THE LATEST SIZE REDUCTION TECHNOLOGY FOR COLOR & MONOCHROME TONERS

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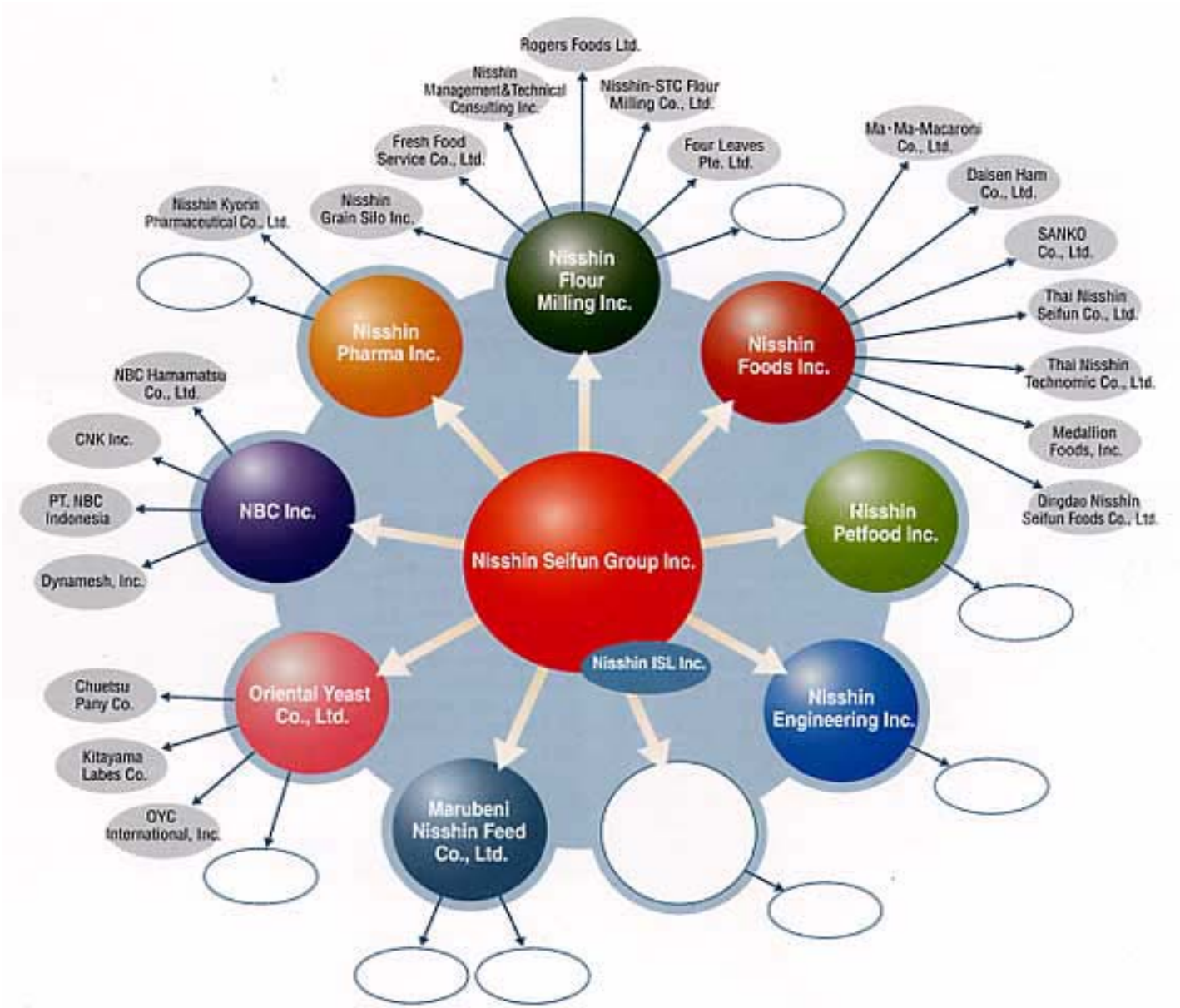
NISSHIN ENGINEERING

CONTENTS

NISSHIN SEIFUN GROUP



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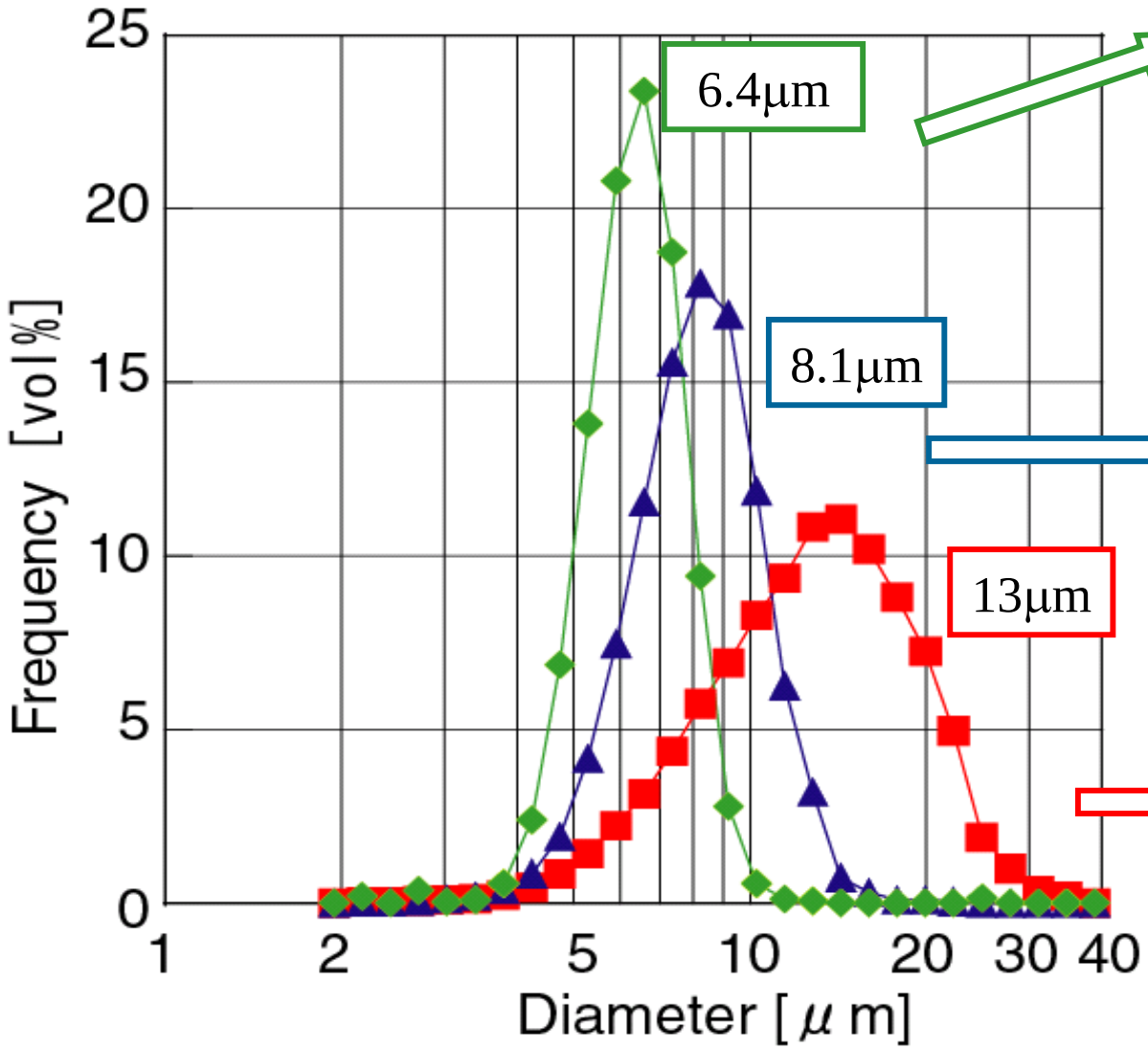
Trends in toner

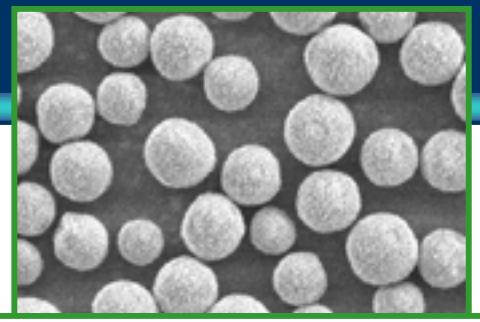
Recent demand for toner

- Smaller particle design
  10μm ⇨ 5μm
- Particle size distribution
  Broad ⇨ Narrow
  Less fine particle & coarse particle
- Particle shape control
  Non Spherical ⇨ Spherical

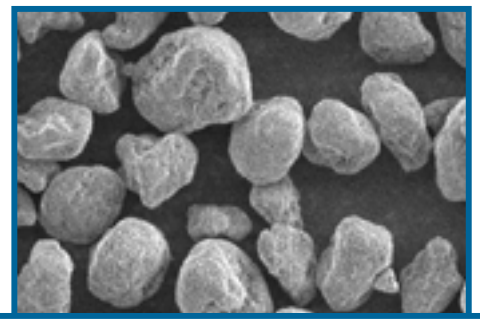
Method of producing toner

- Pulverizing process
- Chemical process

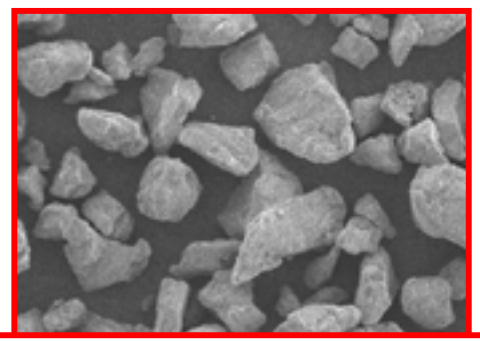




Circularity Index: 0.990



Circularity Index: 0.955



Circularity Index: 0.917

Goal of our company

The design of toner

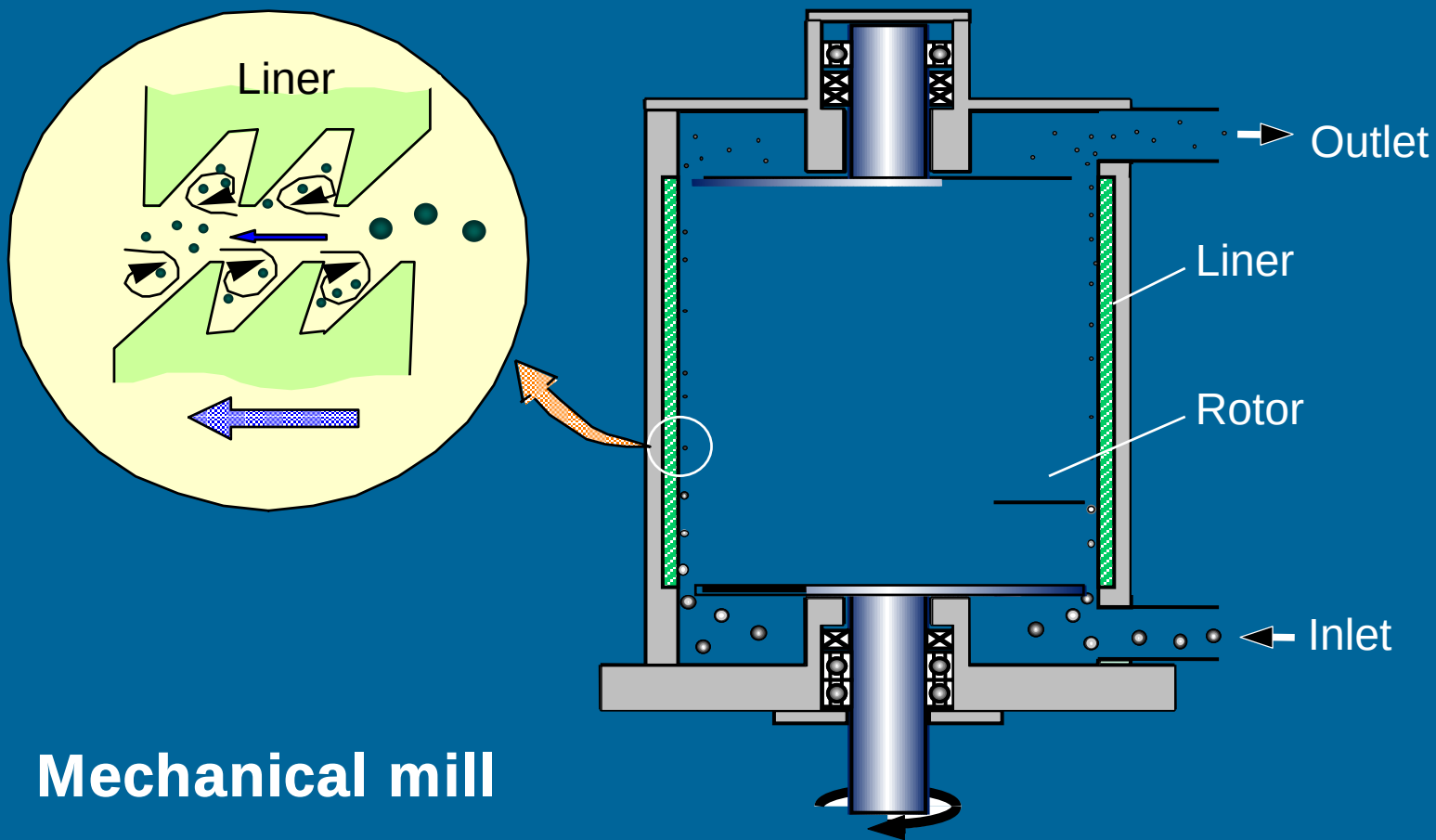
- Pulverized toner (5～10μm)
  - ✓Monochrome toner・・・mechanical mill or jet mill
  - ✓Color toner (especially ,polyester resin)・・・jet mill

