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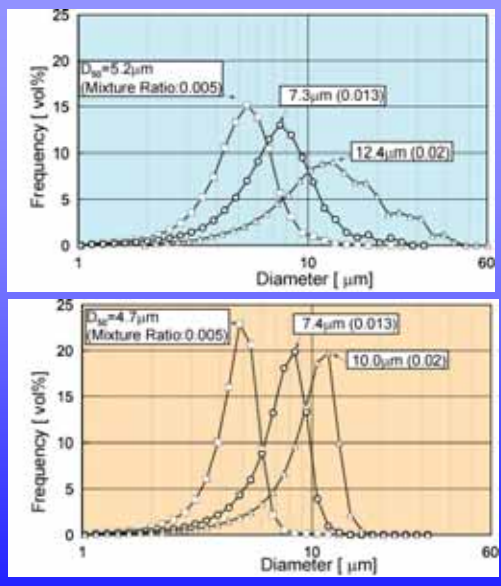

Conventional jet mill

Super Jet Mill

Relation between particle size distribution of product and mixture ratio (color toner)

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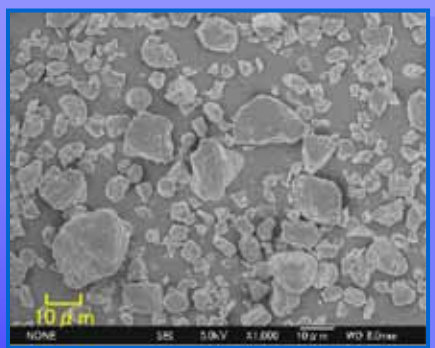

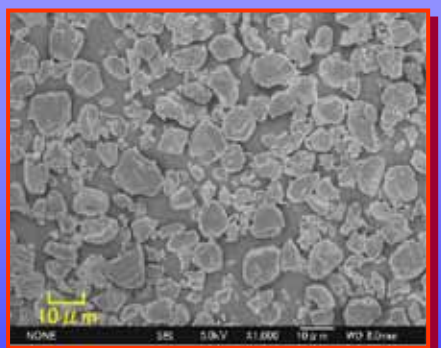

Conventional jet mill

Super Jet Mill

SEM photos of color toners (D_{50}=7μm)

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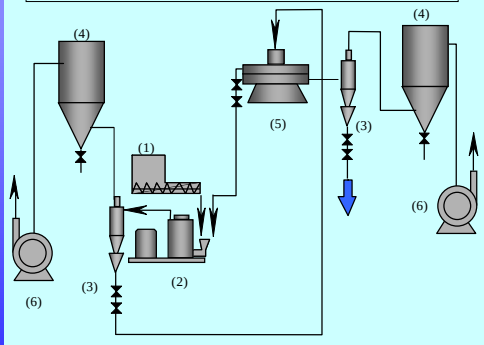
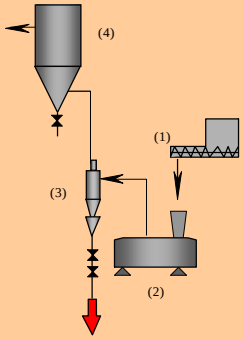
(1) Screw feeder (4) Bag house
(2) Mechanical Mill (5) Classifier
(3) Cyclone (6) Blower



Closed circuit grinding system of mechanical mill

(1) Screw feeder
(2) Super Jet Mill
(3) Cyclone
(4) Bag house



Grinding system of Super Jet Mill

Flowsheets of two kinds of grinding system

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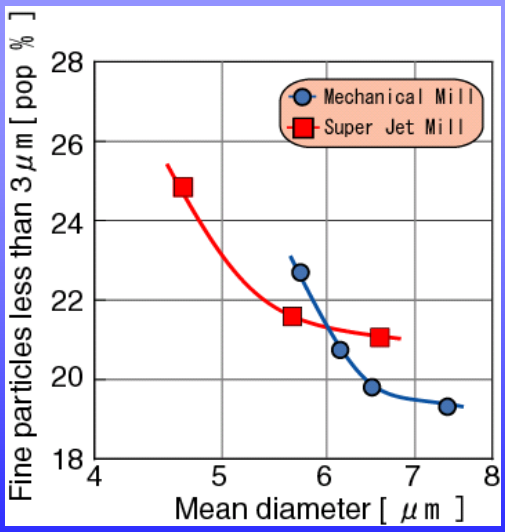

