

充分な粉碎,混合効果を可能とした3次元ボールミル(3次元リアクター)のご提案
To provide the 3D ball mill(3D Reactor) provided with the
sufficient pulverization and mixture effect.

July, 7, 2017

NAGAO SYSTEM INC.

【Company Profile】 NAGAO SYSTEM INC. Is a professional group that solves milling, mixing and dispersion, which was considered impossible in the past by high-speed rotation utilization of patented 3D ball mill (3D Reactor).

Company Profile



NAGAO SYSTEM

Company Name (社名)	NAGAO SYSTEM INC.
Established (設立)	Oct. 1994
Location (所在地)	<ul style="list-style-type: none"> • Head Office: Kawasaki • Exhibition Room : Kawasaki • Bangkok Office: Asok Bangkok • Ho Chi Minh Office
Business Domain (事業領域)	Manufactures/Wholesale/Retail
Employees (従業員数)	3
Annual Sales (年間売上)	500,000 (US Dollar)

Products

- (Middle Size)Table-top type 2-axis 3D Ball Mill
 - 3D-210-D2
 - Pot diameter Φ 210mm
 - Maximum amount of processing 500g(ml)~1,200g(ml)
- (Small Size) 3D Ball Mill(3D Reactor)(Glove box insertion model)
 - 3D-80
 - Pot diameter Φ 80mm
 - Maximum amount of processing 100g(ml)
- (Small Size) Separate type 3D Ball Mil(3D Reactor)
(Glove box insertion model)
 - 3DB-80 (Separate)
 - Pot diameter Φ 80mm
 - Maximum amount of processing 100g(ml)
- (Small Size)Tilted Rotation Planetary Ball Mill
 - Planet M2-3F
 - Contents 80ml × 2