- Sharp particle size distribution
  - ✓Development of grinding and classifying system

- Particle shape control
  - ✓Circularity Index → 0.97

Mechanical mill ～Super Rotor～

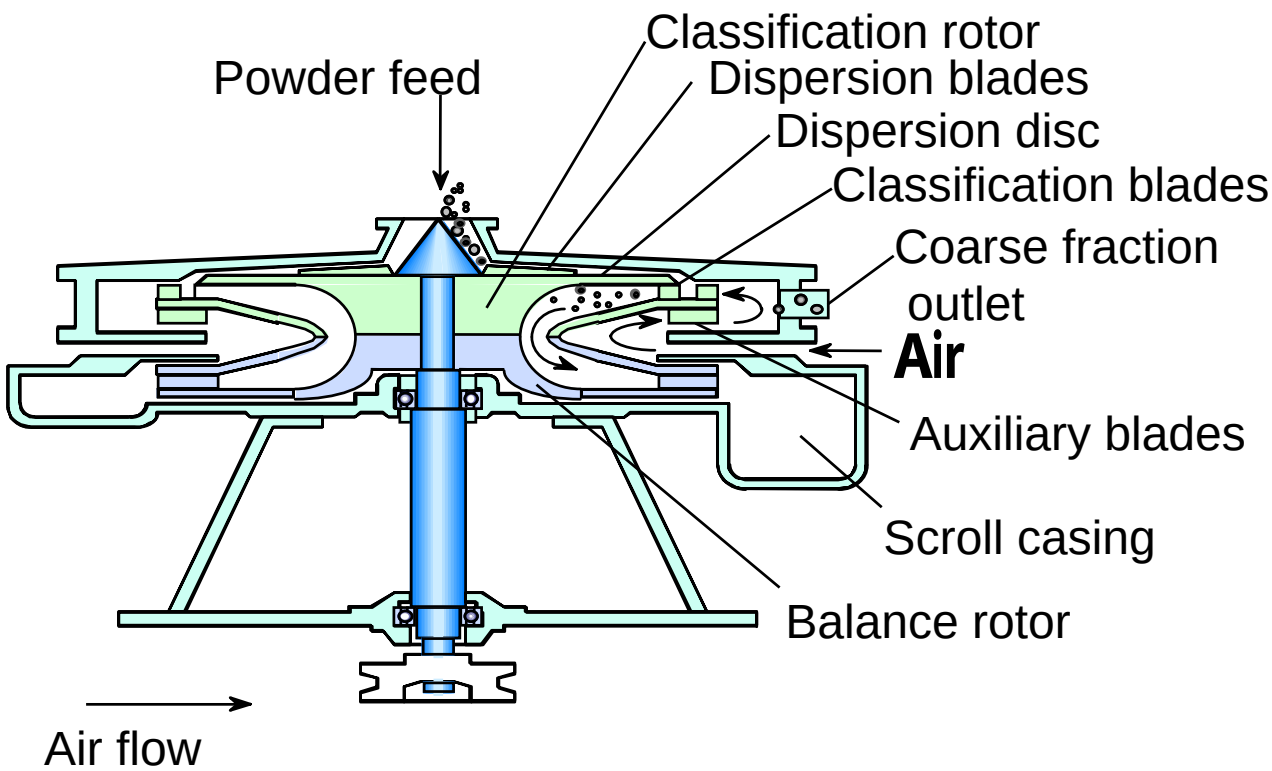
Super Rotor　SR-25



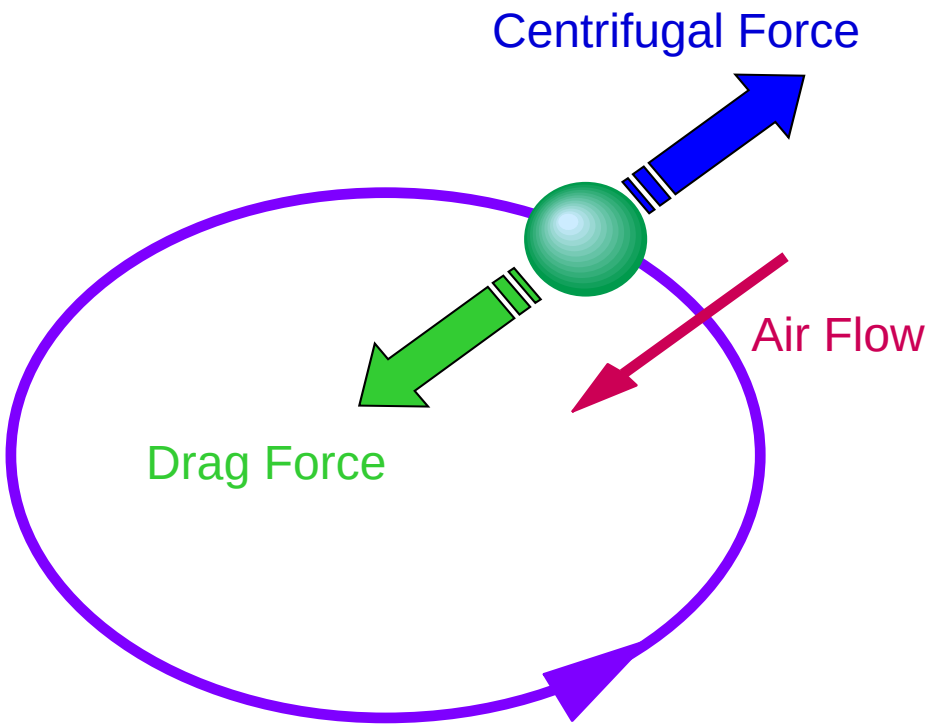
Mechanical mill

Cross sectional view of Super Rotor

Air classifier ～Turbo-Classifier～



Cross sectional view of Turbo-Classifier



Particle Rotation

Large Particles

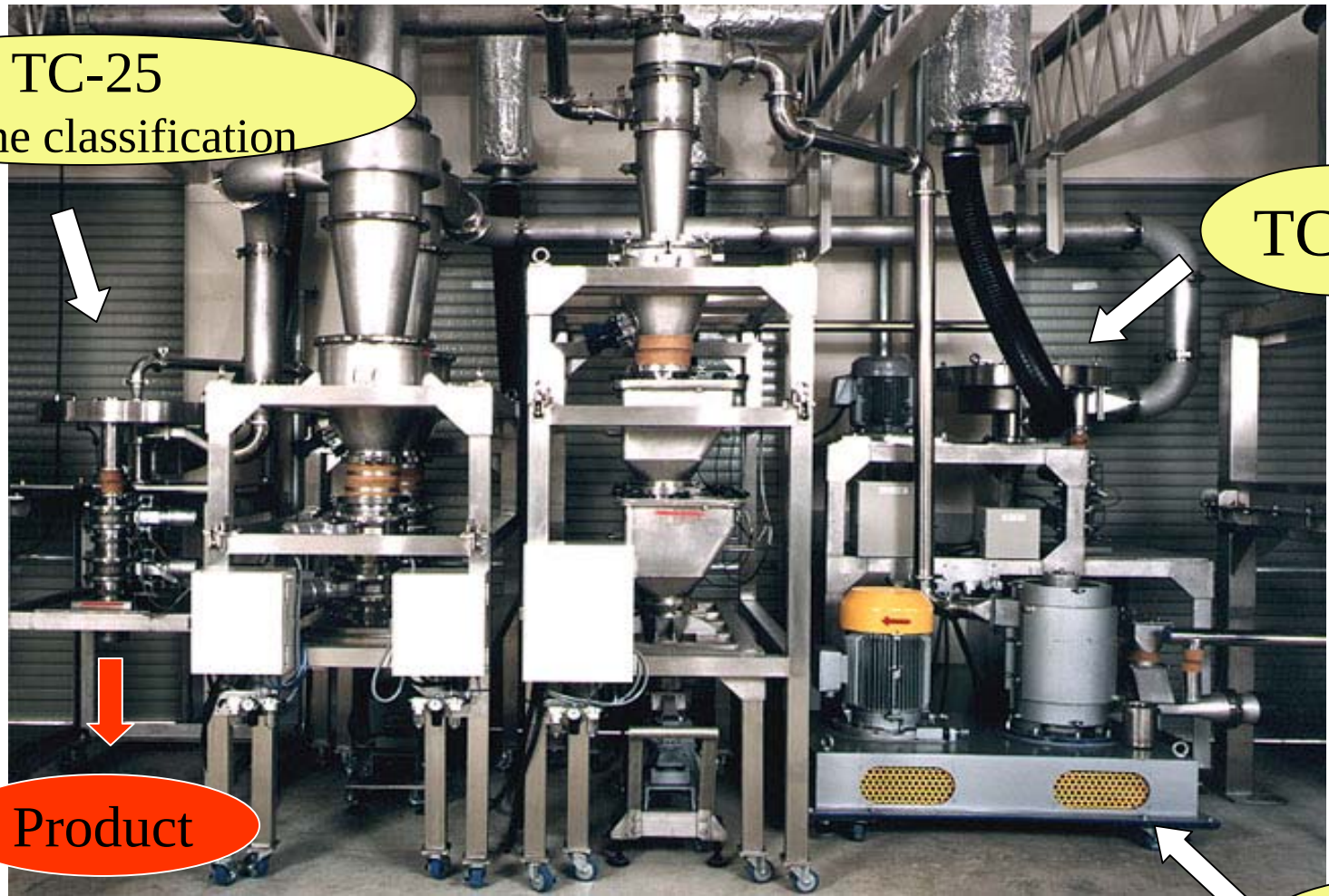
Centrifugal Force > Drag Force

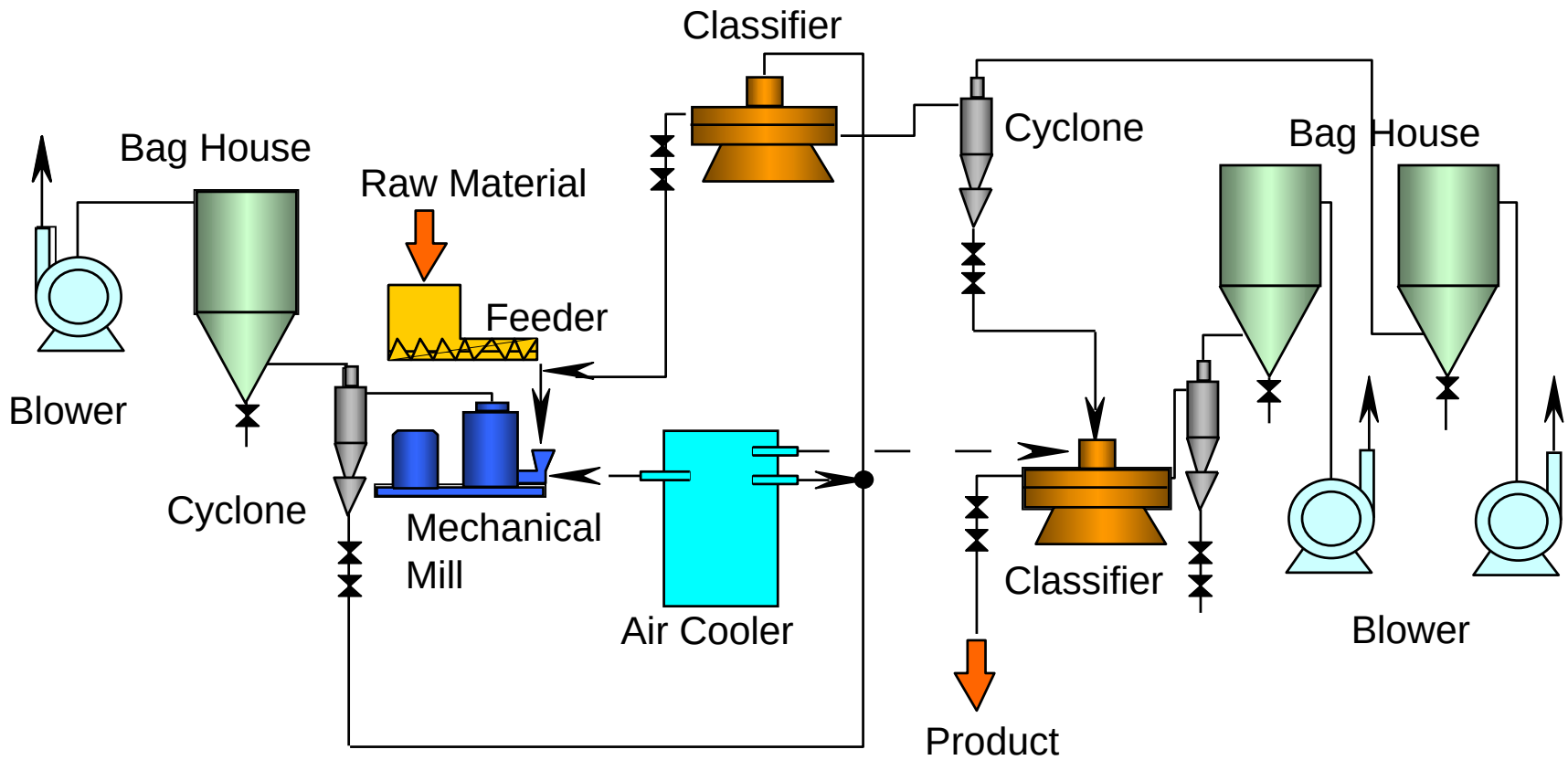
