Feather Grass

Application and Development of Nanotechnology on New Business Model

The third meeting for reading research papers

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Feather Grass Ltd.

[Nanotechnology]

Nano (symbol n), one of the prefixes in the international unit system, is the amount of 10^{-9} times (= 1/1,000,000,000 or 0.000000001times) the base unit as shown below:

one nanometer = 0.000.000.001 meter
one ns= 0.000000001 seconds

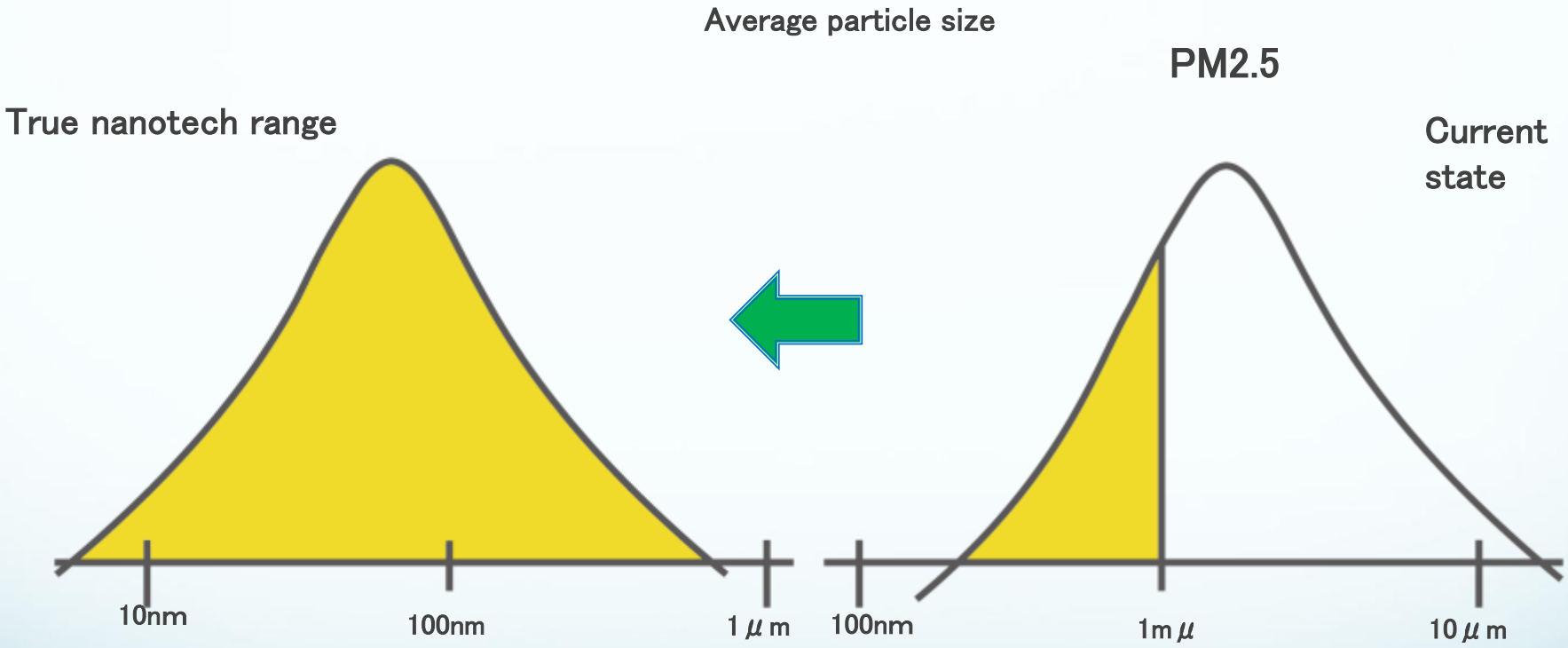
Time and length represented by "Nano" (nano second (ns) and nanometer (nm)) often appear in an electronic equipment and the computer system.

Example: Human cell (leukocyte): 10 μ m, bacilli: 1 μ m, one atom: 0.1nn

Why does Nano receive attention?

“ Beyond 100nm”

General nanotech today is “submicron”



[Nano's characteristic]

Highly "responsive"

As the diameter of a mist becomes 1/10

1mm diameter: Surface area 3.14mm^2

0.1mm diameter: Surface area 0.0314mm^2 1/10

1mm volume: 0.524mm^3

0.1mm volume : 0.0005233 mm^3 1/1000

Surface area becomes ten times larger for the same volume.

When the diameter is decreased to 1/1000, it is 10×10×10, which is 1000 time larger.

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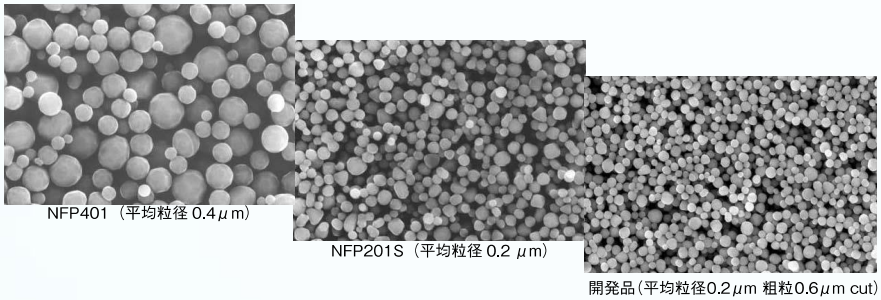
Ultra-fine Nickel powder

The ultra-fine powder technology by CVD achieves high performances of a state-of-the-art electronic parts.



NFP401（平均粒径 0.4μm）

NFP201S（平均粒径 0.2 μm）

開発品（平均粒径0.2μm 粗粒0.6μm cut）

製品の特徴

①球形	
②粒子径の精密な制御が可能	平均粒子径 0.1 ～ 0.5 μ m
③シャープな粒度分布	幾何標準偏差 1.3 ～ 1.5
④高い結晶性	平均結晶子サイズ＞ 0.1 μ m
⑤安定した表面酸化膜	表面が約 3nm の酸化膜で覆われています
⑥平滑な粒子表面	
⑦高純度	Ni ＞ 99.9%

用途

積層セラミックコンデンサ用内部電極
その他電子部品用電極材料など

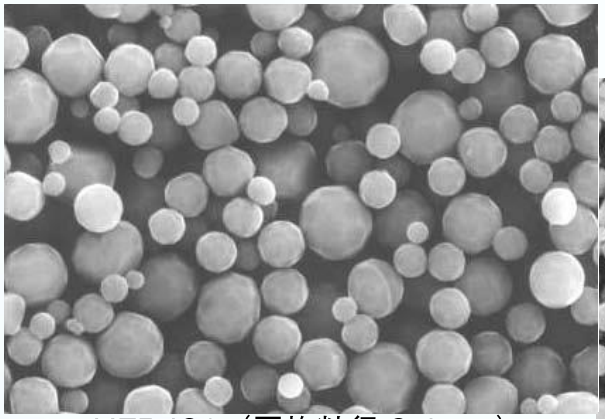
■主な製品の物性値（例）

製品名	平均径（μ m）	比表面積（m^2/g）	タップ密度（g/cm^3）	粗粒計数*（個 /5 千倍 20 視野）
NFP401	0.4	1.7	3.9	
NFP401S	0.4	1.7	3.9	2μm以上 3 ケ以下
NFP301S	0.3	2.6	3.5	2μm以上 2 ケ以下
NFP201	0.2	3.4	3.0	
NFP201S	0.2	3.4	3.4	2μm以上 2 ケ以下
NFP201X	0.2	3.7	3.7	0.8 μm以上 6 ケ以下

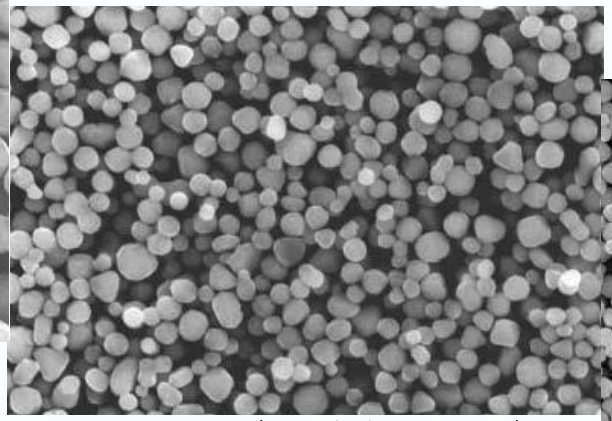
（*社内計測値）

■化学成分（%）

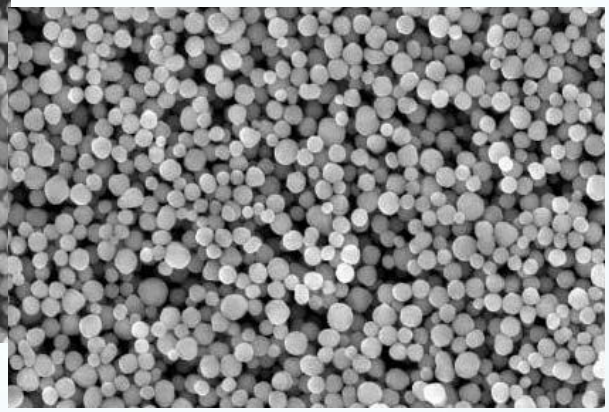
Ni	Fe	Co	Mn	Cr	Na	K	Cl	O	C
＞ 99.9 (0 を除く)	0.005 ～ 0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.8 ～ 0.3	0.06 ～ 0.04