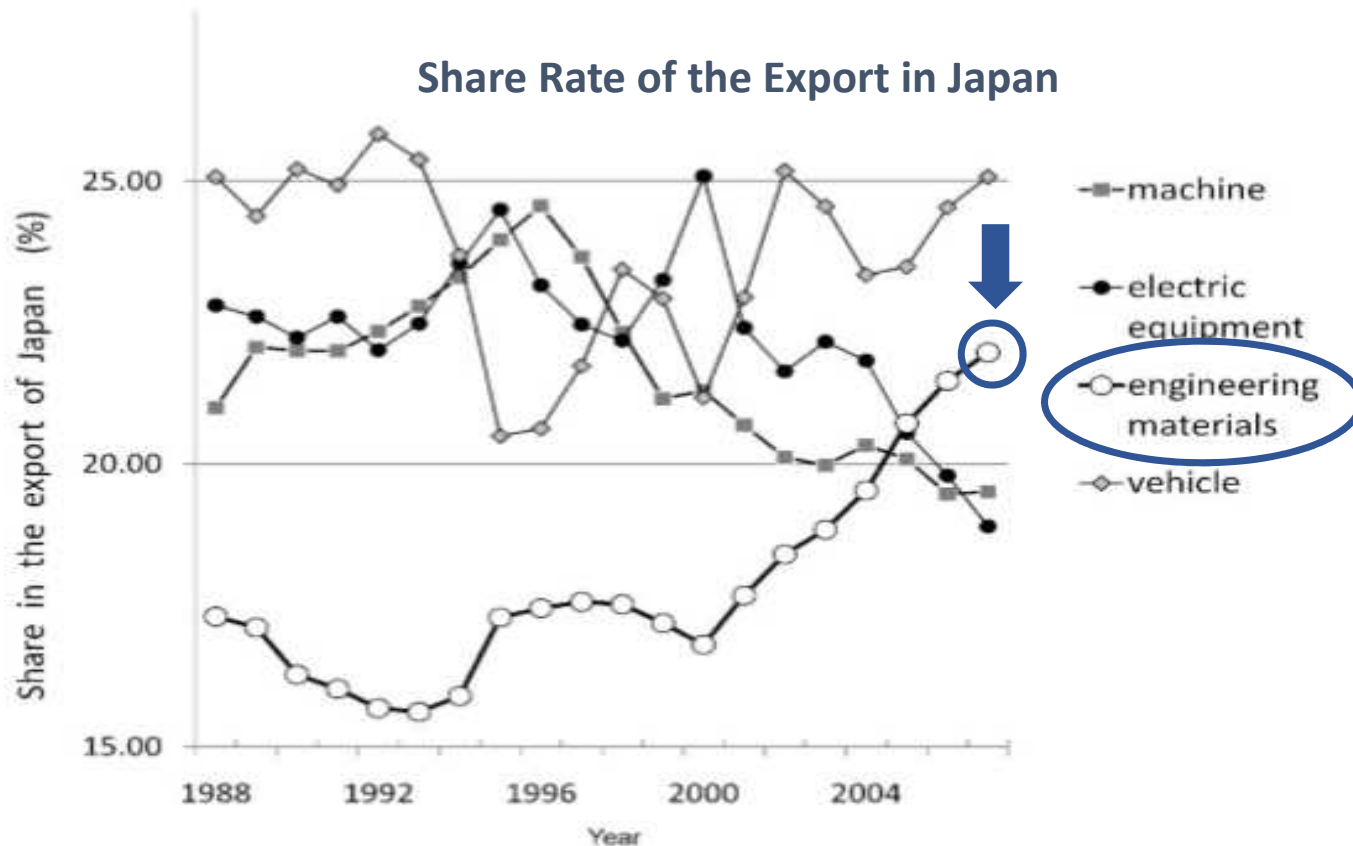
Original mixture/Milling equipment

We contribute by the development of the study apparatus in the 3D Ball Mill(3D Reactor).

【Business market】

Industrial material ratios increase of the export in JAPAN.

The overseas needs is very high now.



【We've got a suggestion.】 We realize impossibility and done pulverization, mixture, dispersion by manufacturing development of the industrial materials conventionally and strengthen your products.

Products solution

1



3D-210-D2

- (Middle Size)Table-top type 2-axis 3D Ball Mill(3D Reactor) 3D-210-D2
- Pot diameter Φ 210mm
- Maximum amount of processing 500g(ml) ~1,200g(ml)

2



3D-80

- (Small Size) 3D Ball Mill(3D Reactor) (Glove box insertion model)
- Pot diameter Φ 80mm
- Maximum amount of processing 100g(ml)

3



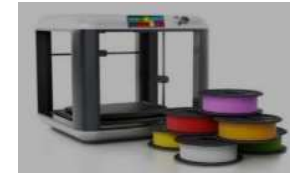
3DB-80

- (Small Size) Separate type 3D Ball Mil(3D Reactor) (Glove box insertion model)
- Separate Model
- Pot diameter Φ 80mm
- Maximum amount of processing 100g(ml)

Application Scene



Conductive pastes



3D printer modeling materials



Electric equipment, Battery materials



Ceramics materials



Inks, Printer inks



Glass materials



Chemical materials



Film materials



Pharmaceutical products

The best choice for research institutes, companies, and universities developing new materials using nano-sized and micron-sized fine particles.

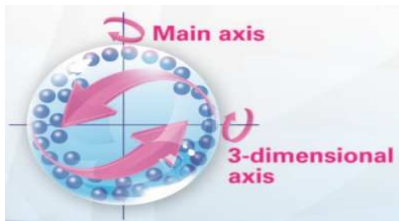
【Background of increased demand for mixing】

Challenges in mixing and dispersing. Cohesion, fever, irregular, occur chronically. Impact on revenue.

Development of the industrial material/Development Issues 【Solution】

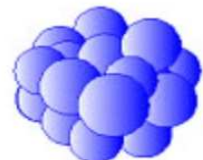
Challenge

- After 2D motion pulverization and mixture generated fine particles cohere at the bottom.
- Highly focused impact force causes of thermogenesis.
- The problem is that particle sizes are not uniform after pulverization and mixture.
- With 2D motion mixing, unevenness is a problem.