Small Particles

Centrifugal Force < Drag Force

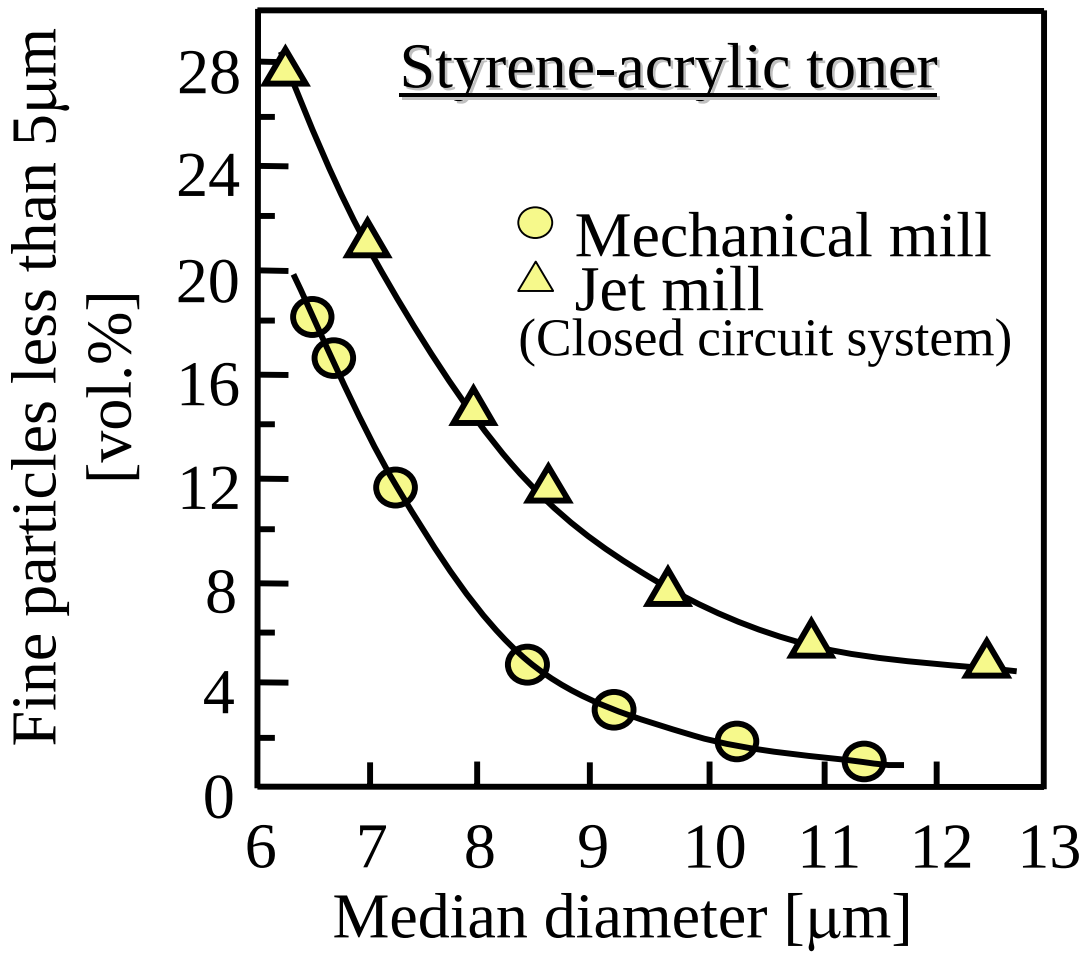
Principle of Air Classification (Centrifugal Force Classification)

Grinding & Classifying System

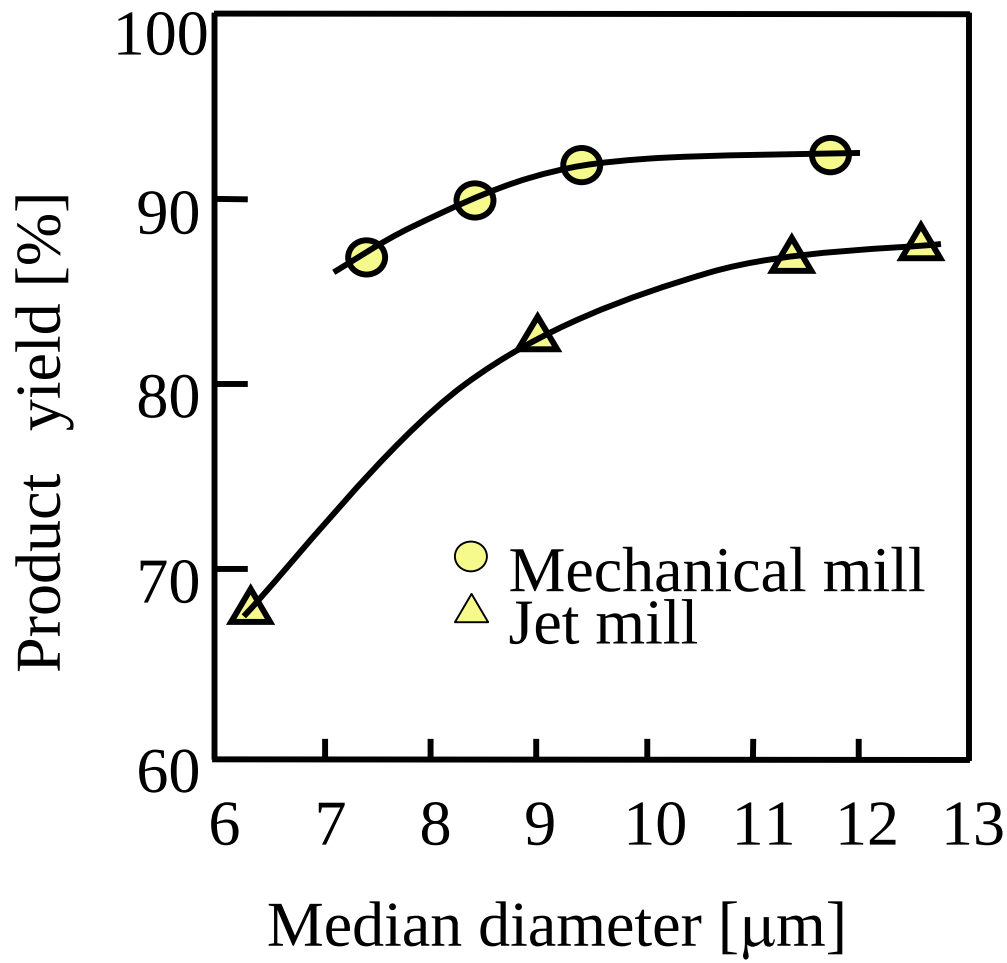




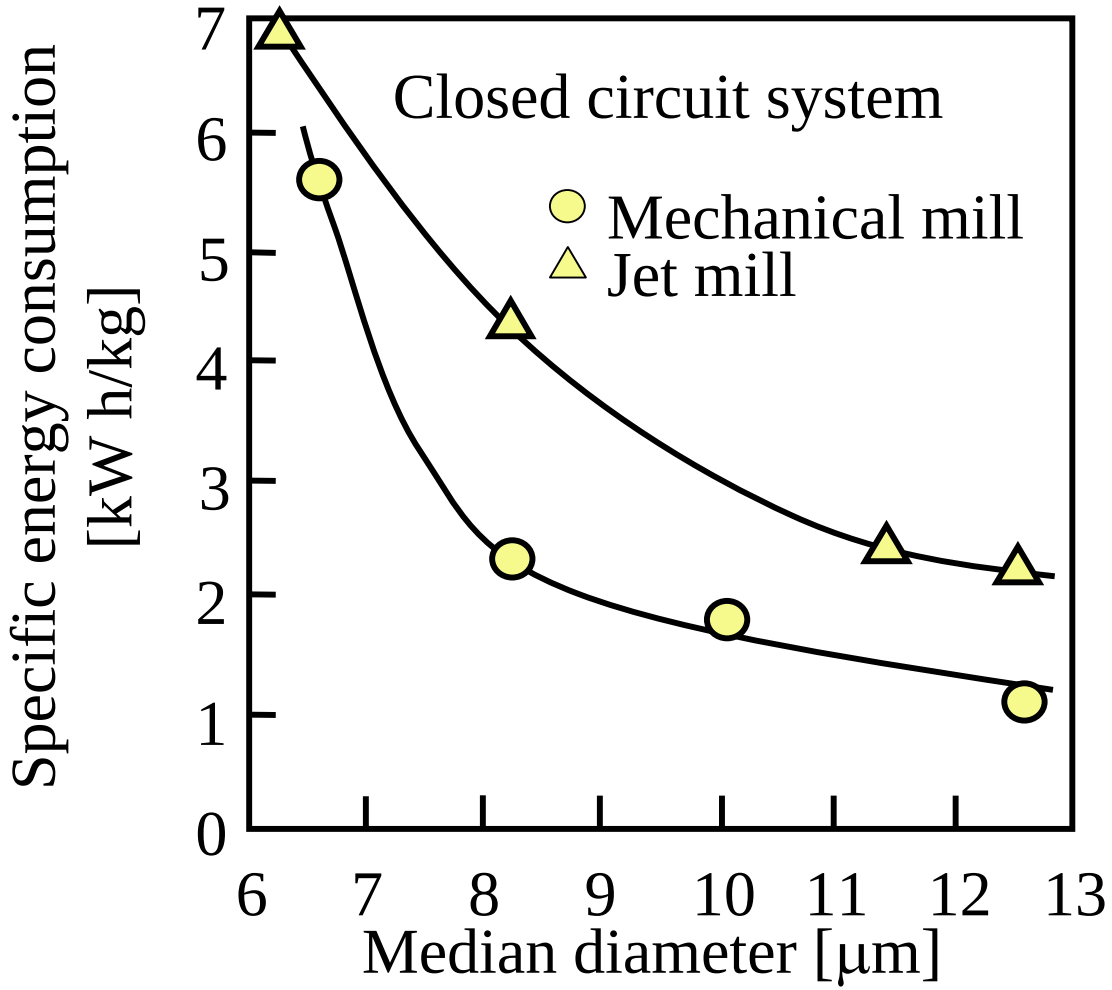
Flow sheet of toner grinding and classifying process



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



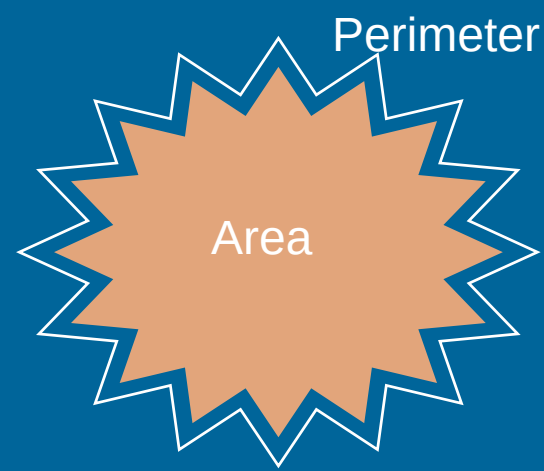
Relation between the median diameter of product and specific energy consumption of closed circuit grinding system