NFP401（平均粒径 0.4μm）

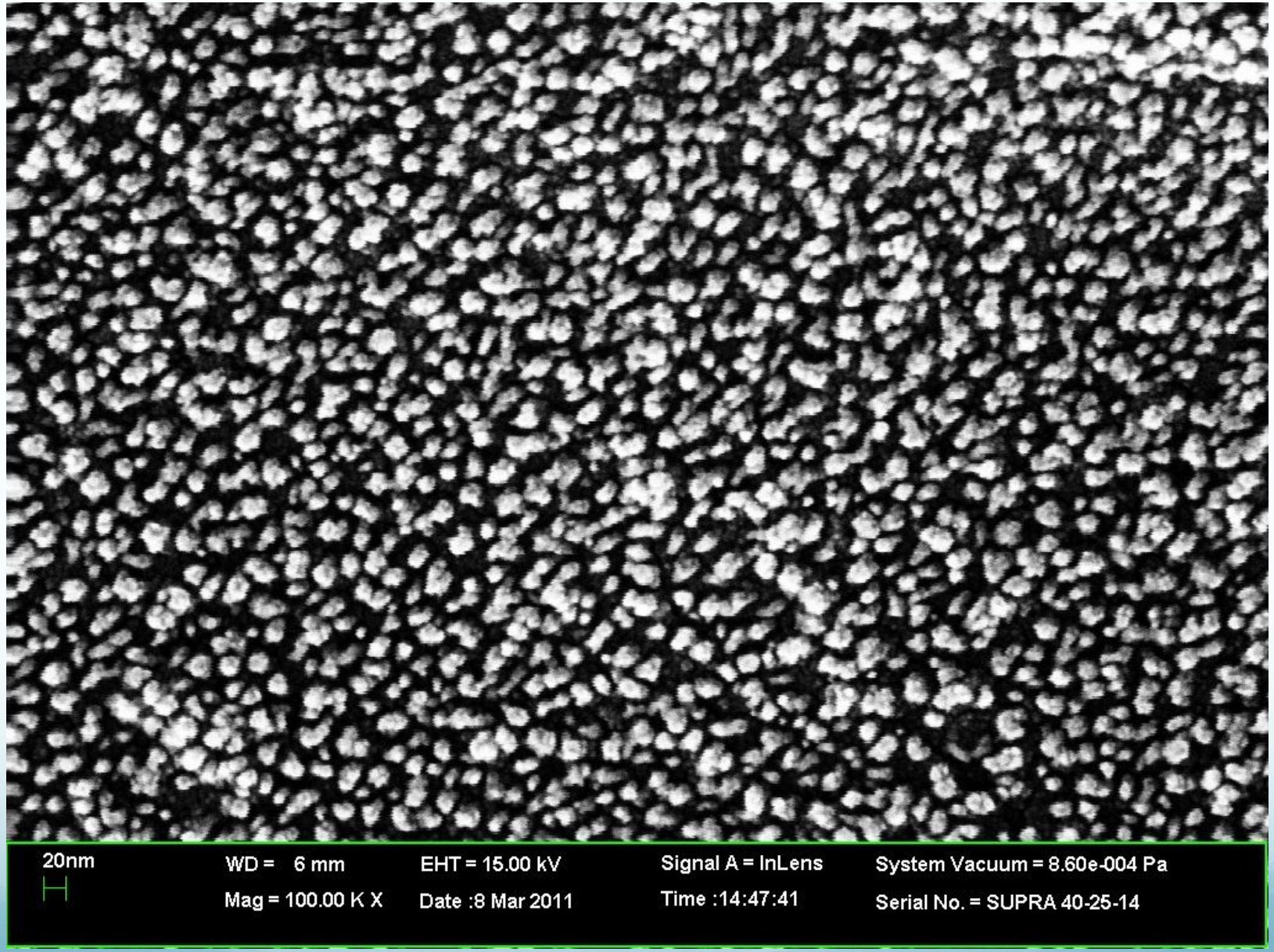


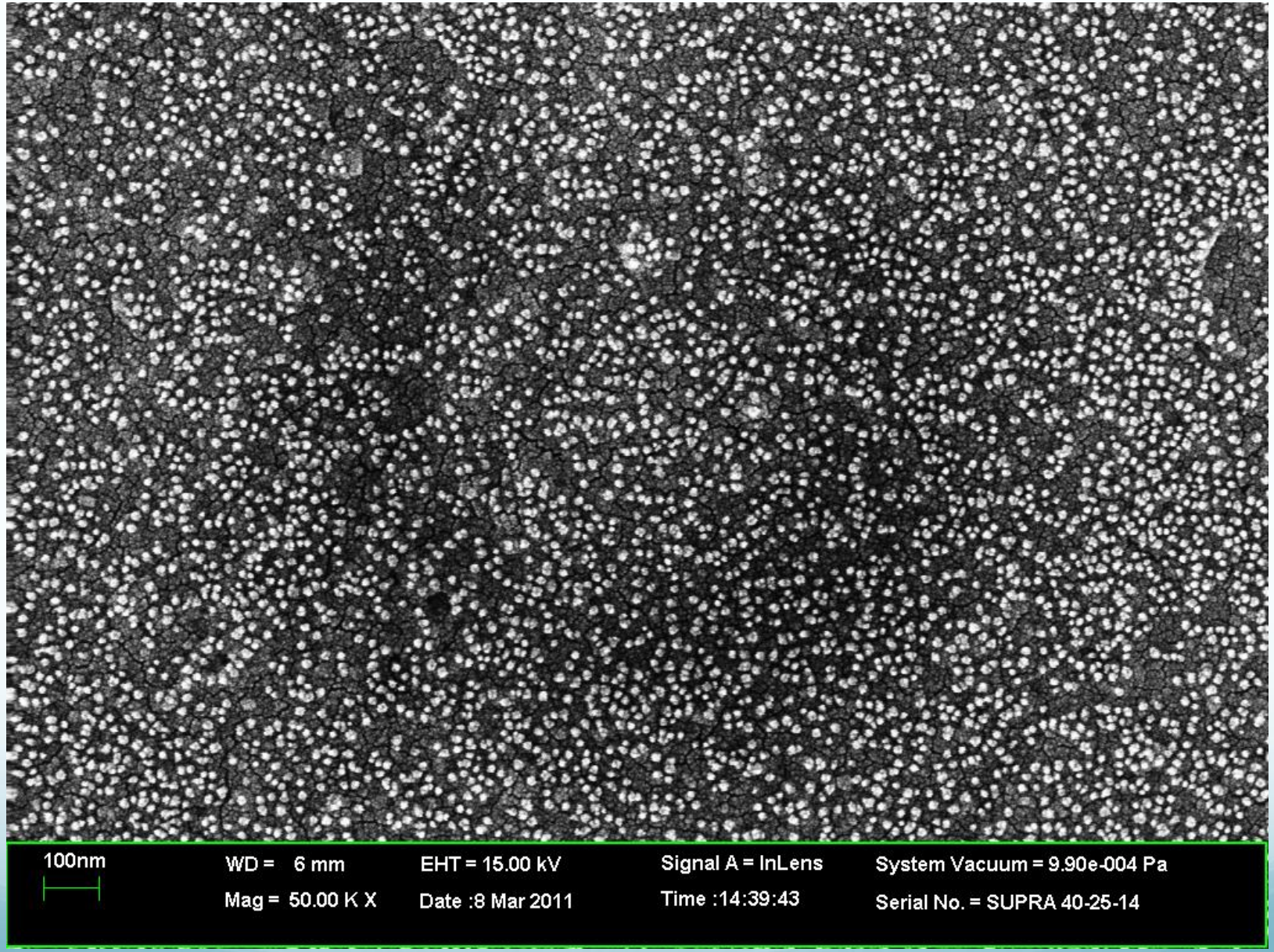
NFP201S（平均粒径 0.2 μm）

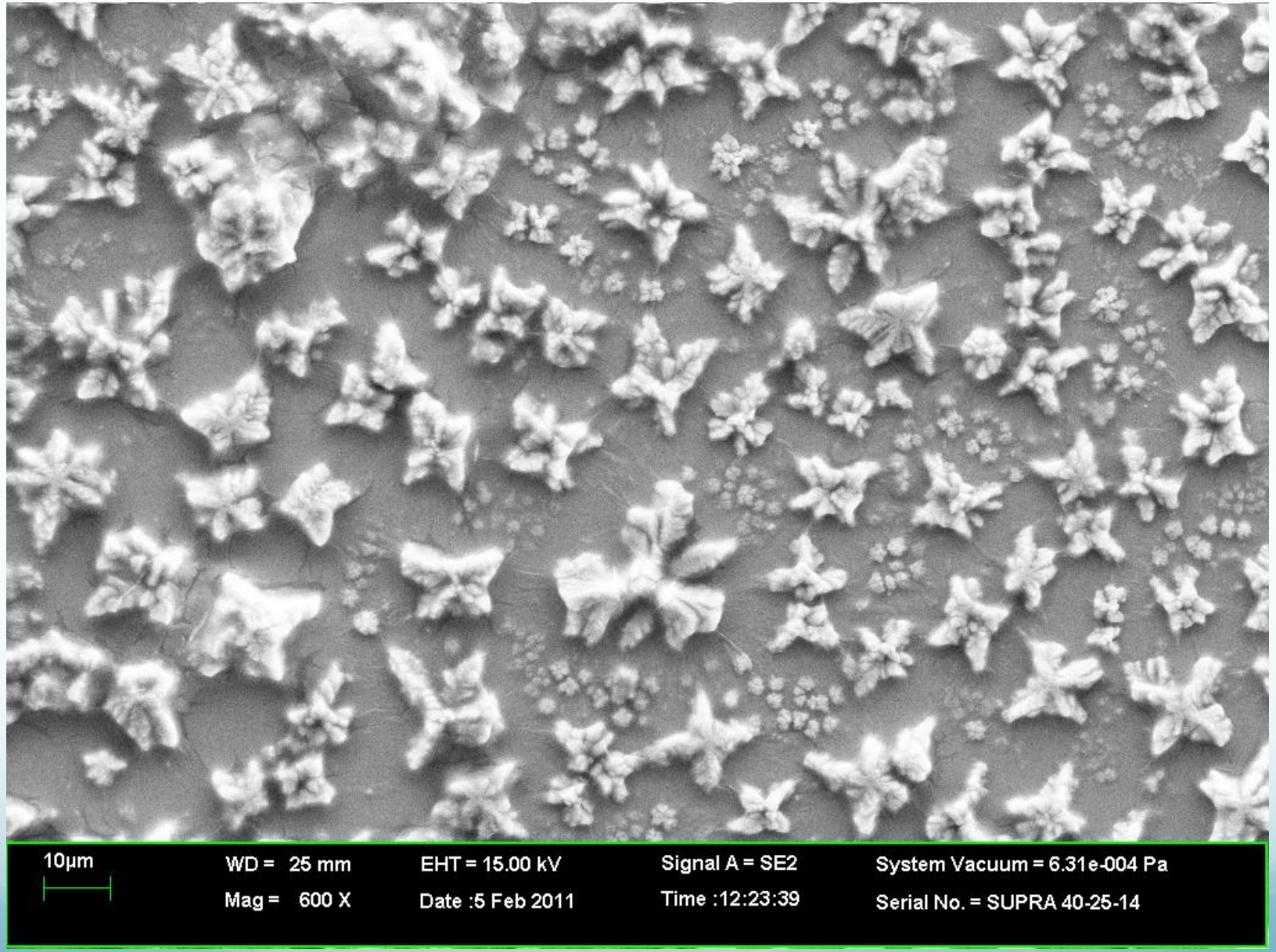


開発品（平均粒径0.2μm 粗粒0.6μm cut）

Not BM-atomization system


20nm
WD = 6 mm
EHT = 15.00 kV
Signal A = InLens
System Vacuum = 8.60e-004 Pa
Mag = 100.00 K X
Date :8 Mar 2011
Time :14:47:41
Serial No. = SUPRA 40-25-14


100nm
WD = 6 mm
EHT = 15.00 kV
Signal A = InLens
System Vacuum = 9.90e-004 Pa
Mag = 50.00 K X
Date :8 Mar 2011
Time :14:39:43
Serial No. = SUPRA 40-25-14


10µm
WD = 25 mm
Mag = 600 X
EHT = 15.00 kV
Date :5 Feb 2011
Signal A = SE2
Time :12:23:39
System Vacuum = 6.31e-004 Pa
Serial No. = SUPRA 40-25-14

Ⅰ Ultra-fine particle selection generation device

[BM-atomization system]

BM-MG20-E
With built-in compressor , also used in a clean room.

Synthetic image that assumes atomization to the entire ship

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[BM-atomization system]

A large amount of mist atomization in a large space is possible for the first time with the combination of a special nozzle and the particulate selection tank. Use of this system will be extending greatly over the applications that have not been feasible up to now, such as metal synthesis, spreading, various chemical sprays, cooling, and insecticidal and sterilization, etc.

[feature of the large-space atomization system]

Ultra-fine particles made from high viscosity raw material (dilution not required) can be sprayed in large quantities during a short period of time.

- The atomization of the high viscosity liquid (viscosity up to 10,000cp) is also possible.
- Ultra-file particle mist of 1 μ size (2 to 5 μ m on average) can be generated (10 to 30 μ m for general sprayer)
