多功能气泡净化船

(Multifunctional bubble treatment ship)

Onsite algae harvesting using micro and nano (sub-micron) bubbles

SEUNG-UK LEE

ULIM CONSTRUCTION CO., LTD.

Contents

Present situations of rivers and lakes

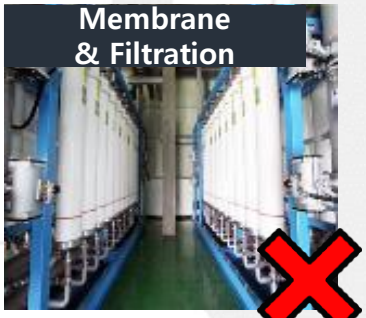
Wastewater (N,P)

SS

Deposition

Lack of oxygen

Bacteria

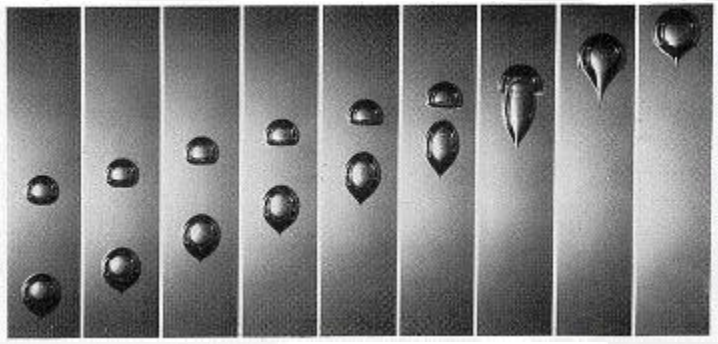


Characteristics of Bubbles

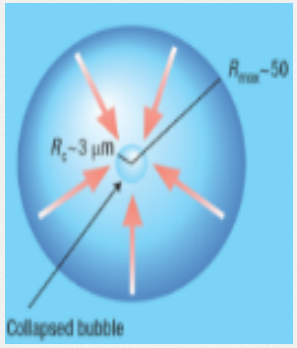
Clean material

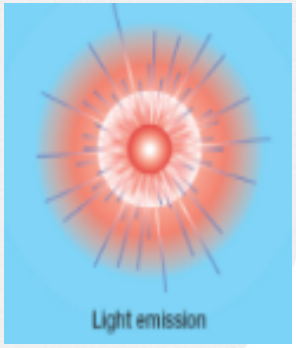
Mass transfer

Flotation



Bursting





SNU Sustainable Water Management Research Center

Head of research center
(Prof. Mooyoung Han)

Micro bubble	***Nano bubble***	***Application***
A. Prof. H. Park	A. Prof. T. Kim	A. Prof. M. Kim
Thuy (doctor´s course) S.Baek (master) Muhamad (master's course)	H. Kim (doctor´s course) Canh (doctor´s course) Tatek (doctor´s course)	Shervin (doctor´s course) Gita (master's course) S.Yoon (master's course)

Research papers+SCI	98+67 건
Patents	63 건
Awards	28 건
Media reports	217 건
Projects	42 건

IWA International Water Association

ISO International Organization for Standardization

국토교통부 Ministry of Land, Infrastructure and Transport

환경부 Ministry of Environment

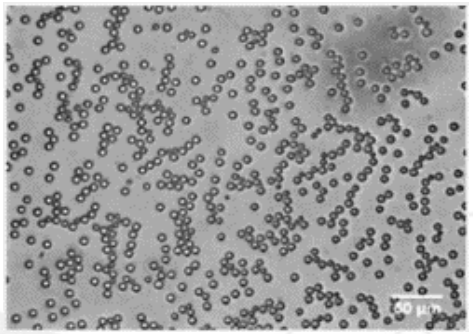
해양수산부 Ministry of Oceans and Fisheries

대한민국 국방부 Ministry of National Defense

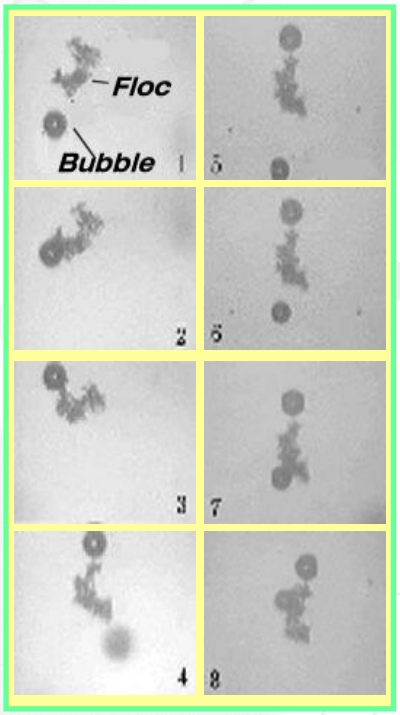
KSEE 사단법인 대한환경공학회 KOREAN SOCIETY OF ENVIRONMENTAL ENGINEERS