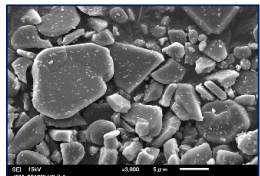


We have a solution


- 3D Ball Mill(3D Reactor)
 - Realize non-cohesion
 - Single Peak Mixing, Milling achieved
 - Mix material of specific gravity and viscosity difference to highly homogeneous mixture




- After 2D motion pulverization and mixture generated fine particles cohere at the bottom.



- The problem is that particle sizes are not uniform after pulverization and mixture.



- Highly focused impact force causes of thermogenesis.



- With 2D motion mixing, unevenness is a problem.

sales

- Solidification, thermogenesis, and non-uniformity in pulverization; and unevenness in mixing often occur and affect sales profits.

cost

- The outbreak of irregular material cost and personnel expenses suppresses cost.

【Company solution】

It adopted 3D motion, and difficulty and done pulverization, mixture, dispersion were enabled conventionally.



Products specifications

- Dry process pulverization without solidification
- Low thermogenesis with spherical motion
- Uniform pulverization, mixing and dispersion
- Non-criticality based on high-speed motion
- Uniform mixing without blade
- Utilizing friction force and achieved pulverization with maintaining particle form

Merit

- 1 ■ **Thermogenesis problem in 2D motion pulverization**
 - **Solution:** Utilizing the entire inner area of the container promotes the dispersion of frictional heat and its generation. Effective with organic and inorganic substances.
- 2 ■ **Uneven particle size in 2D motion pulverization**
 - **Solution:** Batched pulverization utilizing friction force of high-speed 3D motion. Rounded particle form and uniform particle size.
- 3 ■ **Solidification in 2D motion dry pulverization**
 - **Solution:** Achieving no solidification by high-speed 3D motion dry pulverization.
- 4 ■ **Uneven 2D motion mixing (because of only one axis)**
 - **Solution:** Without blade. High-speed 3D motion makes it possible to use entire inner area of container efficiently. Low thermogenesis and uniform mixing can be achieved.

End-users have the benefits

- In the past, the possibility that was able to be considered to be impossibility increases.
- Necessary materials become needless until now. (Sharp reduction)
- The fine particles improve a color development effect.
- The fine particles are available for thermal conductivity, electric conductive, synthetic strength, reactive reinforcement.











Sales agents have the benefits

- The smile curve product without the competition that our products acquired the patents.
- After sale, there are optional parts, repair.
- After sale, the relations with the customer last long. (stock business model)
- It may solve our products that the user of other brands was not able to come out.
- It can raise competition superiority than other companies.

【Merit : 2D Ball Mill VS 3D Ball Mill(3D Reactor)】

2D motion, there was a problem of the irregular by Dry pulverization.

3D motion, there was no the irregular by Dry pulverization.

	Organic Matter Mixture - pulverization	Inorganic Matter Mixture pulverization - Mixture	Influence of mixed and milling heat	Solution of the irregular	Mixing - Milling cohesion
2D Ball Mill (Competing products)					
3D Ball Mill (3D Reactor) (Own Products)					

【Comparison】 2D Ball Mill VS 3D Ball Mill (3D Reactor)

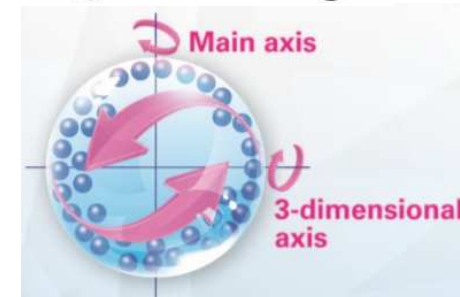
【Merit in details ①Organic Matter Mixture】

- The motion of chisel as for the 2D motion is one direction.
- The 3D motion realizes high efficiency motion using a whole container side.
- It is feasible that the 3D motion was not possible conventionally.