- The amount of real atomization is drastically decreased because of no dilution, and the operation advantage improves greatly by the ultra-fine particle mist.
- There is no worry of humidifying, and is no moisture uptake of the equipment device because there is no dilution water.
- A large amount of spraying is addressed by increasing the volume via plural nozzles and systems.

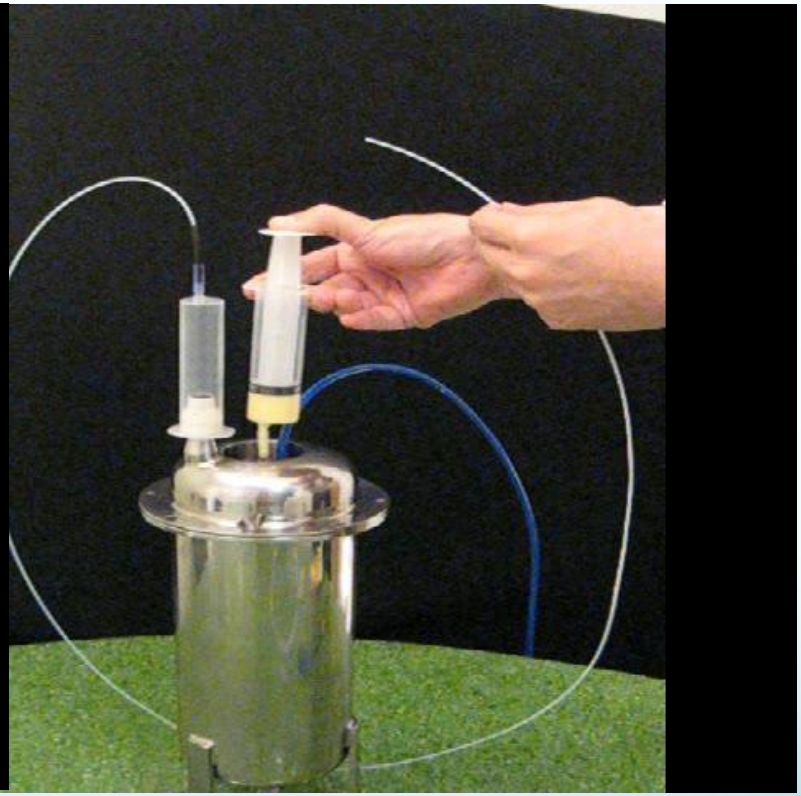
First system generating mist without electric charge

- Since the mist does not have an electric charge, there is no particle cohesion, dew condensation or fog drip, so the amount of mist/density per volume is greatly improved (30 times higher than usual), as well as improving the diffusion distance.
- Because the charge of mist is zero based, charge (+/−) control is easy.
- Control of the system such as connecting to or disconnecting from the target is easily possible.
- Charged ultra-fine particle mist greatly improves the effect per fluid volume.

Maintenance free because there is no clog in the nozzle

- Uniform spraying of ultra-fine mist is possible without clog in the nozzle even with high viscosity medicine.

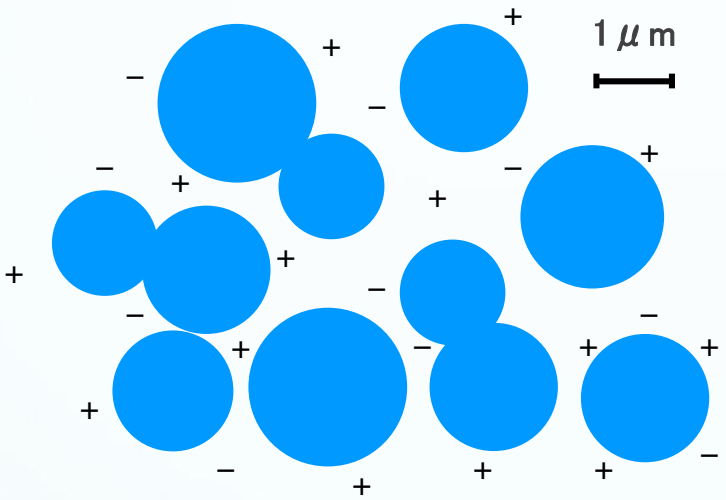
Demonstration: [Ultra-fine particle selection and generation device]



This image is a particle selection from the mayonnaise.

[Uniform nano mist without charge]

General dry mist



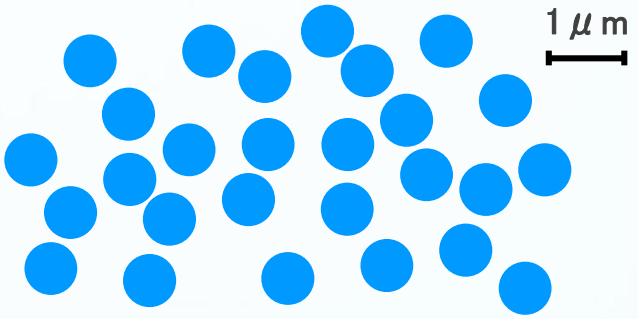
The particle size is large, not uniform, and it has the charge on the surface(Lenard effect).

It is not easy to evaporate because it is easy to cohere.

The surrounding is wet.

It is not suitable for vaporization heat cooling.

Uniform nano mist from Feather Grass



(Note) Nano is smaller than 1 μ m.

The particle size is small, uniform, and there is no charge on the surface.

It doesn't cohere, and it is easy to evaporate.

The surrounding is not wet.