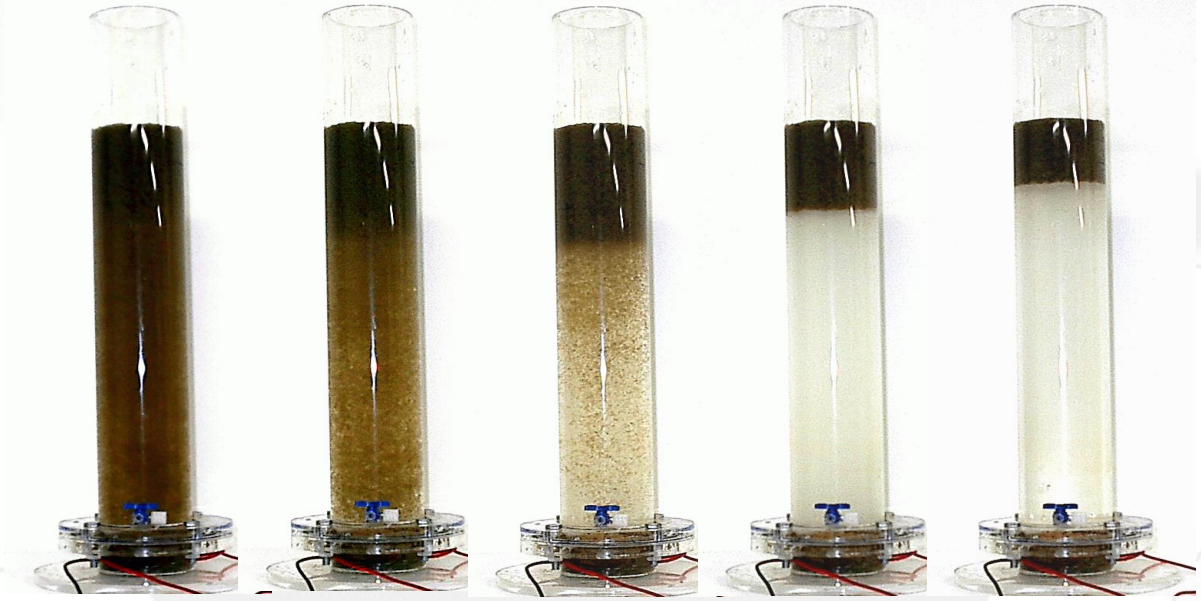
1. Technology of Microbubble

Micro bubble (Fine bubble)



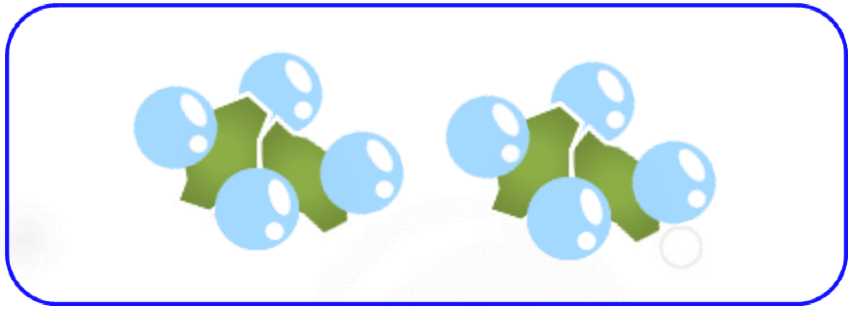
30 ㎛ ➔ 1/2 of the hair thickness





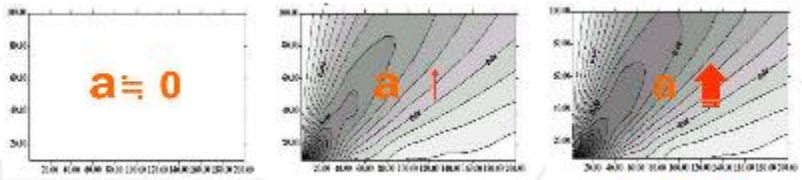
(a) 0.4 min | (b) 0.8 min | (c) 1.2 min | (d) 1.6 min | (e) 2.0 min