Operating time
(Mixture)=3min

2D Mixture ⇒ 3D Mixture

The White mixing



2D Mixing
There are many irregular.
Unevenness in mixing. Less volume.

3D Mixing
There are not many irregular. No unevenness and
uniform mixing. Having higher volume as a whole.

【Merit in details ①Organic Matter Mixture】

2D Motion⇒ Sesame with low specific gravity moves outwardly Salt with high specific gravity moves inwardly.

3D Motion⇒Uniform mixing of whole content.

【Usually】

- Light sesame seeds go up.
- Heavy salt goes down.

Operating time
(Dry Mixture)=2min

2D Ball Mill



- Light sesame outwards
- Heavy salt to the inside

3D Ball Mill (3D Reactor)



- Mix uniformly

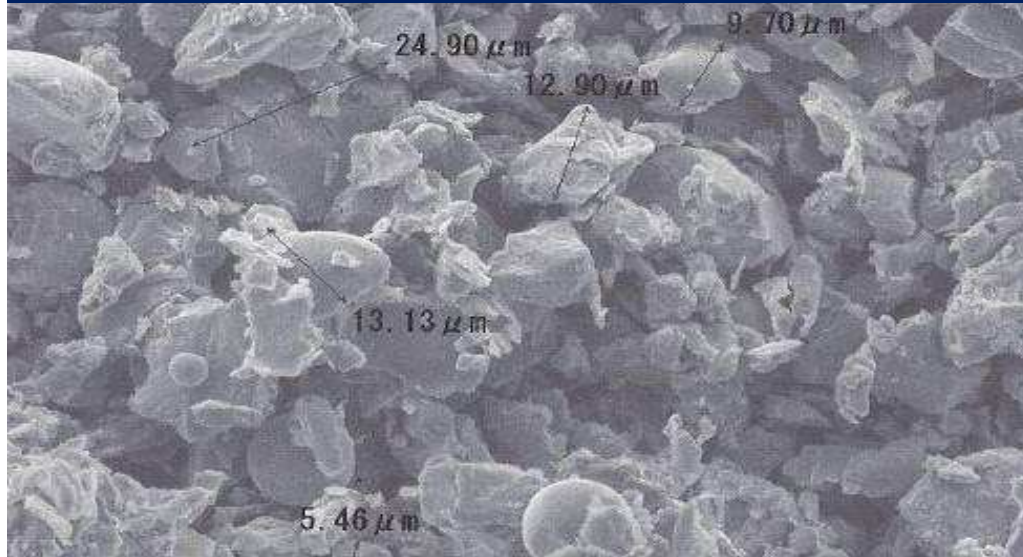
【Merit in details
②Inorganic milling】

Comparison of SEM image for material crushed by 3D ball-mill(3D Reactor) with that by planetary ball-mill

Wet process

Material \Rightarrow Fe-V-Al-Si Alloy

90min 3D Ball-Milling



Round and bulky shape of the particle by **strong frictional force.**

48h Planetary Ball-Milling



Sharp edge and bulky shape of the particle by **strong impact force.**

【Merit in details ②Inorganic Matter Mixture】

Confirmation of the ultra Fine bubble

To mix water with a machine.

- The 2D Ball Mill is no change.
- The 3D Ball Mill(3D Rector) is homogeneous, and it produces many quantity of Nano-bubbles in a liquid.