Relation between the median diameter and percentage of fine particles less than 3μm (color toner with polyester resin)

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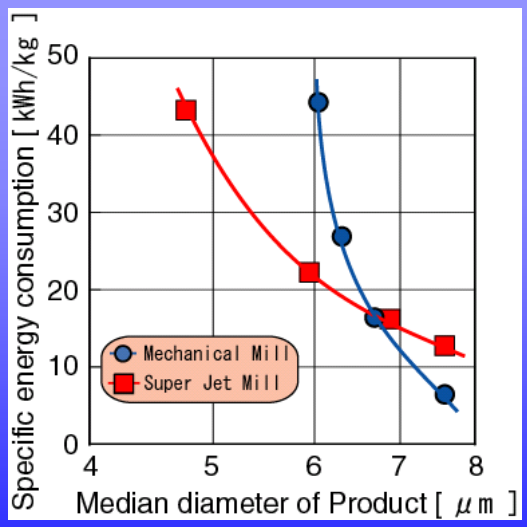

Relation between the median diameter and specific energy consumption (color toner with polyester resin)

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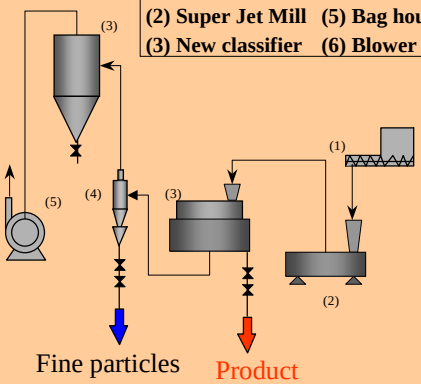
(1) Screw feeder (4) Cyclone
(2) Super Jet Mill (5) Bag house
(3) New classifier (6) Blower



Fine particles

Product
(Coarse particles)

A new classifier for fine classification

Super Jet Mill system with a new classifier without rotor for color toners

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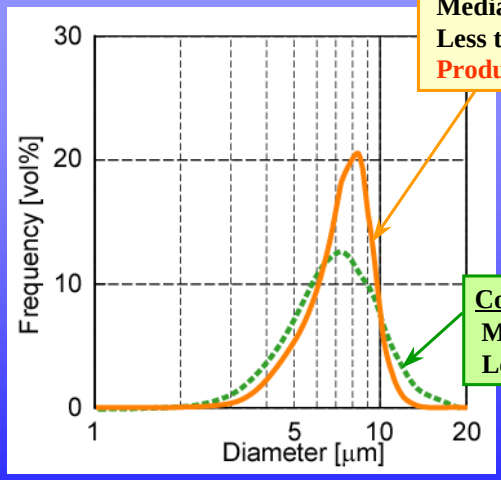
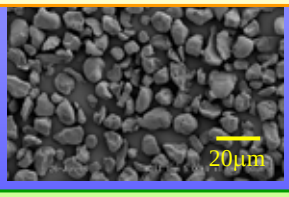
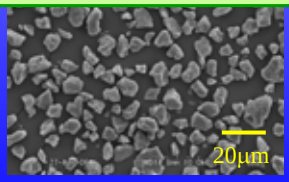


Pulverized toner using SJ system
Median diameter : 7.7μm
Less than 4μm : 26 pop%
Product yield : 93%