Major technologies (MB)

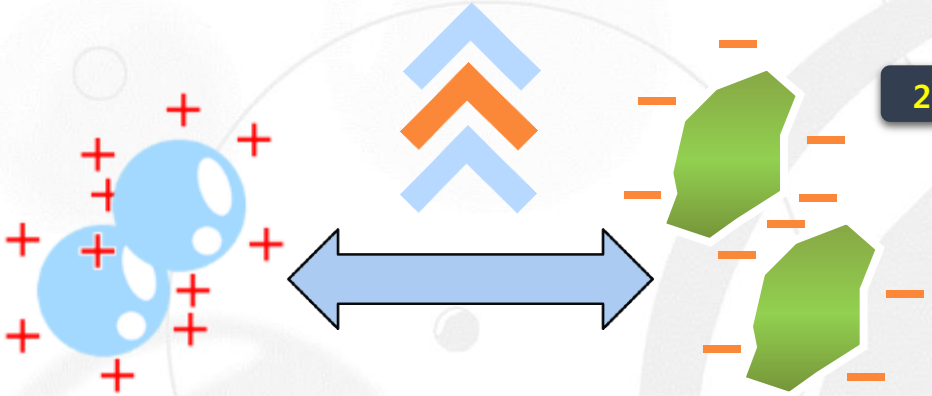


1. Modeling

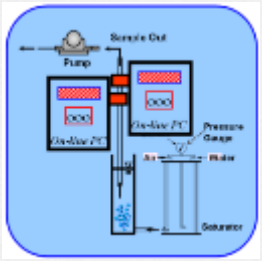
※ *Collision efficiency diagram* (a_{bp}) by trajectory analysis (*Han, et al. 2001*)



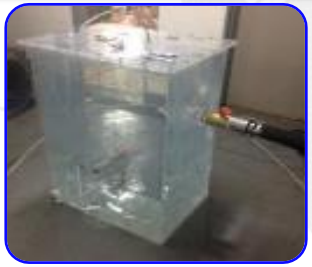
ζp × ζb > 0 ζp = 0 ζp × ζb < 0



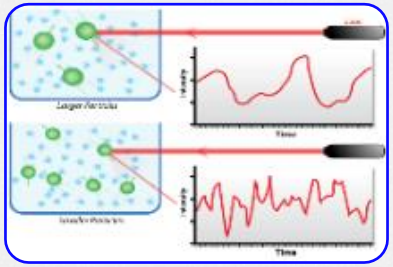
2. Measurement & control of bubble and particle properties



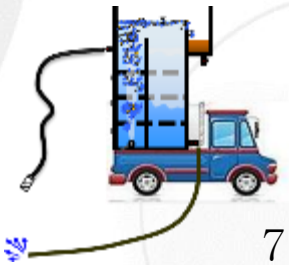
3. Development of the low-cost & high efficiency tailoring bubble generator