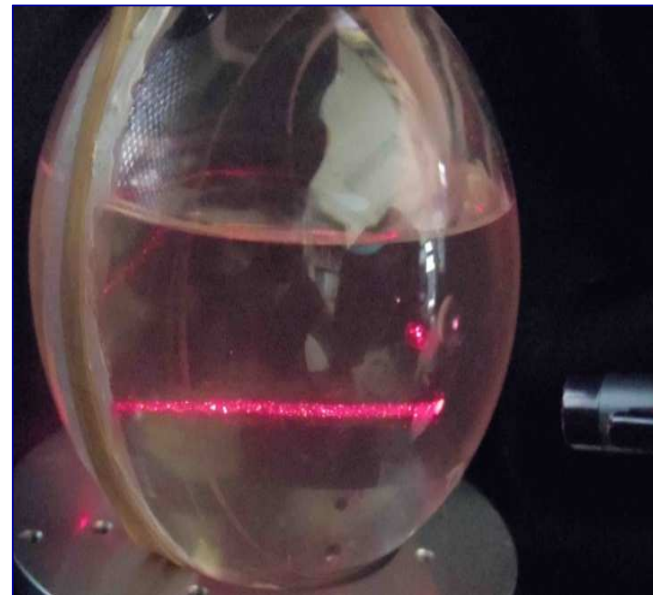
Operating time
(Mixture)=15min

2D Ball Mill



• The laser trace is non-outbreak

3D Ball Mill(3D Rector)



• To confirm a laser trace.
• Air was occurred to many quantities in the liquid.

【Merit in details ①Organic Matter milling】
 【Merit in details ③Influence of mixed and milling heat】
 The 2D ball mill changes to paste by very high impact force heat.
 The 3D ball mill (3D Reactor) has low impact force heat.

Sesame Dry Milling
(Room Temperature 23°C)

Operating time
 (Milling)=5min

2D Ball Mill



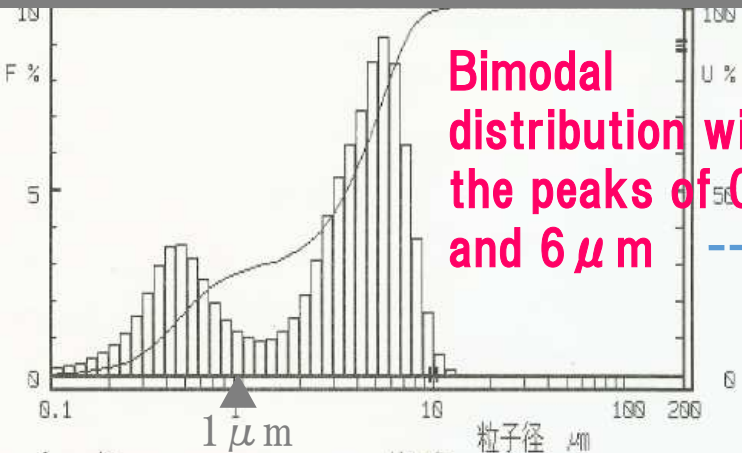
- Rotation axis: 600rpm
- Revolution axis: 1500rpm
- Total load electric current: **2.5A**
- **Fever: 42°C** (Room Temperature 23°C)
- **Change to paste with impact heat.**
- **Milling failure.**

3D Ball Mill (3D Reactor)



- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm
- Total load electric current: **0.2A**
- **Fever: 26°C** (Room Temperature 23°C)
- **Low impact heat.**
- **Milling success.**

Original particle size distribution



Bimodal distribution with the peaks of 0.45 and 6 μm

【Merit in details ④Solution to irregularity】
 【Merit in details ⑤Non-solidified admixture of Dry pulverization】