Conventional pulverized toner
Median diameter: 7.0μm
Less than 4μm : 53 pop%



Comparison of two kinds of pulverized toners

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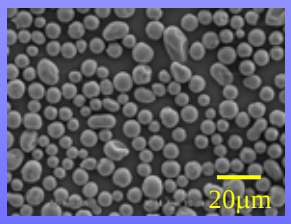
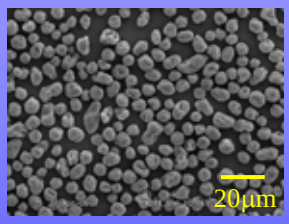


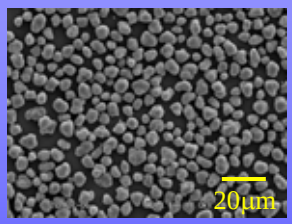
Median diameter : 7.5 μm
Less than 4μm : 12 pop%
Circularity Index : 0.99

Canon
(Suspension)



Median diameter : 6.2 μm
Less than 4μm : 11 pop%
Circularity Index : 0.97

Ricoh
(Ester elongation)



Median diameter : 5.6 μm
Less than 4μm : 24 pop%
Circularity Index : 0.97

Fuji Xerox
(Emulsion aggregation)

Example of chemical toners on the market

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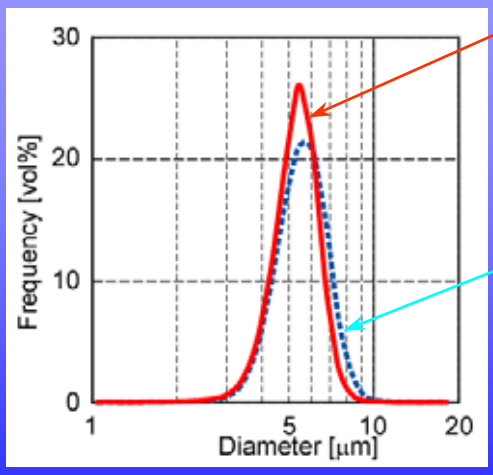

Pulverized toner
Median diameter : 5.4 μm
Less than 4μm : 26 pop%

Chemical toner
Median diameter : 5.6 μm
Less than 4μm : 24 pop%

Particle size distributions of pulverized toner using Super Jet Mill system and chemical toner

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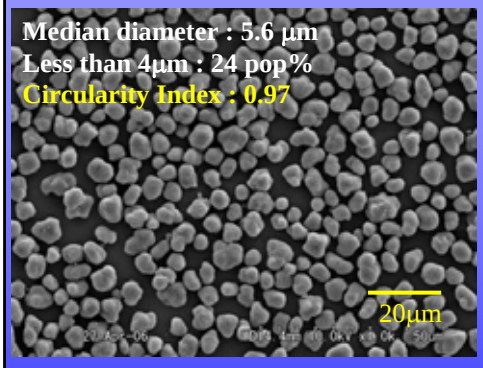
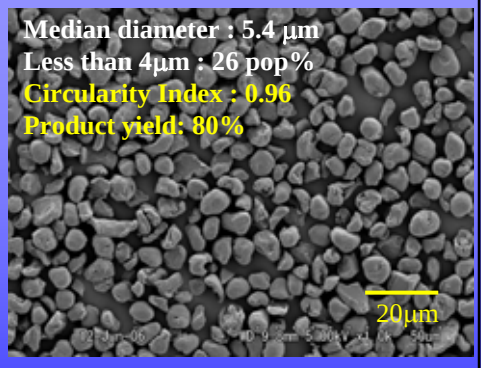


Chemical toner



Pulverized toner using Super Jet mill system

Comparison of particle characteristics of chemical toner and pulverized toner using Super Jet Mill system

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Conclusions

1) In order to save energy and running costs, it is important to use a suitable grinding machine for particle size and characteristics of toners because it consumes a lot of energy compared with other machines.

2) Using grinding and classifying technologies, it is possible to produce toners similar to chemical ones in particle shape and size distribution.

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Thank you very much

for your kind attention.