4. ISO

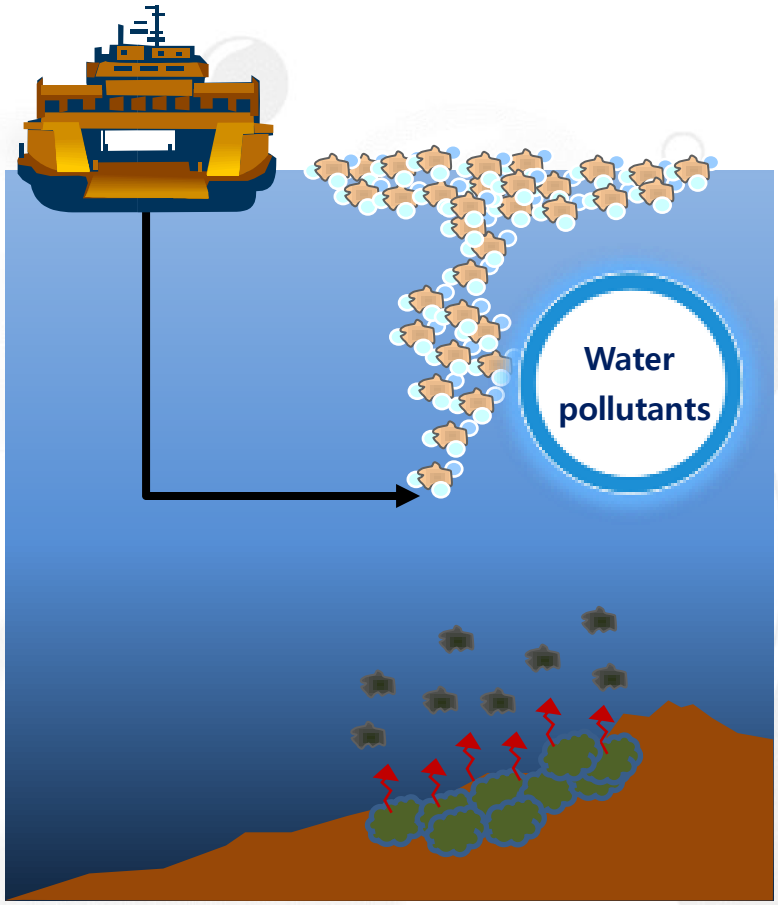


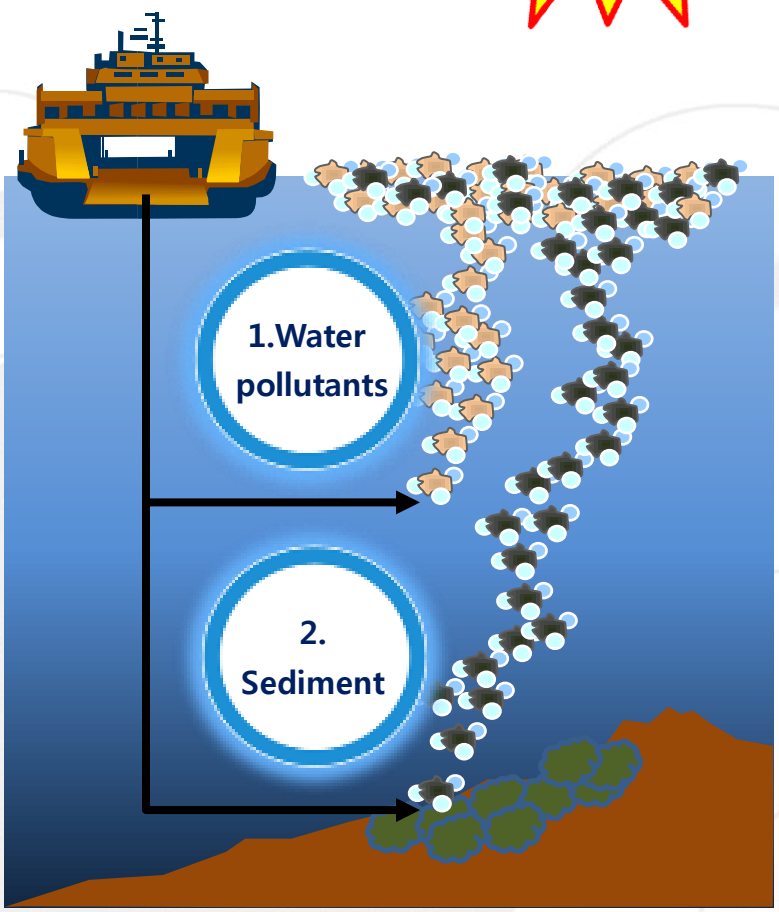
5. Various applications



Removal of natural water pollutants