Determination of particle shape of toner

Malvern ; FPIA-2000

(Flow Particle Image Analyzer)

$$\text{Circularity index (C.I.)} = \frac{\sqrt{(4\pi * \text{Area})}}{\text{Perimeter}} \leqq 1$$

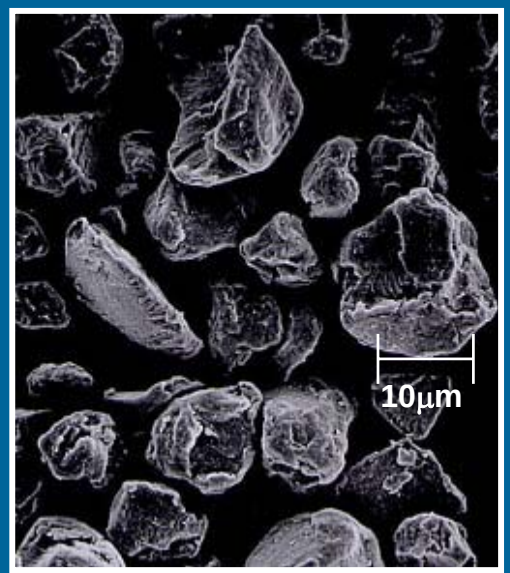


NIRECO ; LUZEX

$$\text{Surface shape factor (S.S.F.)} = \frac{(\text{Perimeter})^2}{4\pi * \text{Area}} \geqq 1$$

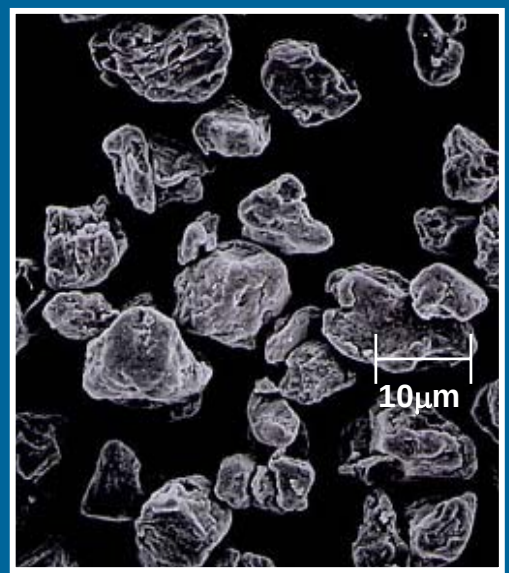
Smooth & rounded surface shape ⟶ 1 (Spherical shape)

Measuring particle shape



C.I. = 0.927
S. S. F. = 1.41

(a) Target jet mill



C.I. = 0.927
S. S. F. = 1.35

(b) Pancake jet mill

C.I. = 0.941
S. S. F. = 1.26

(c) Mechanical mill

SEM photos of toners

TEMPERATURE CONTROL FOR MECHANICAL MILL

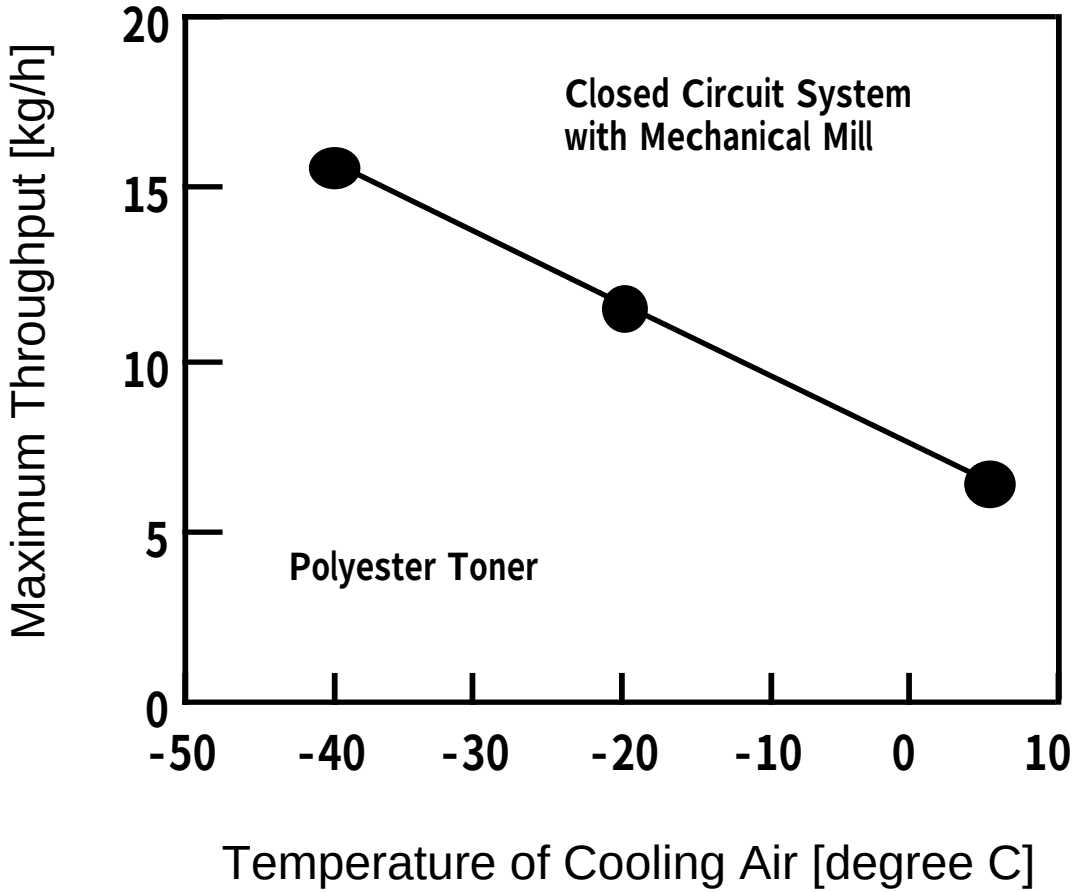
Feed Material: Non-magnetic Toner with Polyester Resin,
D_{50}=500μm (Color Toner)

Grinding Mill : Mechanical Mill with Cooling Air

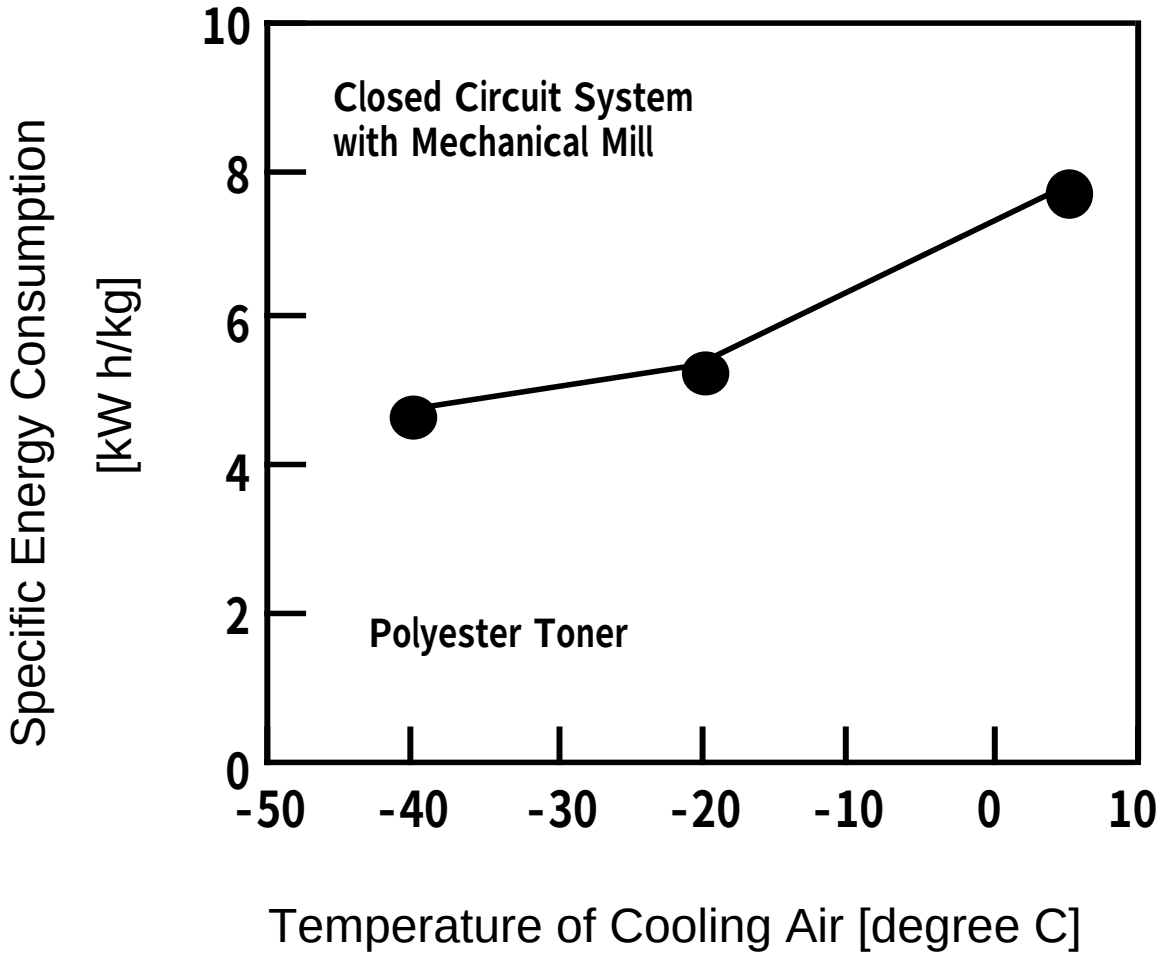
Product Diameter: 8 μm

Temp. of Mill Outlet: 50 degree C (122 degree F)

Temp. of Cooling Air: from +5 to -40 degree C
(from 41 to -40 degree F)

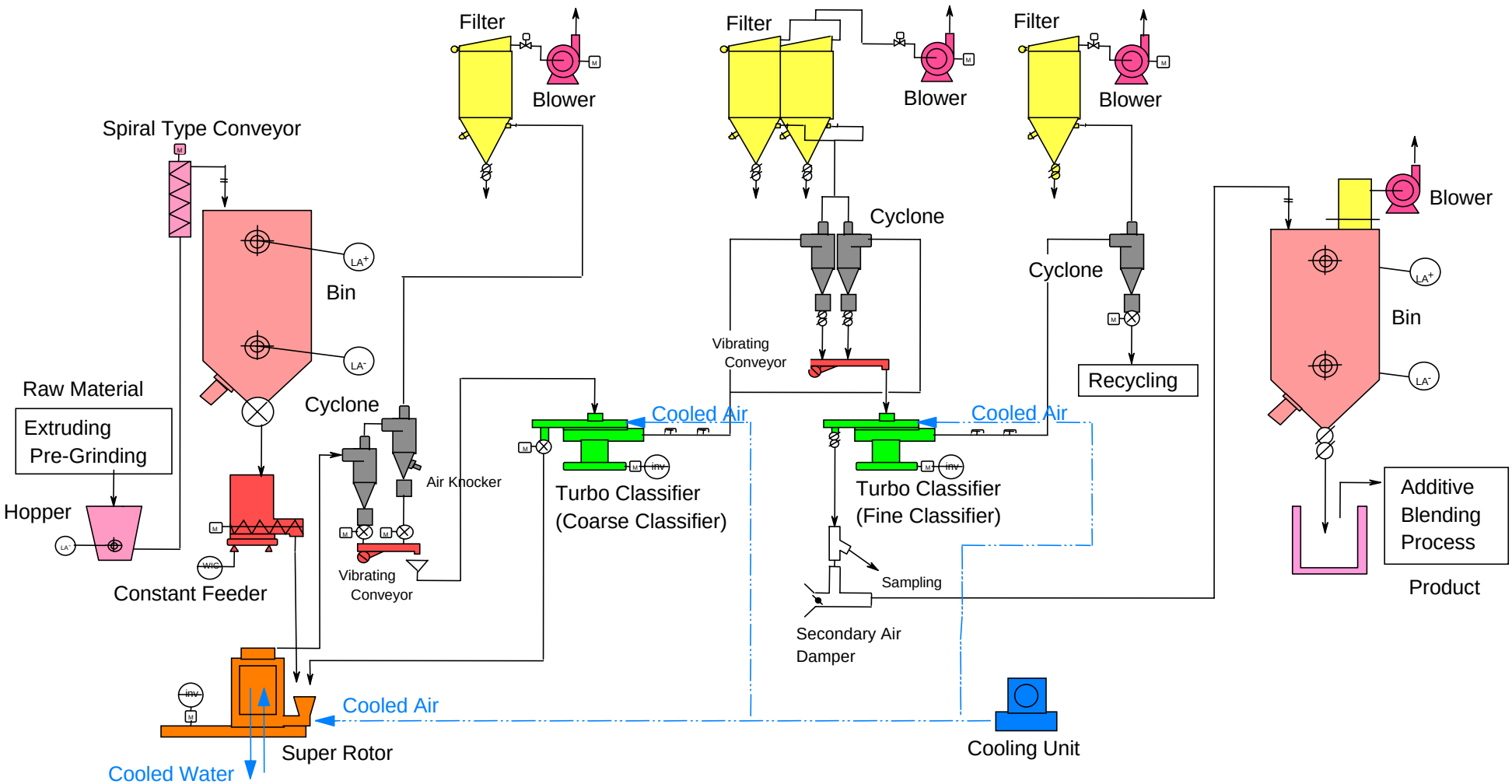


Relation between the Temperature of Cooling Air and the Maximum Throughput of the Mechanical Grinding System