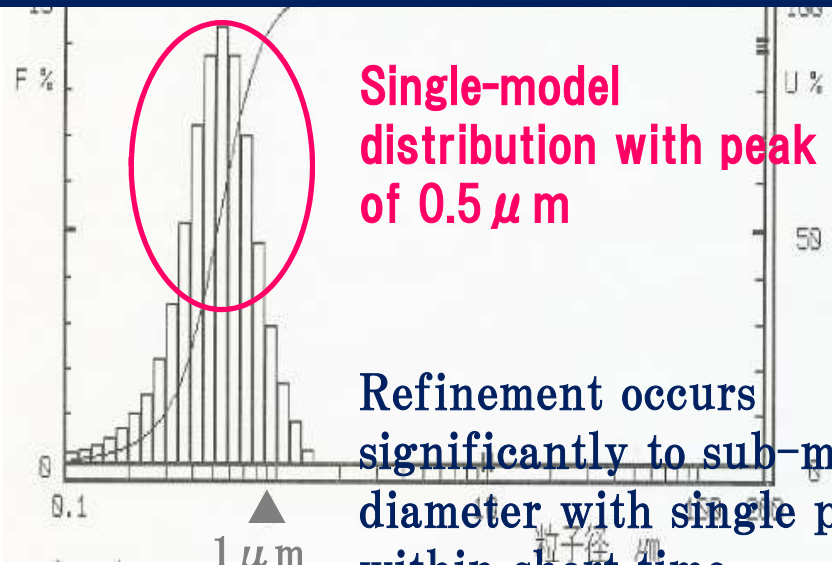
Dry condition

Sample ⇒ **Nickel oxide (NiO)**

Ordinate : Volume %
 Abscissas : Particle diameter

30min Planetary Ball-Milling

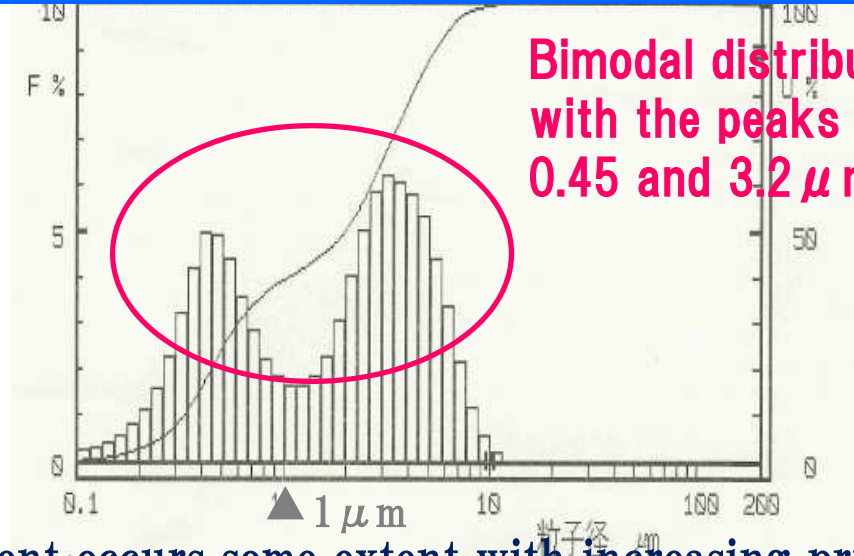
30min 3D Ball-Milling



Single-model distribution with peak of 0.5 μm

Refinement occurs significantly to sub-micron diameter with single peak within short time

Comparison of particle size distribution after 3D ball milling with that after planetary ball-milling.