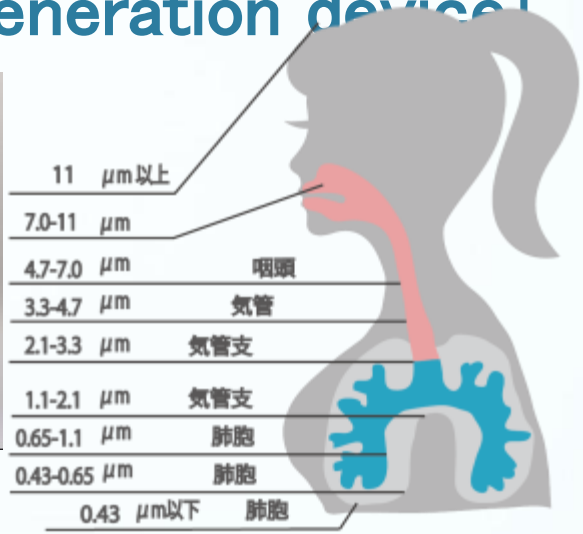
It is the best for vaporization heat cooling.

[Nebulizer administering system]

- Technological limit and problem with the current nebulizer
- ① The mean particle size of the mist that can be formed is 10 to 20 μm. How deep the mist can enter (such as trachea → bronchial → pulmonary alveolus) depends on the actual particle size. The size of 5 μm or less can reach the entrance to the pulmonary alveolus, but cannot reach the pulmonary alveolus. Only about 10% of the atomization administering medicine can reach the bronchial tube.
- ② Cannot do the atomization of the medicine of a high viscosity. Cannot do the atomization of most models even by alcohol.
- ③ Heat/pressure denaturation disallows a large number of simultaneous vaccination.
- ④The existing nebulizer can be used by one person at a time, therefore it demands more steps and time than injection.

[Ultra-fine particle selection and generation device]

- Can generate uniform particles of sever tens of nn to μm without heat/pressur denaturation.
- Also mixture/encapsulation of two material types of different physical properties can be performed simultaneously.



WT Nano particulate selection generation system

- Supports delicate materials and high viscosity materials, even those of 10,000cP or more.
- Decreases damage to materials. Particle crush or friction will not happen, and there are neither damage, denaturation nor deterioration in the material.
- Can generate uniform ultra-fine particles of several tens of nn to μm intensively according to the particle diameter target setting.
- Capable of controlling the charge (+, 0, −) for the first mist with a neutral surface charge.
- Targets throughput for 10^{-5} to 10^{3}g/min order from research level to plant level.

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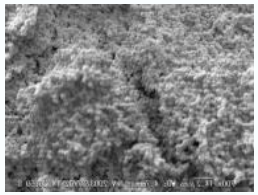
[Nebulizer]

[Ultra-fine particle selection and generation system]
Can generate uniform particles of 0.1 μm to several tens of μm without heat/pressure denaturation, and also can mix two material types of different physical properties simultaneously.

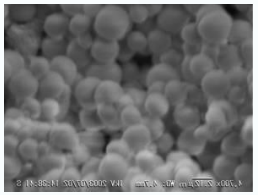
Pharmacokinetics by nebulizer particle diameter
- 4.7-7μm: Throat
- 3.3-4.7μm: Trachea
- 1.1-3.3μm: Bronchial tube
- 1.1μm or less..: The pulmonary alveolus.

[albumin SEM image]

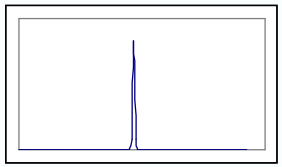
After processing the particulate selection device



700 × 14.2 μm

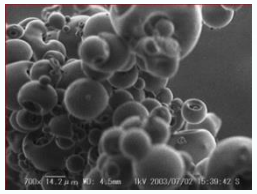


4700 × 2.12 μm

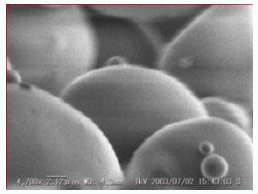


Particle size distribution of ultra-fine particle selection generation device

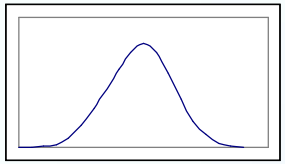
Object (usual reagent)



700 × 14.2 μm



4700 × 2.12 μm



Usual particle size distribution (normal distribution)

① Generates the mist of non-coherent particles of several tens of nn to several μm (about 2～5 μm), allowing 100% of particles to reach deep into the pulmonary alveolus.

② Allows atomization of the high viscosity liquid medicine. Medicines of high viscosity can be used, and no requirements for low viscosity of medicines are applied.

③ There is no destruction in physical properties by heat/pressure denaturation, and the titer doesn't change.

④ A large amount of atomization can be done by one unit.

⑤ By using "Spray Blend System" from Feather Grass together (can be incorporated as a single unit), 1) mixing of 2 or more types of liquid and 2) Nano-encapsulation of particles are possible just before atomization. Also 1) and 2)

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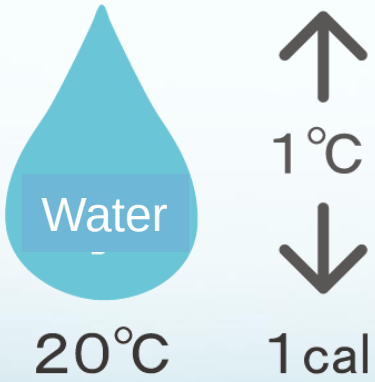
[Vaporization heat cooling system]

The third cooling system that exceeds limit of air cooling and water cooling

- Unlike the conventional cooling method, there is no need of using and cooling the refrigerative to exchange the heat with the heat source.
- The refrigerative (air and water, etc.) is not needed.
- Water deprives and exhausts the calorie for heat of vaporization.

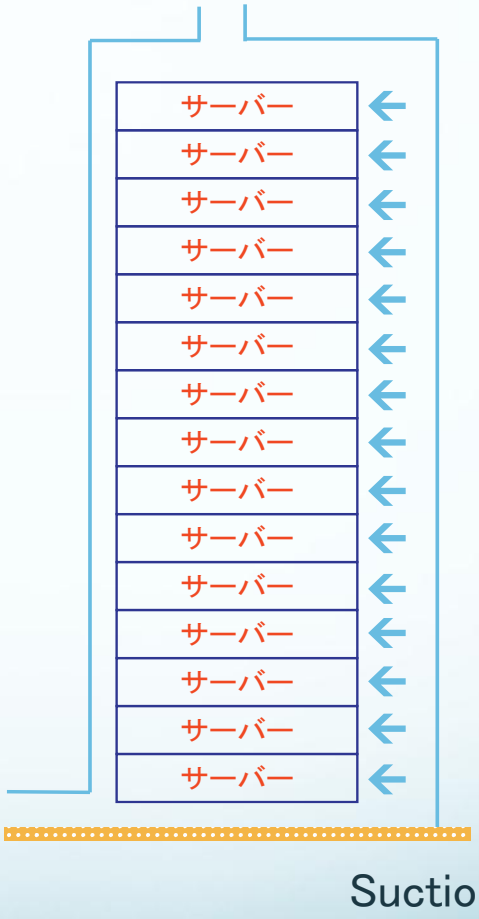


The calorie in which the temperature of 1g water is increased/decreased by 1℃ is 1 cal. The heat of vaporization of 1g water (latent heat) is 596cal.

With small nano mist of water,
a large cooling effect is demonstrated.

＊The particle size of current dry mist is large (several tens of microns). It does not diffuse but coheres, so condensation will occur before evaporation.

- Perform vaporization heat cooling at the place as close as possible to the heat source (the most efficient cooling method).
- The exhaust goes out.
  As the water expands by vaporization, free convection occurs and no fan or the like is needed.
- The side effect is that the server is managed under a high moisture environment so the generation of static electricity is prevented. Also the dust generated will be removed at the same time.
- Theoretically, most of power consumption cost can be reduced, for heat generation or cooling of the server.
- The generated nano mist will not condense, so there is no direct influence on the server. Ultra-pure water is used for increased safety. Remove the influence by the bleaching powder.



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[Milk Processing Systems]

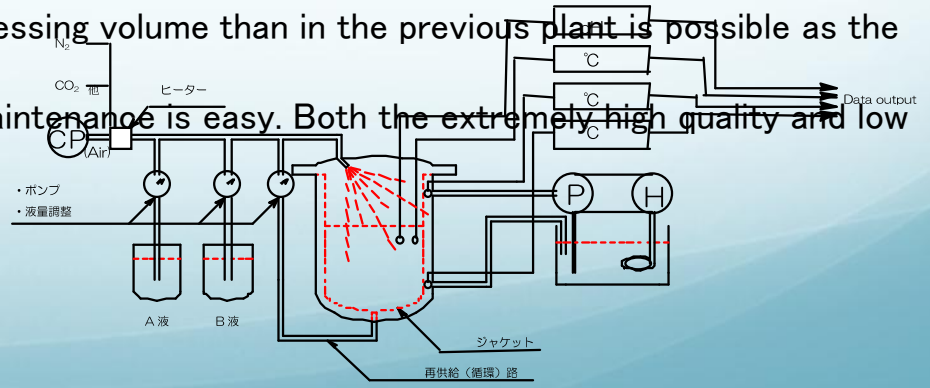
Innovative technology that enables a line processing of high quality cell subdividing (non-homogenized), deaeration (nitrogen substitution of the remaining oxygen), and sterilization on a large scale by using a spray method.

◆ **What is spray method/Milk Processing Systems?**

The raw material milk is introduced by the pressure difference caused by the compressed nitrogen, then dispersed into a minimum particle size (Nano level) at the nozzle. This dispersion state is highly reactive, and the remaining oxygen in the raw material milk is efficiently substituted for nitrogen here. The germicidal treatment is also possible at the same time by the use of the superheated steam. Therefore, all the processes are processed in the line within a short period of time simultaneously.