Relation between Temperature of Cooling Air and Specific Energy Consumption of Closed Mechanical Grinding System

Toner manufacturing plant



Toner Manufacturing Process Flow Sheet

Outline of toner plant

Equipment : Grinding and classifying systems

Feed material : mainly monochrome toner

Product capacity : 30-100 ton / month / line

Product diameter: 8 ～10 μm

Product yield : 85～93 %

New jet mill ～Super Jet Mill～

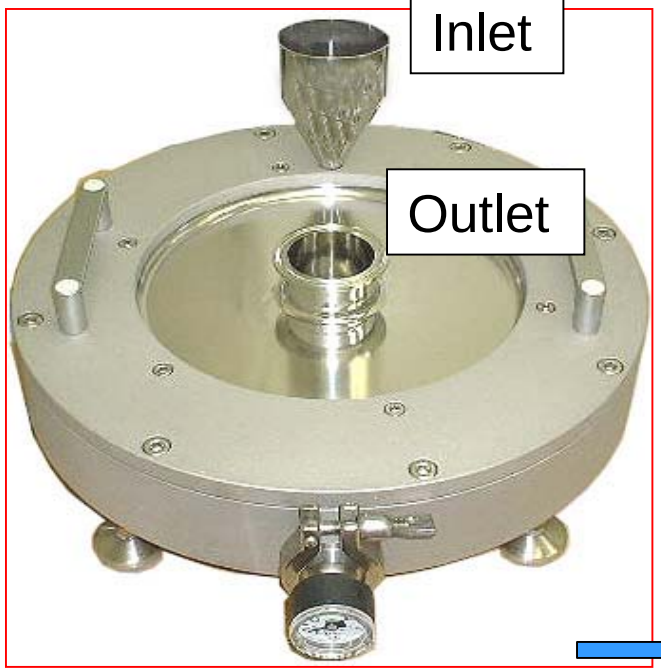
SJ-500

Contents

- Super Jet Mill' features
- Performance of SJ for color toner
  - ➢Comparison with
  - →conventional jet mill,
  - →target jet mill
  - →mechanical mill
- Overall summary

Features

- Two stage classification
- Prevent coarse powder from mixing, achieves narrow particle size distribution.
- Simple inner structure without moving parts
- Less dead space for internal structure, less powder accumulation and adhesion.
- Easy maintenance and cleaning.



Comp.air

Grinding nozzle

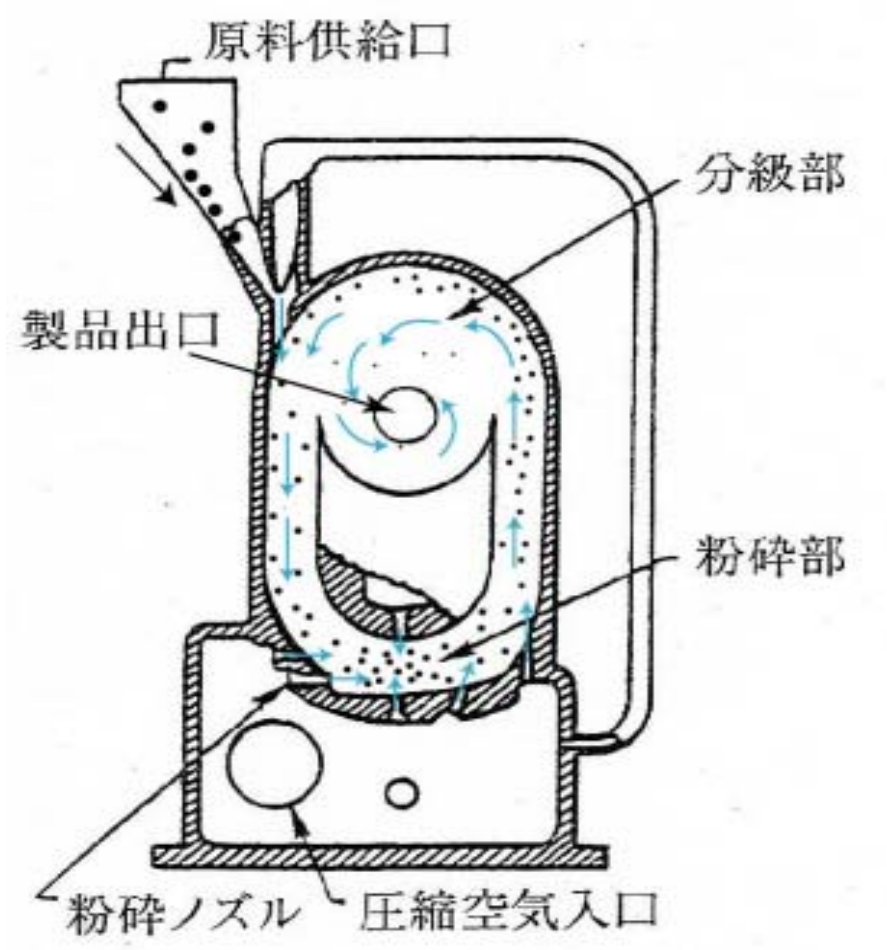
Outlet

Inlet

Grinding zone
(1st stage classifying)

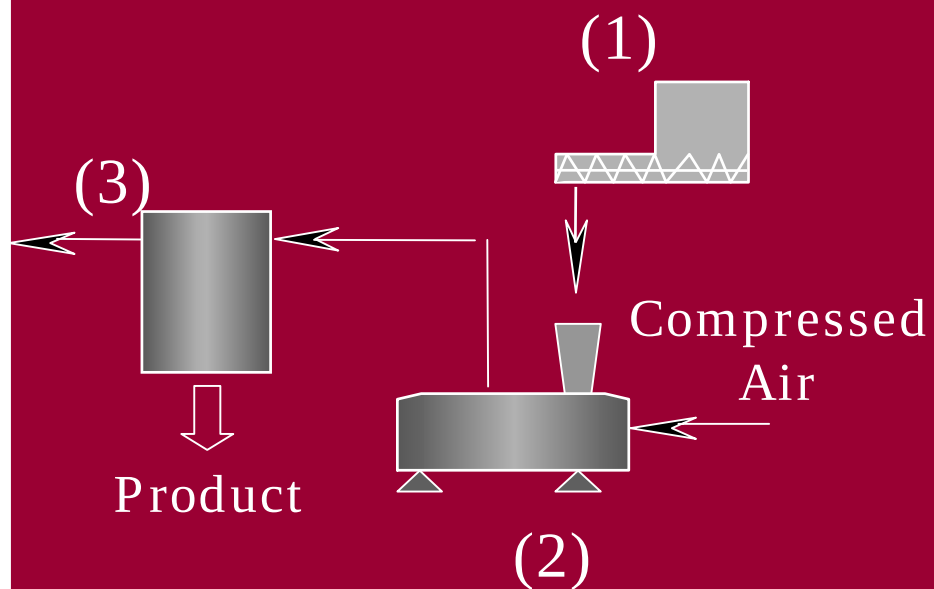
Classifying zone
(2st stage classifying)

Comparison between Super Jet Mill and our conventional jet mill



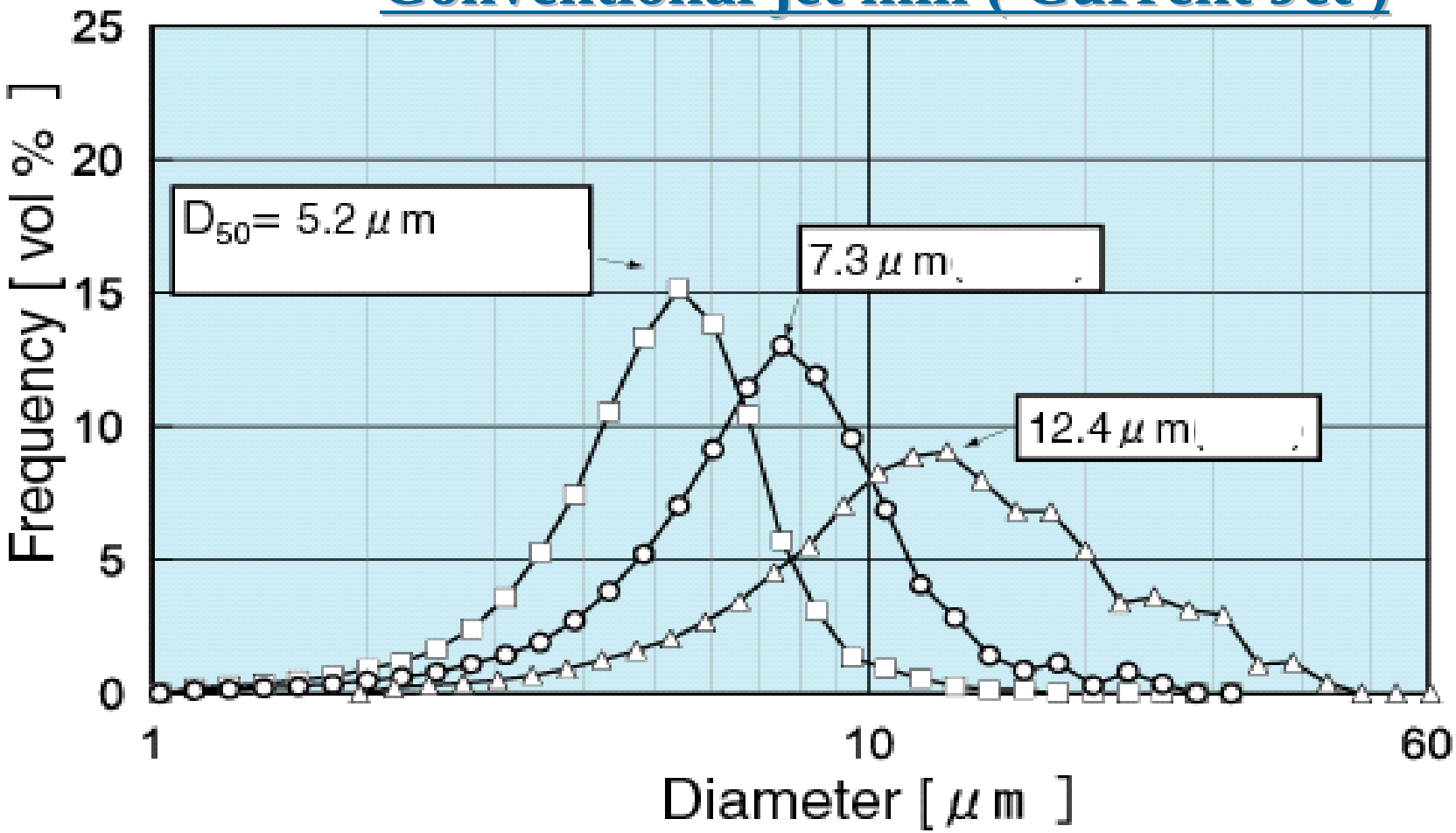
Current Jet (Loop jet type)