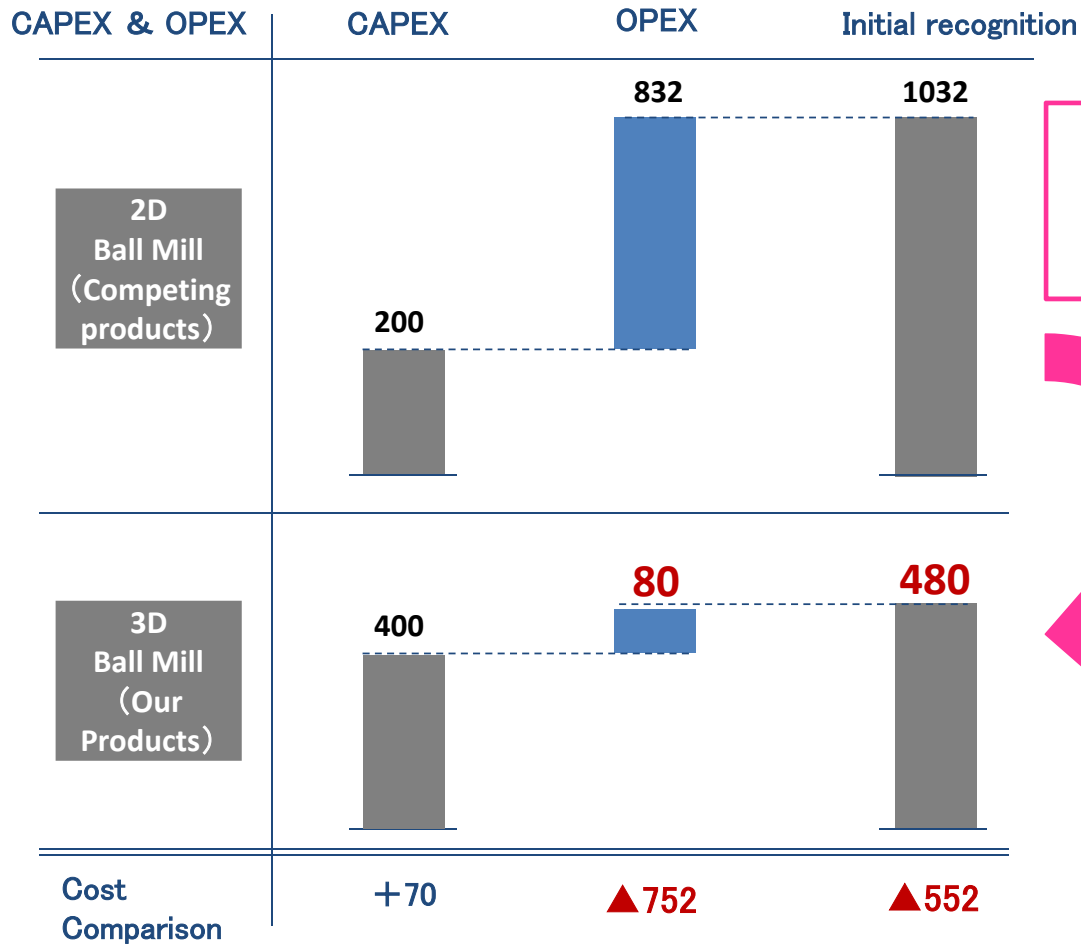
Bimodal distribution with the peaks of 0.45 and 3.2 μm

Refinement occurs some extent with increasing primary peak height and decreasing secondary peak height accompanying peak shift to small diameter (6 ⇒ 3.2 μm)

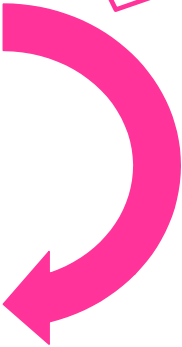
【Total cost】

The 2D motion, fine particles gather in the bottom at the time of a pulverization. It is the cohesion. If a crush material coheres, there is work to loosen.

The 3D motion, fine particles always move about the container at the time of a pulverization. It did not give time to cohere.



In the first year, approx. 54% total cost reduction has been achieved.



【Results】

The experiment results, the effect of the 3D Ball Mill(3D Reactor) becomes determination. There are large number of results in the delivery to the companies , the governments , the universities.

Customer testimonials

- Material cohered after fine grinding and was troubled. It was settled in the 3D Ball Mill (3D Reactor).
Major car company (Company A)
- The realization of the non-critical actions is radical.
NIMS The manager of Development Center is Dr. H
- It is succeeded by an organic crush with many heat changes.
Major chemical company (Company B)
- We were looking for a crusher with a little fever. We are satisfied very much.
Major food company (Company C)

The Delivery performance

■ Administration(Government)

- ✓ Tokyo University
- ✓ Kyoto University
- ✓ Hokkaido University
- ✓ Kyushu University
- ✓ Tohoku University
- ✓ AIST
- ✓ NIMS

■ Private enterprise

- ✓ Major car companies
- ✓ Major electrical equipment companies
- ✓ Major glass companies
- ✓ Major chemical companies
- ✓ Major pharmaceutical products companies
- ✓ Major paint companies

The media results



TV Tokyo WBS 2010.1



J-GoodTech 2015.2

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