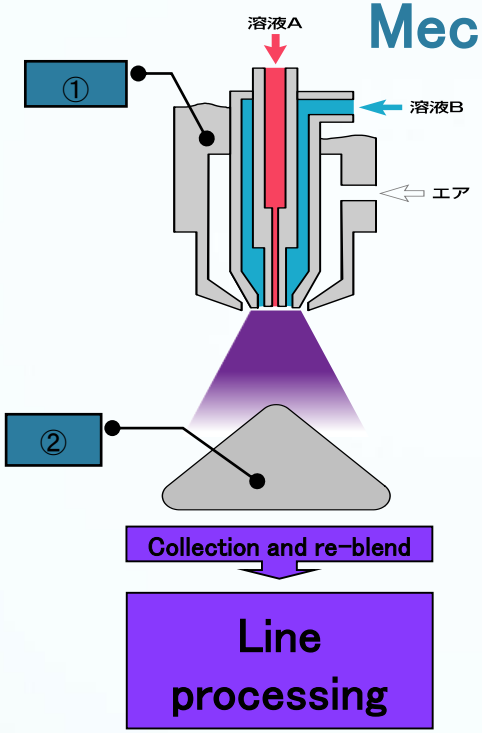
– **Feature**

1. Highly precise and stable generation and dispersion of particles increase the quality and quality durability.
2. Subdividing of particles into nano level will not cause heat denaturation, destruction of membrane or molecular structures in materials (biomaterial such as the proteins).
   Subdividing by non-homogenization.
3. The nitrogen substitution efficiency of the remaining oxygen is extremely high (almost 100%), and the quality (good and stability) as well as quality durability are improved.
4. The germicidal treatment with the superheated steam is a new sterilization method that can be processed instantaneously (A few seconds: heating ⇔ cooling).
5. Change from the old batch tank processing to the new inline processing realizes remarkable decrease of the plant size to 1/10 of the previous plant. Larger processing volume than in the previous plant is possible as the batch tank or stock tank are not necessary.
6. The new system has very simple structure and maintenance is easy. Both the extremely high quality and low cost are achieved at the same time.



Ⅱ Advanced mixture system (SPRAY BLEND)

Mechanism of [spray blend device]



Mixing nozzle of spray blend device

Main features

- Further homogenization is possible by mixing immediately before atomization and the mixed fluid of constantly steady quality can be obtained.
- The nozzle has a simple structure, and high viscosity materials can be used. Does not cause clogging easily and has great wear resistance.
- For instance, when oil and water are sprayed, the dispersion state is kept for a long time.
- Features a degassing capability and no air can be mixed inside the medium sprayed on the batch tank.
- The cohesion of the medium doesn't happen because dispersion and preparation are done with a minimum particle size.
- It is possible to disperse, mix and prepare for Liquid, Liquid, Solid, Liquid, and Air and Liquid (Attention should be exercised for powder materials as they may cause static generation.

[Spray blend device]

Mixture of water and salad oil

Water

salad oil

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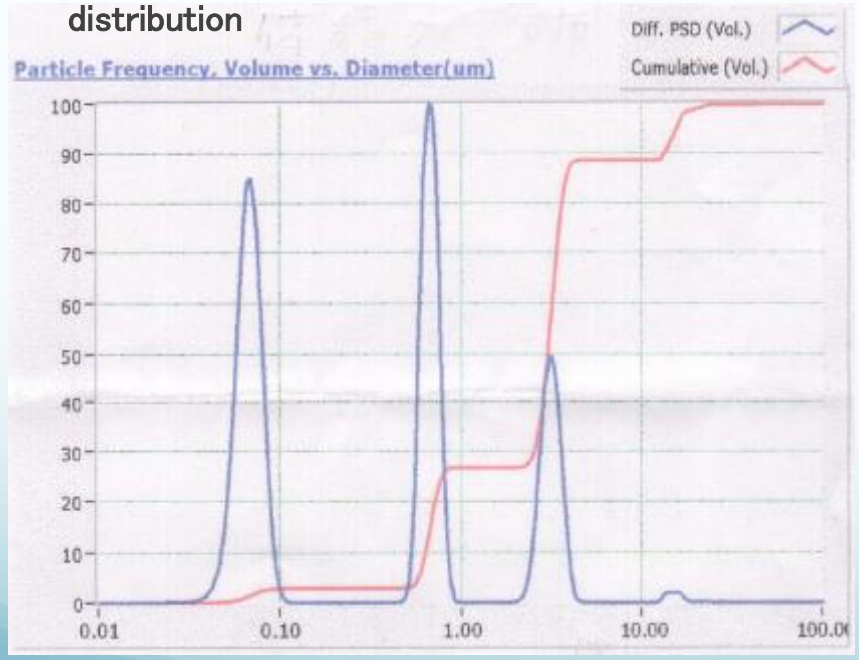
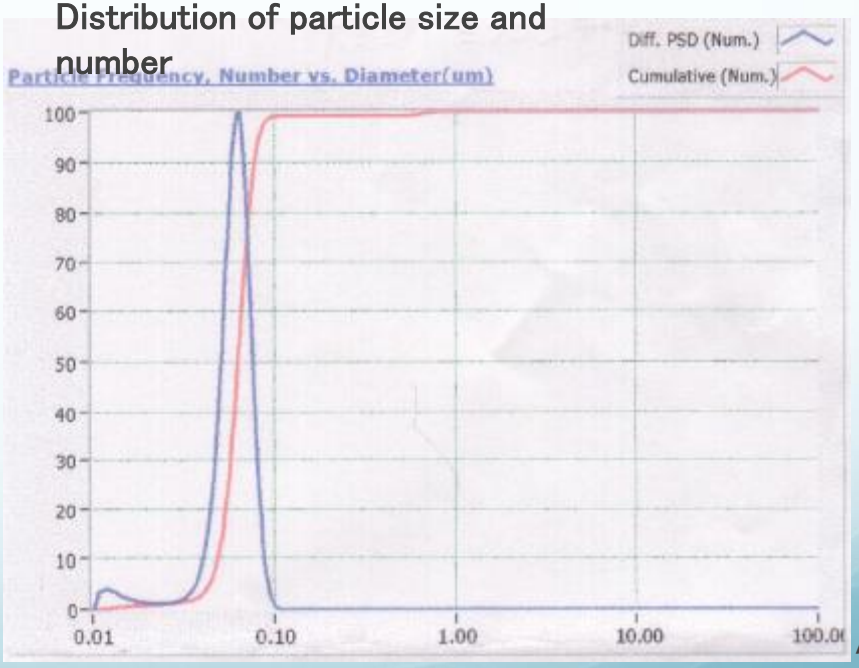
[Spray blend device] Mixture of light oil and water

Volume distribution



Distribution of particle size and number

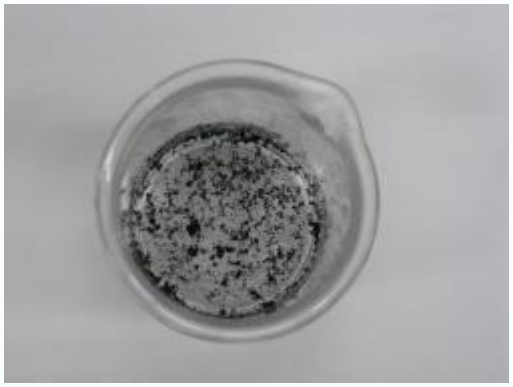


Measured with Matec Applide Sciences supersonic wave attenuate grain degree distribution measuring instrument APS-100.

[Spray blend device]