(1) Screw feeder
(2) Jet Mill
(3) Bag house



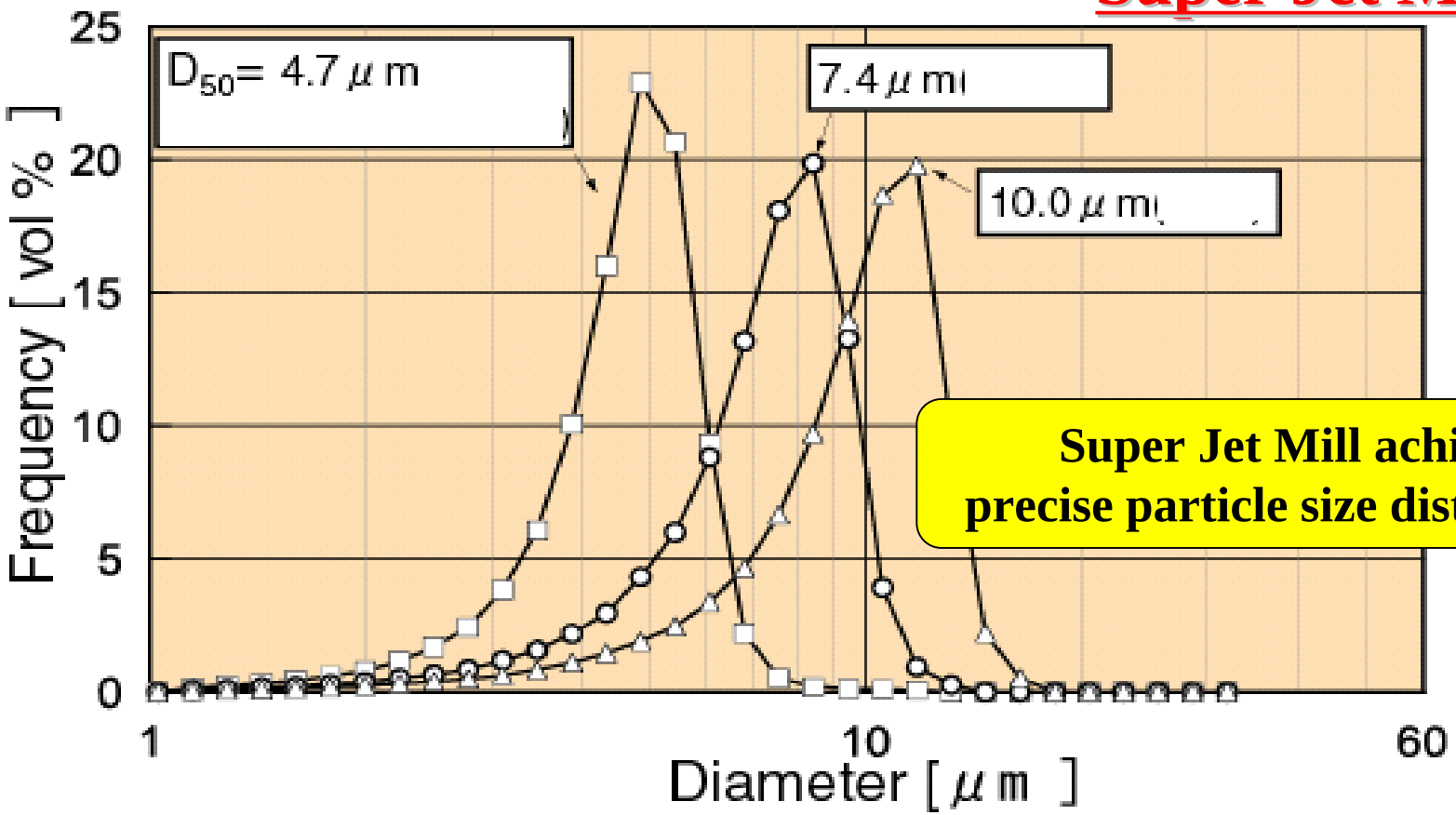
Grinding system of Jet Mill

Conventional jet mill (Current Jet)



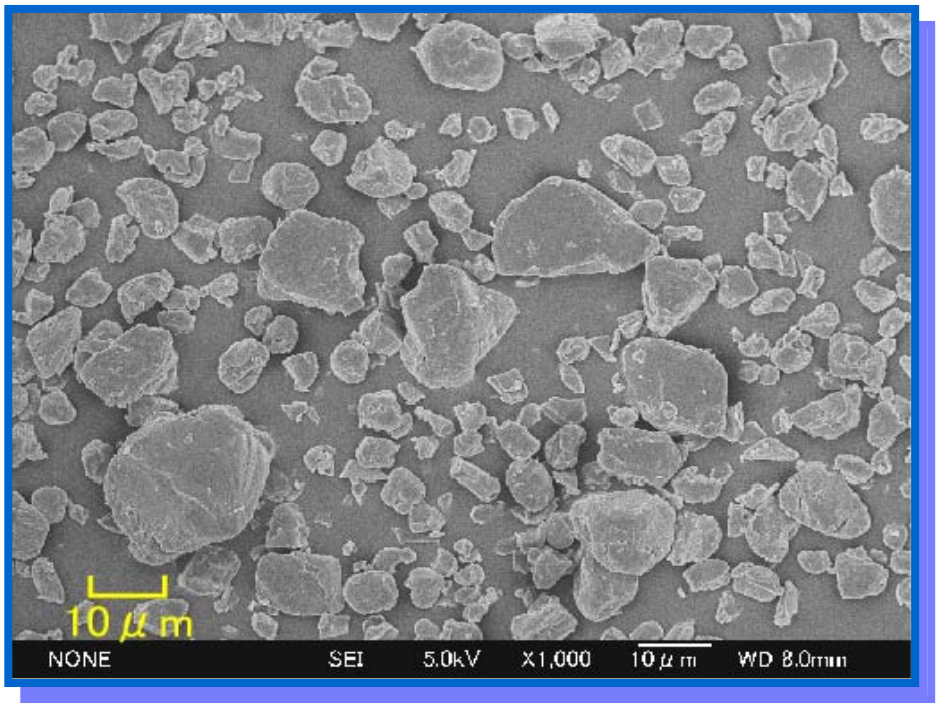
Relation between particle size distribution of product and mixture rate (Color toner with polyester resin)

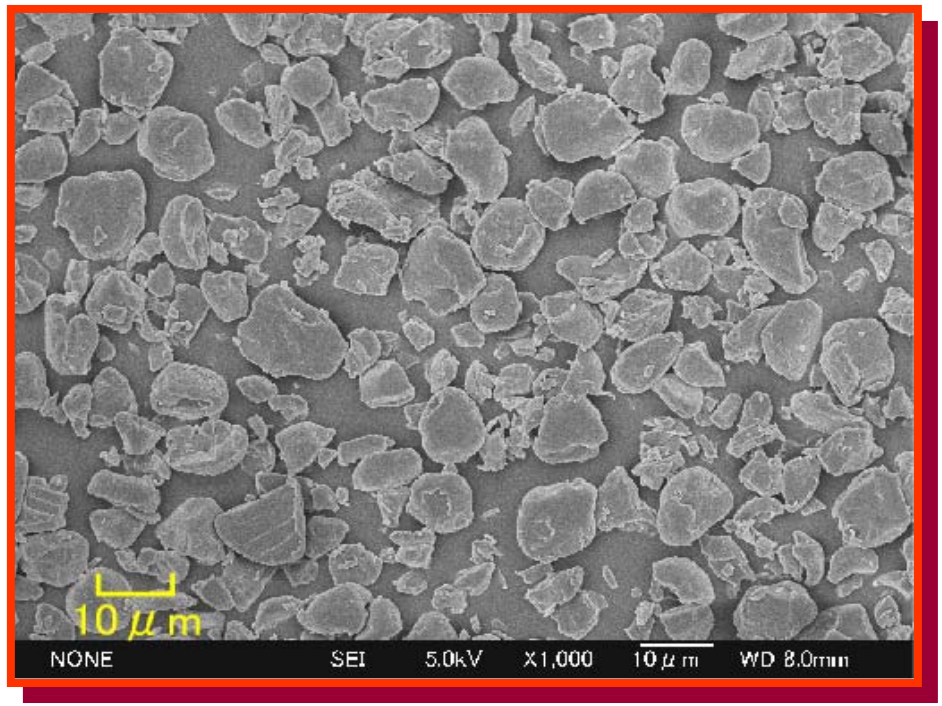
Super Jet Mill



Super Jet Mill achieves precise particle size distribution!

Relation between particle size distribution of product and mixture rate(Color toner with polyester resin)

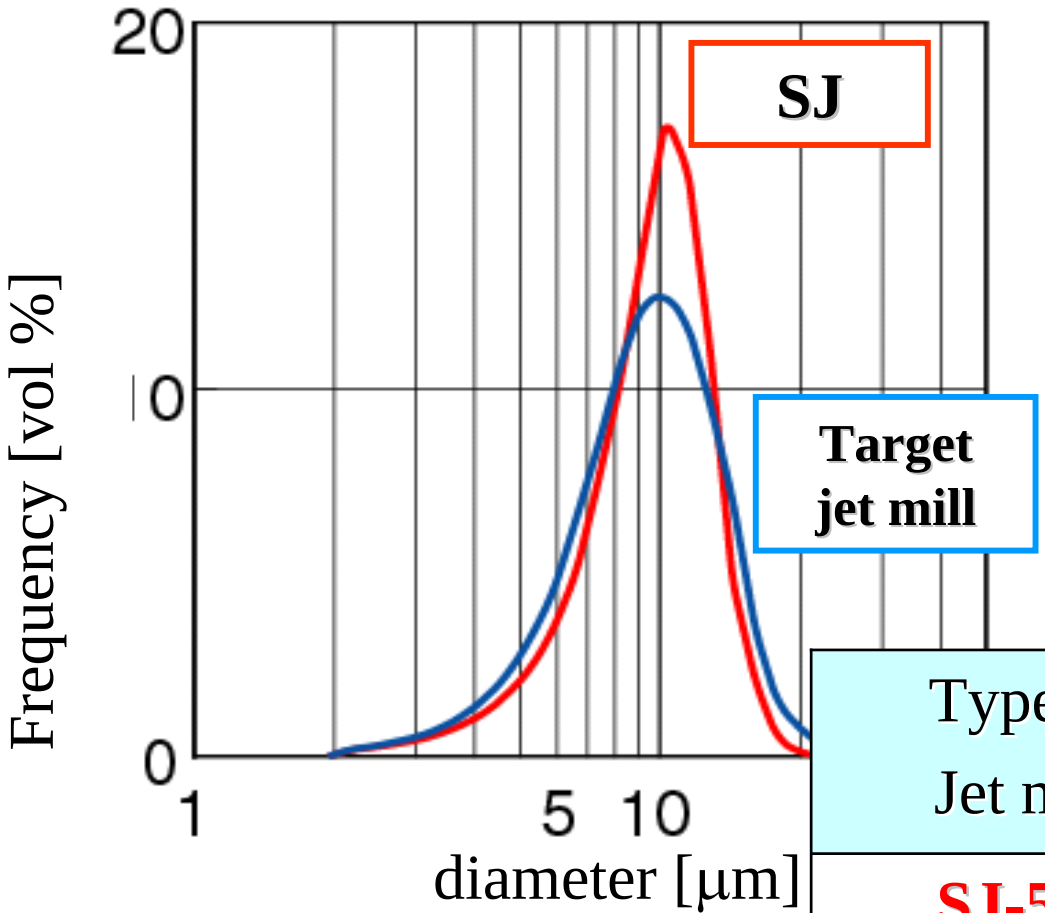




Current Jet ***Super Jet Mill***

SEM photos of color toners (Median diameter : 7μm)

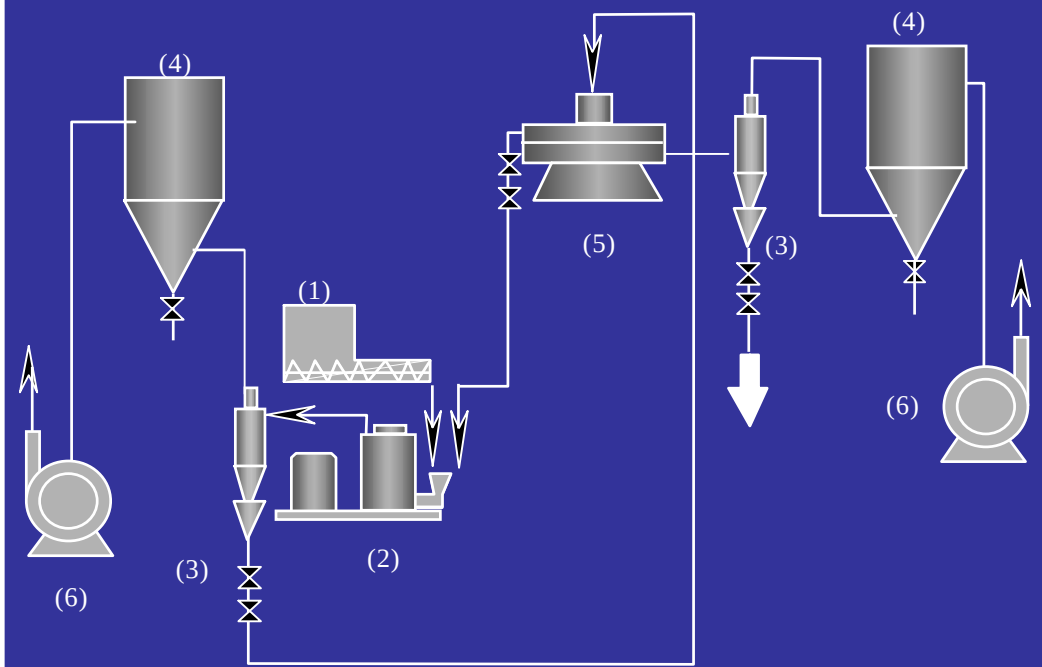
Comparison between SJ and a target jet mill



Type of Jet mill	Median diameter [μm]	Over 16μm [vol%]	Under 5μm [pop%]
SJ-500	**9.8**	**1.57**	**48.5**
Target jet mill	**9.5**	**3.80**	**51.9**

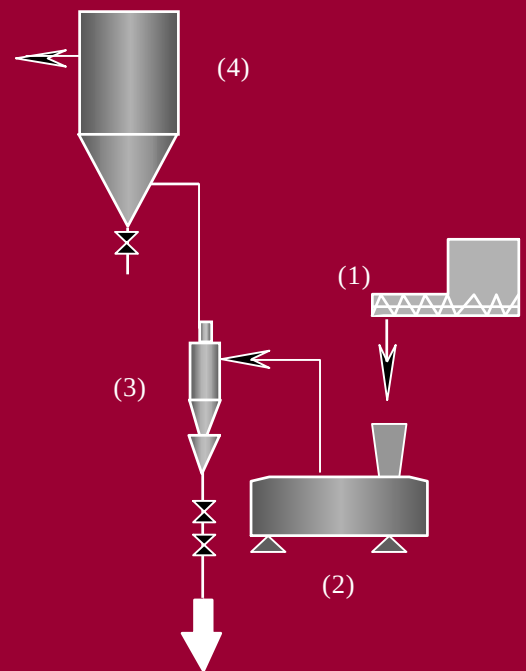
Comparison of Mechanical Mill and Super Jet Mill

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

Test condition

Mechanical grinding system

Raw Material: Color & Monochrome toner

Mechanical mill : SR-15 (rotor diameter ϕ150)

Rotational speed : 13,000～14,000 min^{-1}

Air flow rate : 1.5 m^3/min

Throughput : ～ 1 kg/h

Air classifier : TC-15 (rotor diameter ϕ150)

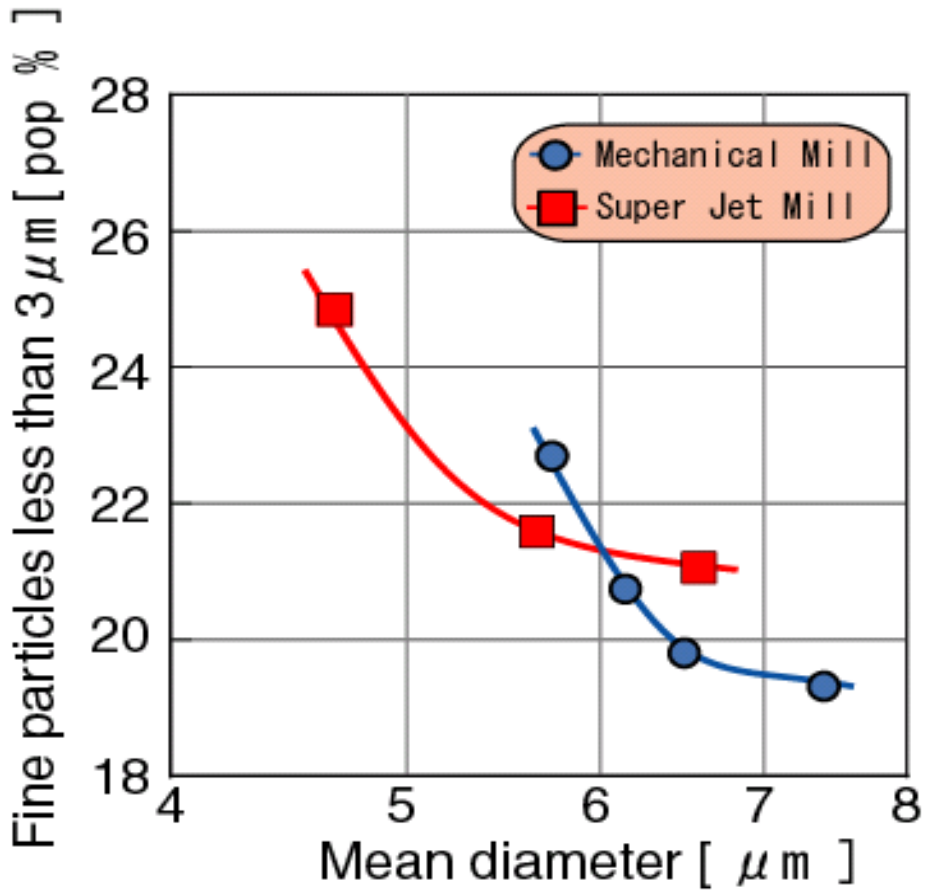
Rotational speed : 5,000～7,000 min^{-1}

Air flow rate : 2.5 m^3/min

Grinding system of Super Jet Mill

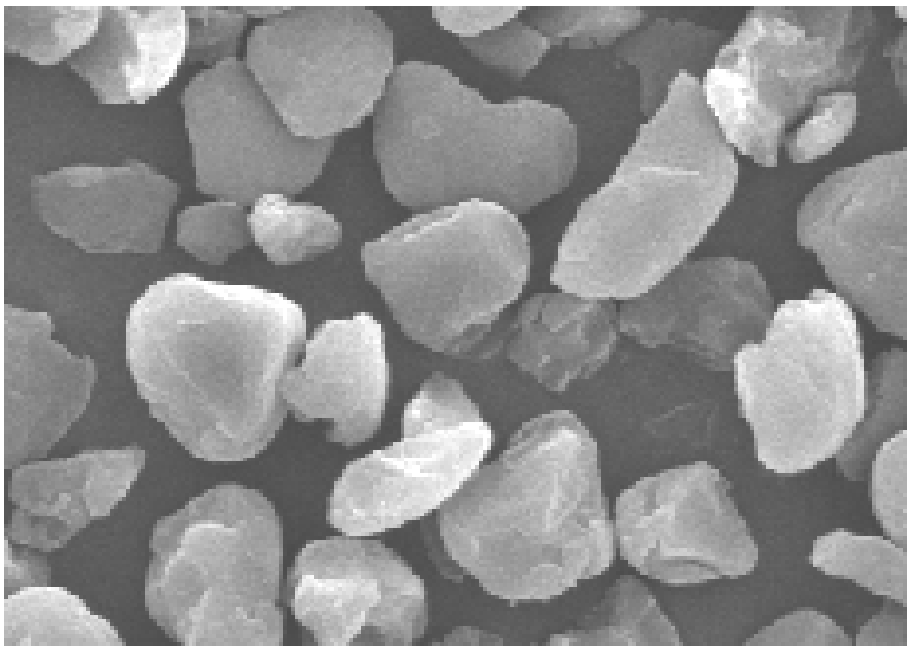
SJ-500 **Air Pressure : 0.6 MPa (0.55m^3/min)**

Throughput : ～ 1 kg/h



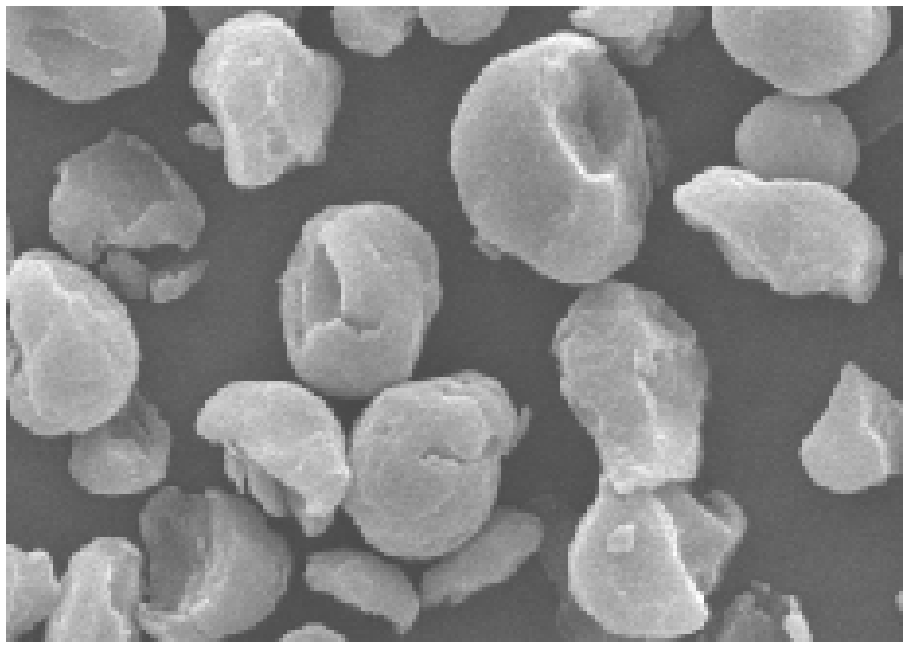
Relation between the median diameter and the population percentage of fine particles less than 3μm (Color toner with polyester resin)

SEM photo of color toner



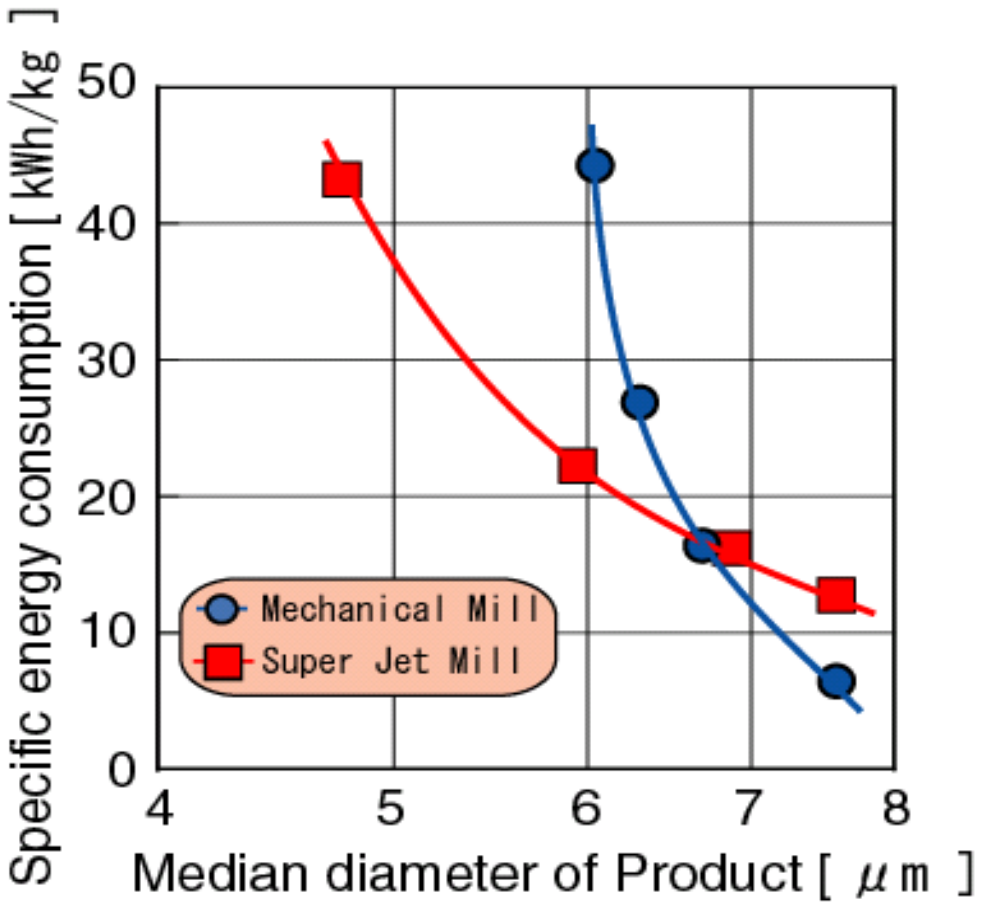
C.I.= 0.944

Mechanical grinding system



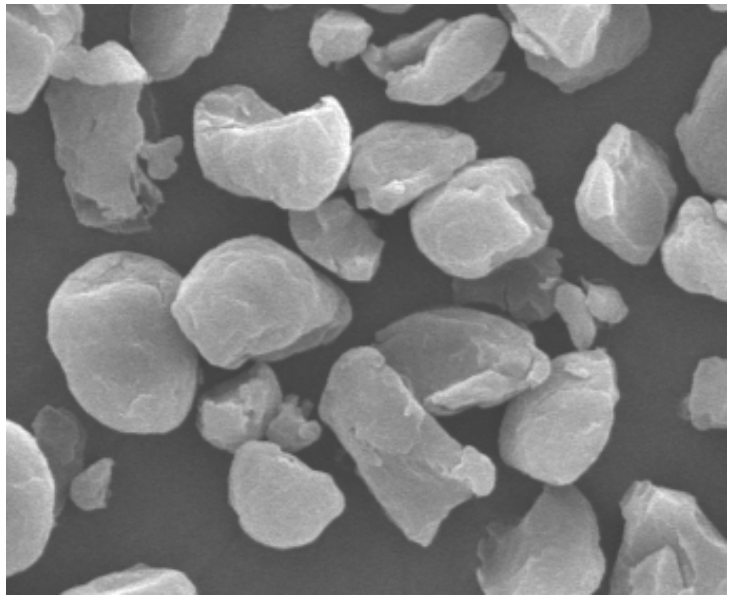
C.I.= 0.943

Super Jet Mill



Relation between the median diameter of product and specific energy consumption (Color toner with polyester resin)