Mixture of Carbon nanotubes and 10% PVA solution

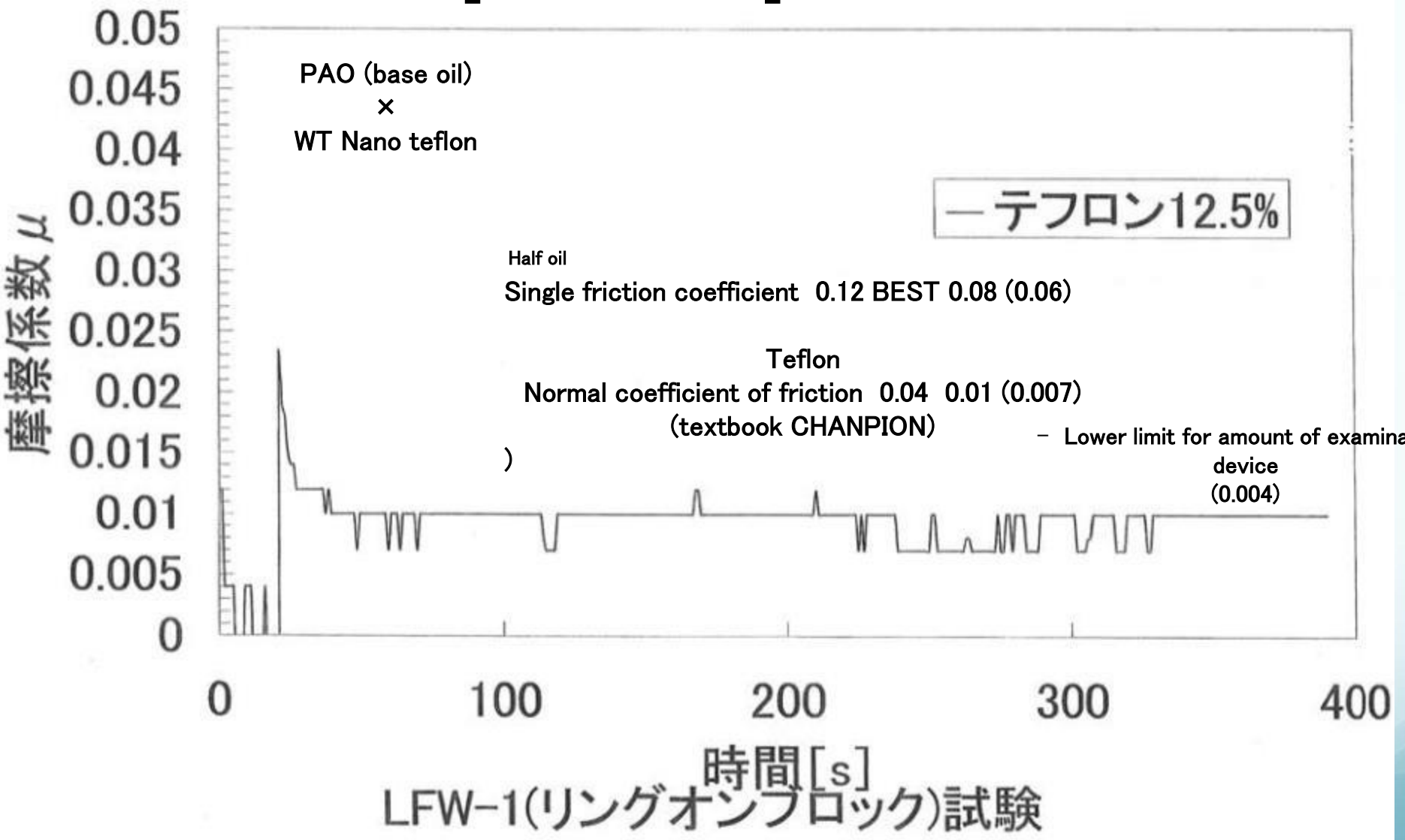
With Carbon nanotubes
10% PVA solution



Before the spray blend

After the spray blend

[Nano Teflon]


PAO (base oil)
×
WT Nano teflon
—テフロン12.5%
Half oil
Single friction coefficient 0.12 BEST 0.08 (0.06)
Teflon
Normal coefficient of friction 0.04 0.01 (0.007)
(textbook CHANPION)
)
– Lower limit for amount of examina
device
(0.004)
摩擦係数 μ
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
100
200
300
400
時間[s]
LFW-1(リングオンブロック)試験

- The lubricant of the teflon system has been described as low degree (0.015~0.020) of the coefficient of friction. The single friction coefficient of the original base oil is 0.12 (0.06), while it is 0.01 (0.007) with nano teflon contained. As the lower quantitative limit for the device is 0.004, which means "almost no friction".

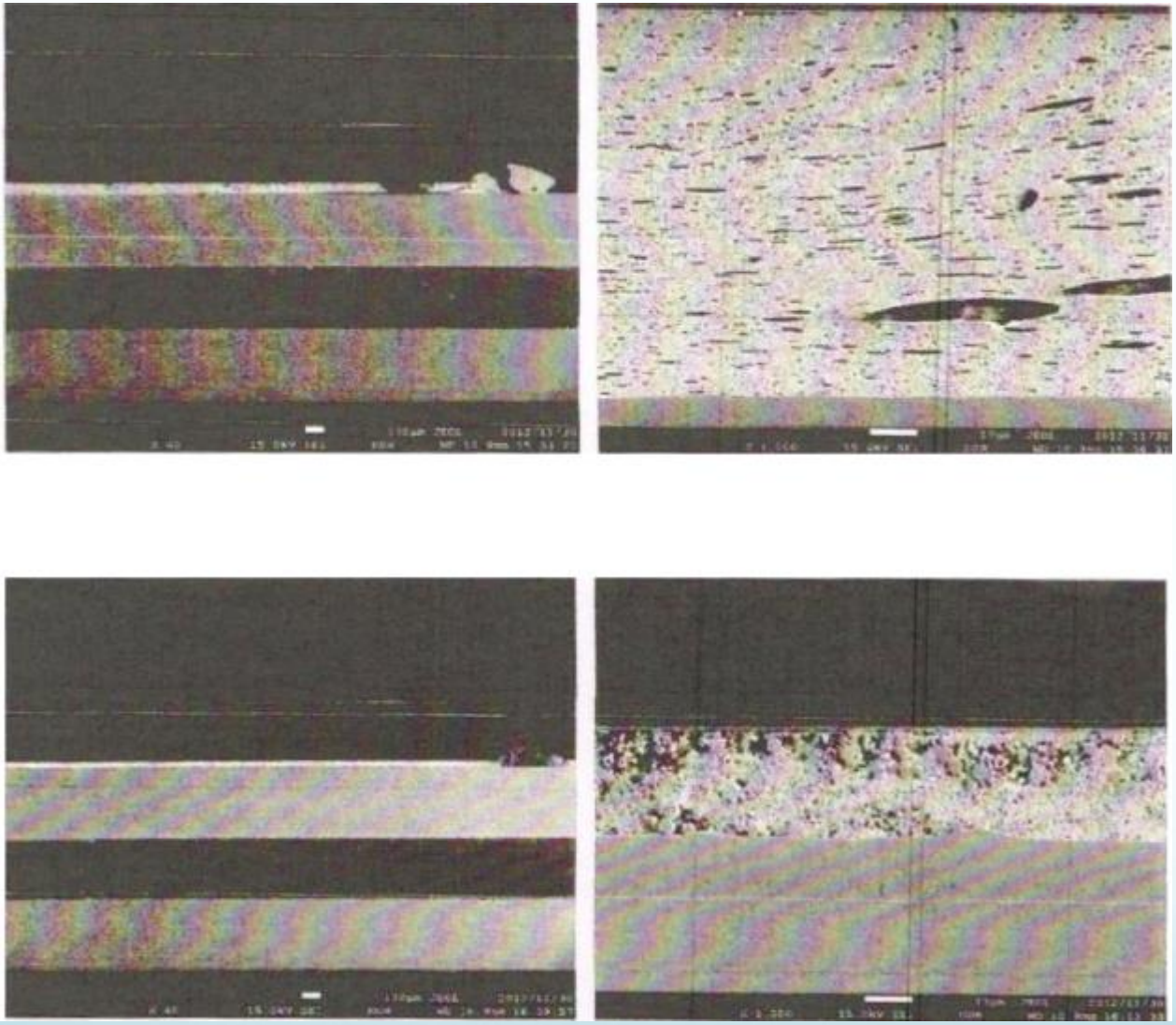
  (Depending on the further investigation continued, it can be lower than this limit.)

  Lower than 1/10 of the current product

  Experts in tribology claims "That is impossible".

- Uniform dispersion of particles in nano size is possible, though teflon is not dispersed easily.

- Teflon is highly volatile. It can be mixed with oil or oil-based materials, but not with water or water-based materials. However, our nano teflon can be mixed with water or water-based materials. We have shown you samples mixed with alcohol, which is not usually possible. This can be used for other applications