Effect of fine classification on particle shape



Color toner with polyester resin

TC-15

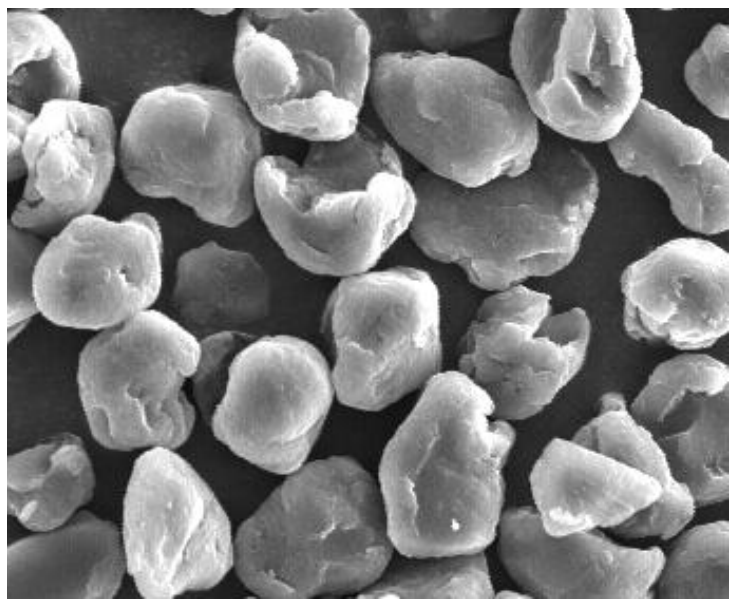
Rotational Speed : 10,000 min^{-1}

Air Flow Rate : 2.1m^3/min

Throughput : 1.8kg/h

Before fine classification

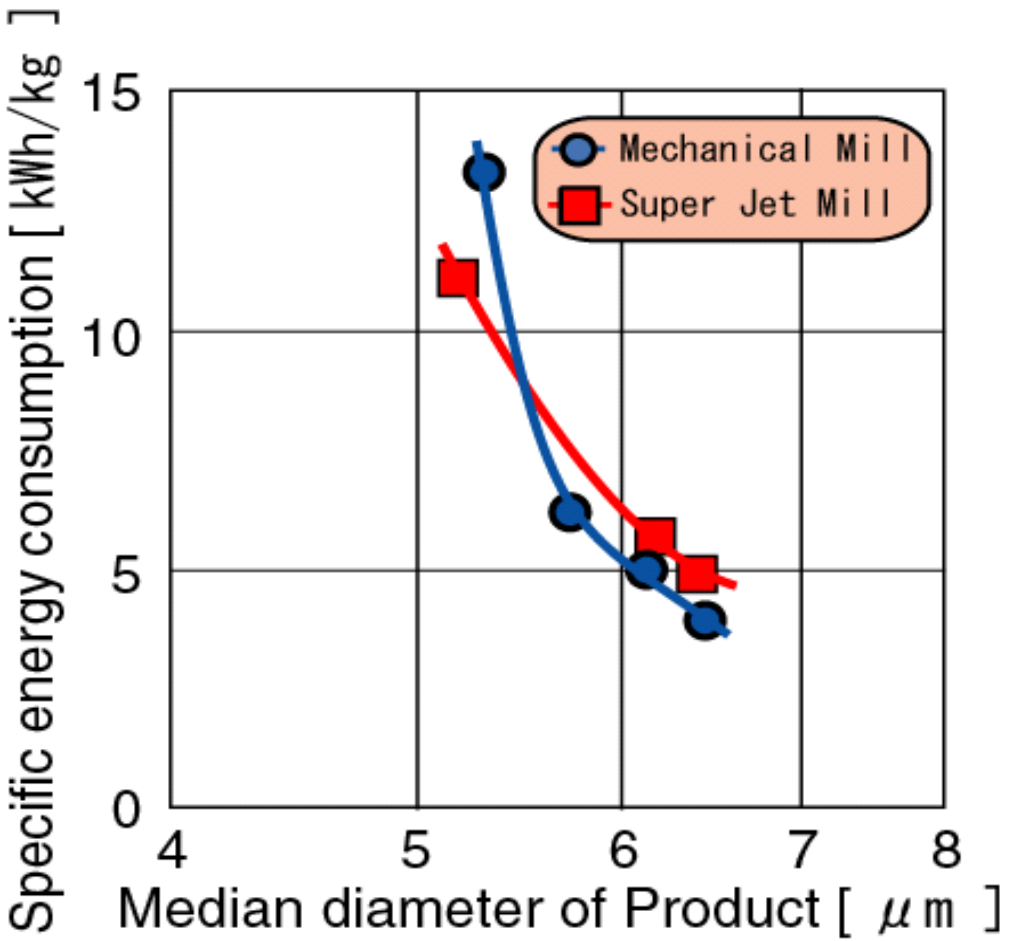
C.I.=0.943

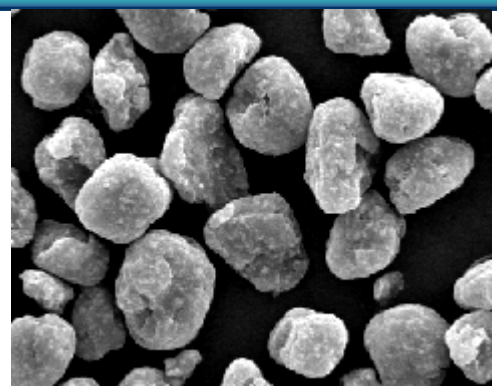


After fine classification

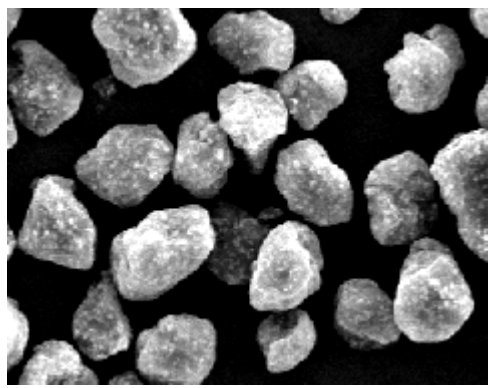
C.I.=0.959

Monochrome toner





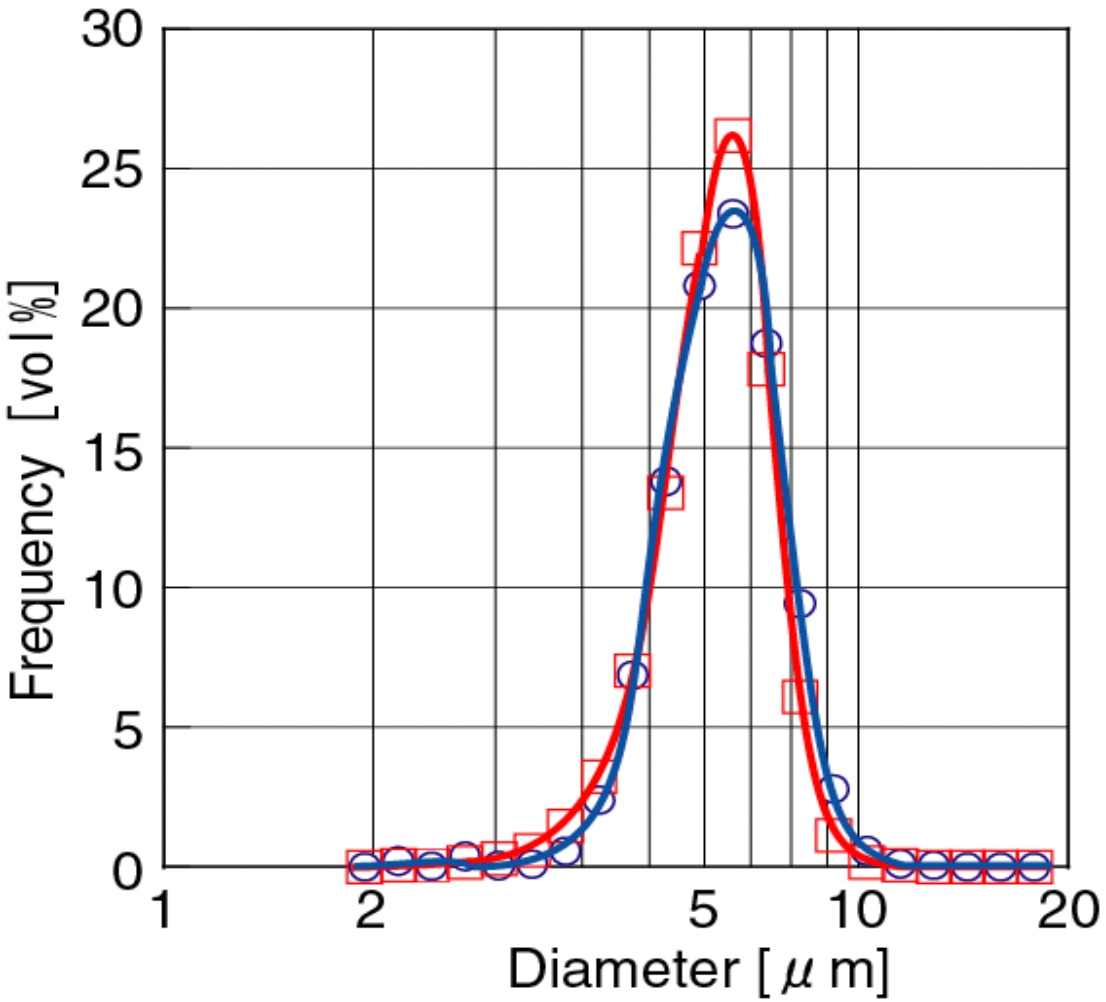
Mechanical mill (6.1μm)



Super Jet Mill (6.2μm)

Relation between the median diameter of product and specific energy consumption (Monochrome toner with Styrene-acrylic resin)

Comparison of our toner and chemical toner



Chemical toner

D_{50}= 6.4μm
Coefficient of Variation = 21.5
Circularity Index = 0.990

Pulverized toner

D_{50}= 6.3μm
Yield= 72 %
Coefficient of Variation = 17.9
Circularity Index = 0.956

Line-up

	Pulverizer		Fine classifier	
Throughput	Type	Power consumption	Type	Power consumption (with blower)
～2 kg/h	SJ-500	～7.5 kW (10HP)	TC-15	～3.7kW (5HP)
～10 kg/h	SJ-2500	～22 kW (30HP)		
～40 kg/h	SJ-10K	～90 kW (120HP)	TC-25	～13 kW (18HP)
(～120 kg/h)	(SJ-30K)	(～190 kW) (250HP)	TC-40	18.5～37 kW (25 ～50HP)

Summary

- **Mechanical Mill**

(for monochrome toner with diameter more than 5.5-7μm)

① It can easily prevent over-pulverization

→ narrow particle size distribution

→ less power consumption

② It produces spherical toner accepted in market without additional treatment for rounding

➢New Jet Mill -Super Jet Mill

(for color & monochrome toner

with diameter less than 7μm)

① It can prevent the mixture of coarse particles

→narrow particle size distribution

→easy to control particle size

② It has less dead space for internal structure

→less the powder accumulation and adhesion

③ It produces spherical color toner as same as toner ground by mechanical mill