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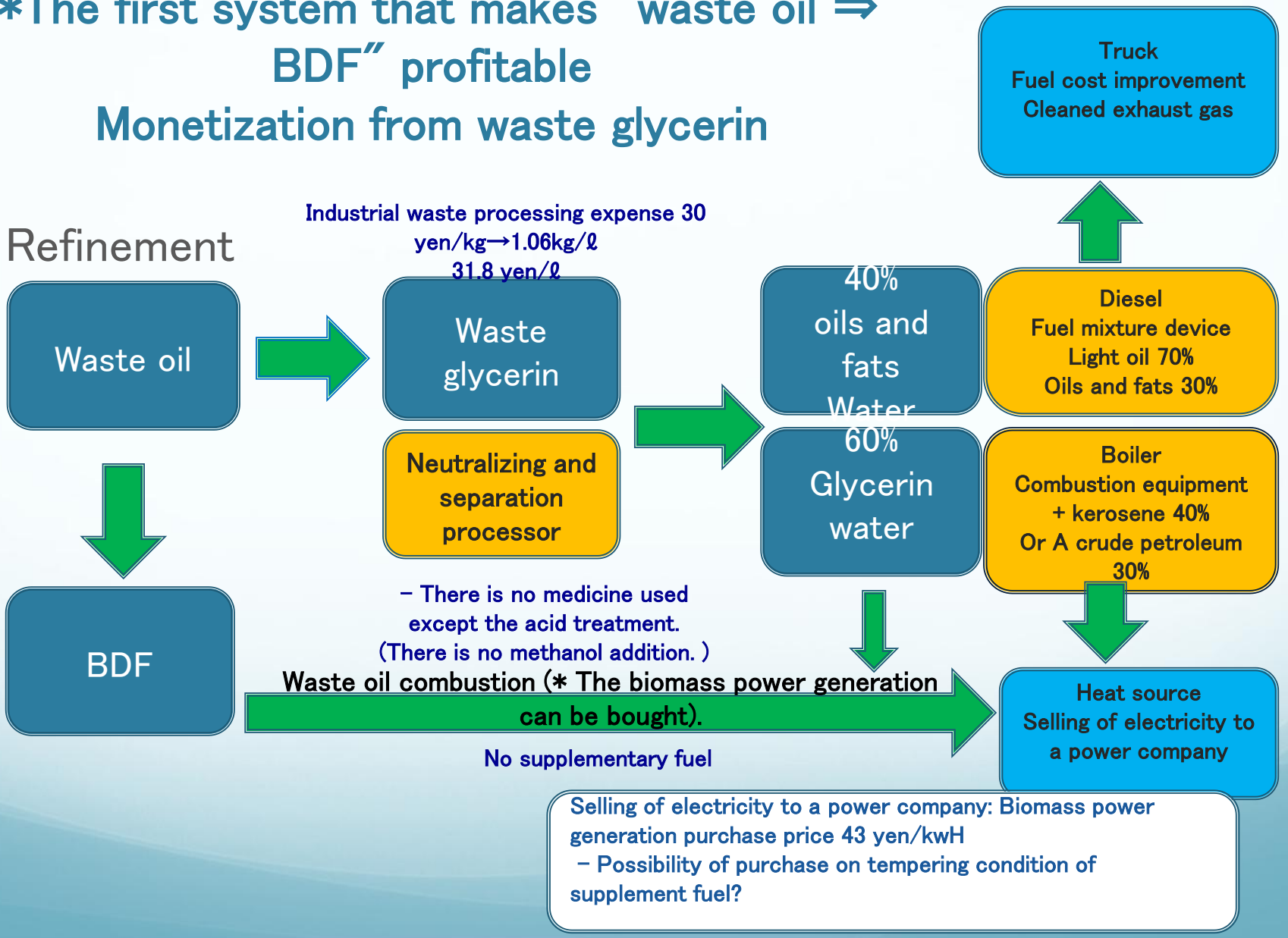
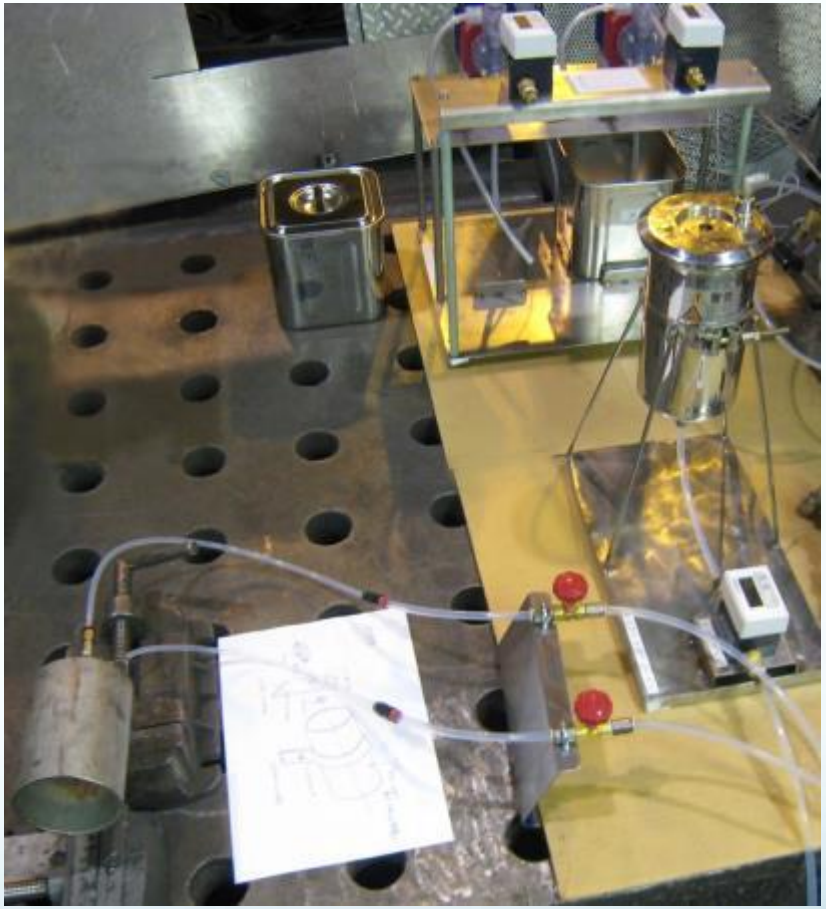
[BDF waste glycerin processing system]
*The first system that makes "waste oil ⇒ BDF" profitable
Monetization from waste glycerin

- Refinement



[Example of experimenting on device and combustion]

Combustion situation at light oil 7: water 3



Simple mixture experiment device immediately before combustion

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[Nano capsule/liposome]

In Wing Turf, the proprietary nano capsule/emulsion generation technology is applied, and the liposome manufacturing device is produced.

No Hydrophobic solvent

A multiple film can also be formed.

Support for delicate materials and high viscosity materials

Purpose-oriented liposome design is possible!

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[Nano capsule/liposome]

Device principle

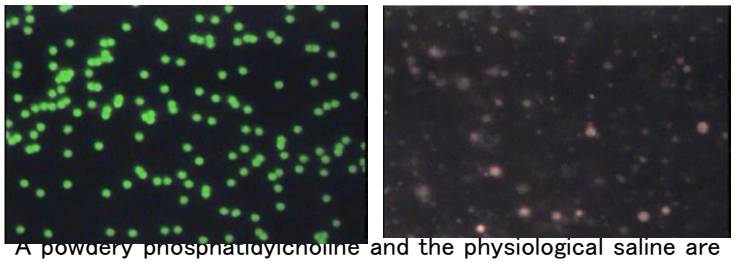
A lipid bilayer is formed when the phosphorus lipid is added to the aqueous layer, and the liposome is generated. However, it is required that the phosphorus lipid be used with the hydrophobic solvent in the current liposome formation, and it takes steps and time for eliminating solvent.

Nano capsule/emulsion technology of Wing Turf is a new technology that instantaneously mixes the hydrophilic material and the hydrophobic material by the order of several nm to 500nm. It can mix solid and liquid, so by adding powder of the phosphorus lipid to the hydrophilic solution, liposome can be instantaneously produced without using the hydrophobic medium.

Moreover, because it is a mixture technology that realizes extremely homogeneous particles, the capsule/liposome of a uniform particle size of the Nano order can be easily produced.

Liposome image by the light microscope

1 μm particle for specimen　　Liposome particle



A powdery phosphatidylcholine and the physiological saline are mixed.

Mean particle size (μm) and ratio (%) in sample

試料	ピーク1	ピーク2	ピーク3
M 2Pass処理	1.248 (93.9%)	0.463 (6.1%)	–
M 3Pass処理	1.067 (89.9%)	–	–
P 2Pass処理	1.371 (8.5%)	0.253 (91.5%)	–
P 3Pass処理	0.985 (99.6%)	–	–

M:Mono-olein P: phosphatidylcholine

* The peak at which the particle is judged to be dust is not described (Target: M 3Pass processing and P 3Pass processing).

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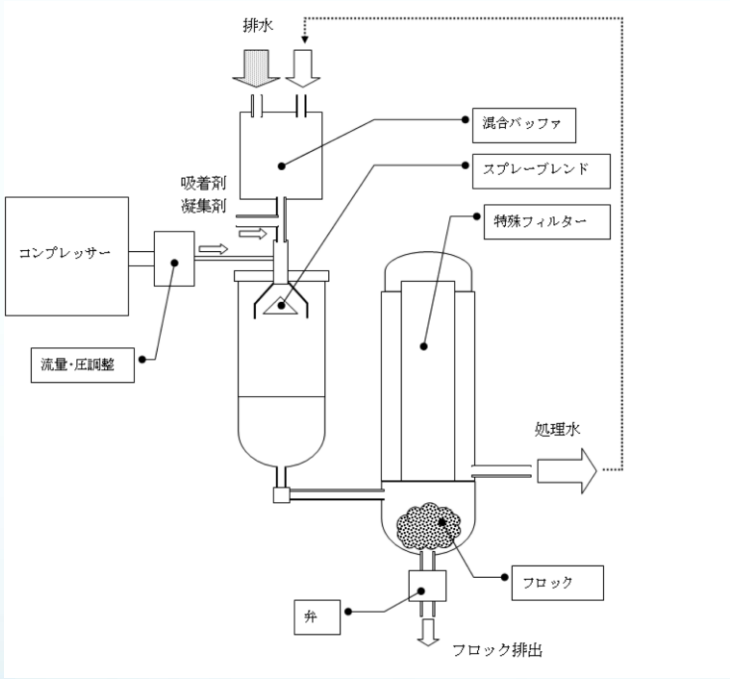
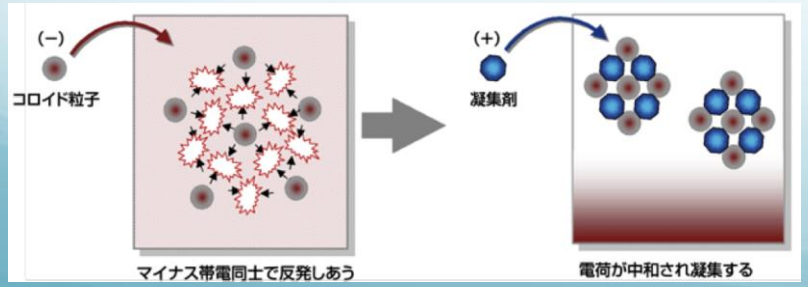
[Polluted water processing unit]

4-1) Composition of waste water treatment equipment

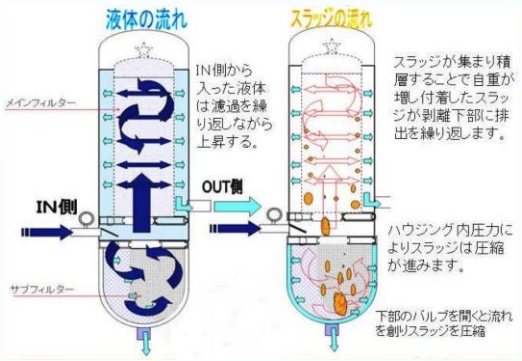
SPRAYBLEND → Adsorption (cohesion) system





4-2) Outline of special filter (reference)

The main filter performs filtering, and the sludge, etc. that adhere to the filter are exhausted to a lower sub-filter. Through repetitive lifting, rotating and uniting, adhered materials on the filter surface with increased specific gravity are dropped to the sub-filter due to the flow velocity and the impact.
When the flowing volume is decreased, vibration is caused by the upper compressed air IN mechanism so that the sludge, etc. adhered on the main filter can be removed and exhausted.



4-3) Outline of inorganic multifunctional flocculant (reference)

In general, while the turbidity elements of 0.45 μm or larger are relatively easy to be removed through the coagulating sedimentation and the filtration, colloid elements of 0.45 μm or less cannot be precipitated completely.
That is because colloid elements have a negative charge, so they are mutually repulsing as dispersed in the liquid.
Since the inorganic multifunctional flocculants have a positive charge, the negative charge of the colloid elements are neutralized. This will form a fluke so that cohering and precipitating become possible.

＊・Flocculant for collecting flocculant of a target element is added to this inorganic multifunctional flocculant for use.
・These flocculant is made into a medicine of Nano size by the SPRAY BREND processing.

Problem and solution for biotechnology and fermentation system

[Aeration]

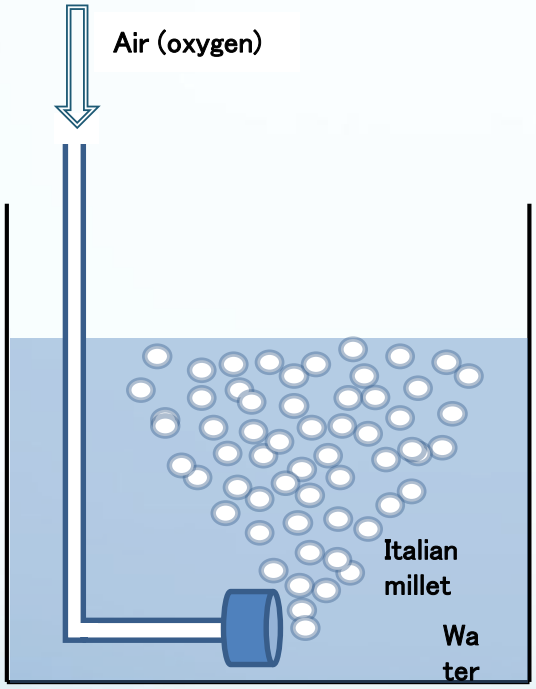
Hidden terrific energy problems

An aeration tank (tank for aerating the microorganism) is essential for the ″Activated sludge procedure″ by microbial degradation, which is a general means of processing the life drainage and the plant effluent. It demands a huge amount of electrical energy for stirring water and adding oxygen for aeration. It is estimated that the power consumption by this is 5.8 billion KWh, which is about **0.5% of the total power used in the country**.

The aeration tank oxygen supply by the spray blend can usually add oxygen by the spray blend for several tens %⇒ 100%, is that decrease from 0.5% of total power consumption in the country down to 0.2 to 0.3% is possible. Also, by a drastic decrease of time for fermentation process from some days to some hours, reducing the power consumption at the incidental facility as well as the miniaturization and decrease of facility will be possible. Such energy-saving effect will correspond to **several % of total electric power consumption in the country**.

[Bubbles in goldfish water tank]

Current technology and limit



①Only 10 to 20% of the saturated amount (relieved critical mass) can be added.

②When the viscosity is high, addition is also impossible.

③The micro bubbles require strong energy of high pressure (350MPa or more). Higher pressure than that is necessary for the nano bubbles. An expensive large-scale device and the high operation cost are necessary.

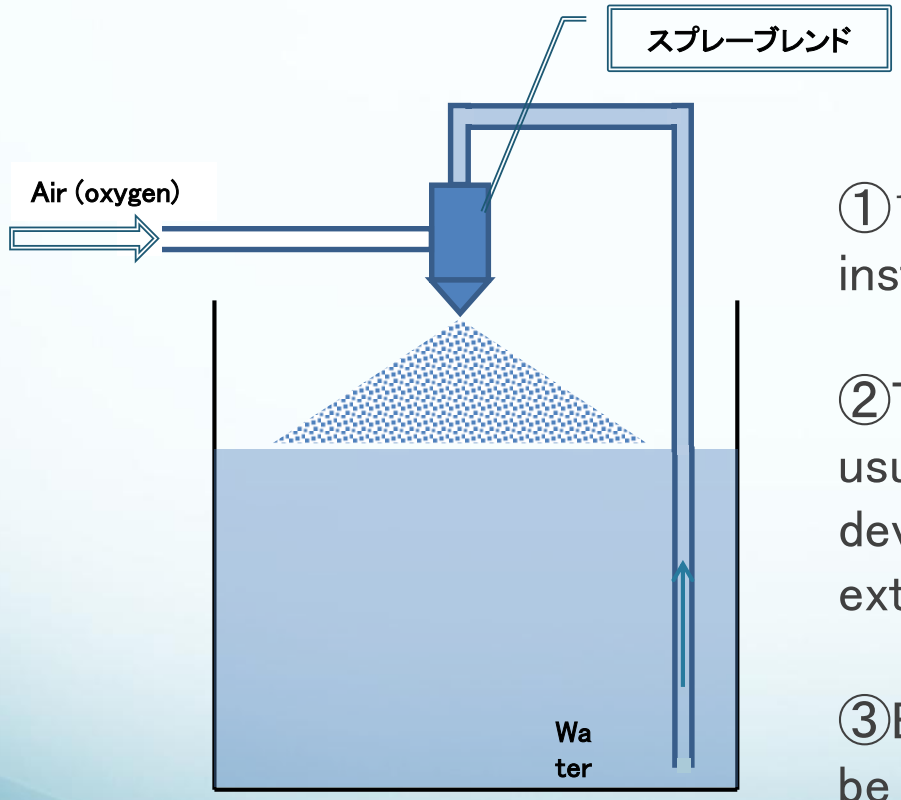
Bottleneck of fermentation system

The cause of not going well is common only by one. That is poor ″Fermentation″.

The fungi is divided into two types: aerobic (Oxygen is necessary) and anaerobic (Carbon dioxide is necessary). Aerobic breathes in oxygen, and exhausts carbon dioxide. Anaerobic is opposite. For instance, the aerobic respiration is necessary in an aerobic yeast fermentation system in case of the shochu fermentation. If the oxygen cannot be added to the culture object of rice or the potato, there will only be carbon dioxide existing from the breath exhaust. Like human beings, as the oxygen is decreased, hypoxia occurs, which means the fermentation stops. It is suffocated when completely disappearing and the bacterium dies out. As the oxygen is completely consumed and the exhausted carbon dioxide is increased, anaerobic fungi that takes carbon dioxide will replace and grow. The fungi is often called putrid bacteria, causing stink or rot. To expedite the fermentation of aerobic bacteria, increased supply of oxygen is fine, but it will not work. The current situation is just like the bubbles in goldfish's water tank. With this, only about 10% of saturated amount (relieved critical mass) can be added. And it takes much time. Oxygen doesn't enter from the substances which is sticky like shochu squeezed residual

[Spray blend air and liquid mixture]

Solution



①100% of the saturated amount can be instantaneously added.

②The nano bubbles can be generated by a usual compressor (about 0.5MPa). The device is small, and the operation cost is extremely low.

③Even the liquid with high viscosity can be added.

④A large capacity can be processed.

[Spray blend]

Toward a new stage

Our spray blend enables the oxygen and carbon dioxide to be added easily. Almost 100% addition of the saturated amount was enabled in quite a short period of time. It can also use materials of any level of viscosity and the mass processing is possible. Now the optimal condition in the fermentation system can be obtained which has not been possible. This is all about this new technology.

Time required for fermentation is decreased from about two days to few hours.

Shochu squeezed residue, starch residue, lunch leftover, domestic animal's excreta (biomass), or other food residue, materials in the aerating tank, and fish gut, all of them can be feeds and fuels.

Expensive wastes from industrial waste processing now will bring money in future.

The stink and rot that are the primary problem will disappear first.

This technology is expanding not only to waste processing but also to the processing of brewing and fermentation of sake, medicine, and a variety of biotechnology and the fermentation systems and fish cultivation, etc.

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[Milk Processing Systems]

Innovative technology that enables a line processing of high quality cell subdividing (non-homogenized), deaeration (nitrogen substitution of the remaining oxygen), and sterilization on a large scale by using a spray method.

◆ **What is spray method/Milk Processing Systems?**

The raw material milk is introduced by the pressure difference caused by the compressed nitrogen, then dispersed into a minimum particle size (Nano level) at the nozzle. This dispersion state is highly reactive, and the remaining oxygen in the raw material milk is efficiently substituted for nitrogen here. The germicidal treatment is also possible at the same time by the use of the superheated steam. Therefore, all the processes are processed in the line within a short period of time simultaneously.

– **Feature**

1. Highly precise and stable generation and dispersion of particles increase the quality and quality durability.
2. Subdividing of particles into nano level will not cause heat denaturation, destruction of membrane or molecular structures in materials (biomaterial such as the proteins).
   Subdividing by non-homogenization.
3. The nitrogen substitution efficiency of the remaining oxygen is extremely high (almost 100%), and the quality (good and stability) as well as quality durability are improved.
4. The germicidal treatment with the superheated steam is a new sterilization method that can be processed instantaneously (A few seconds: heating ⇔ cooling).
5. Change from the old batch tank processing to the new inline processing realizes remarkable decrease of the plant size to 1/10 of the previous plant. Larger processing volume than in the previous plant is possible as the batch tank or stock tank are not necessary.
6. The new system has very simple structure and maintenance is easy. Both the extremely high quality and low cost are achieved at the same time.