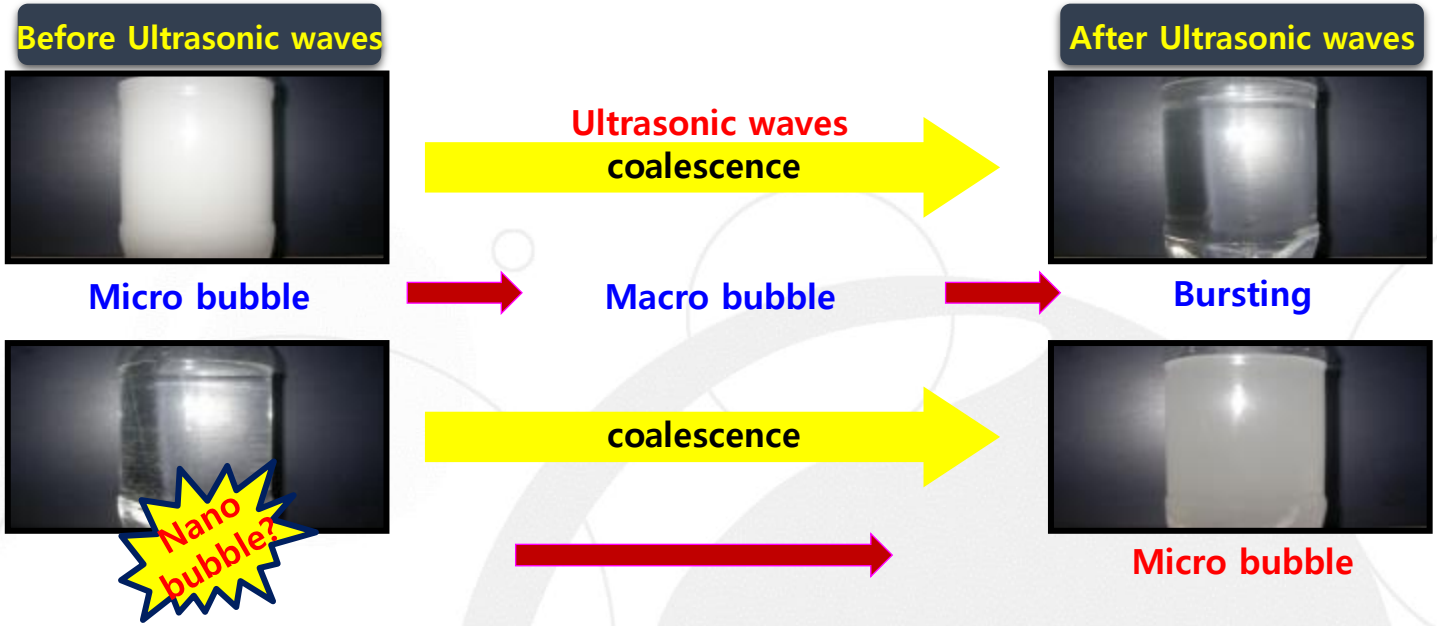
Unique technology

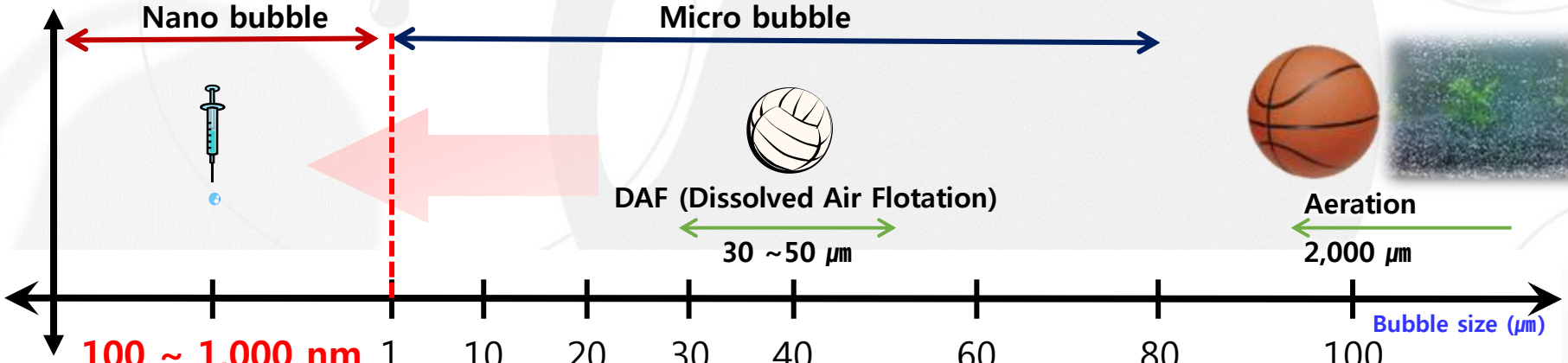




2. Technology of Nanobubble

Nano bubble (Ultrafine bubble)

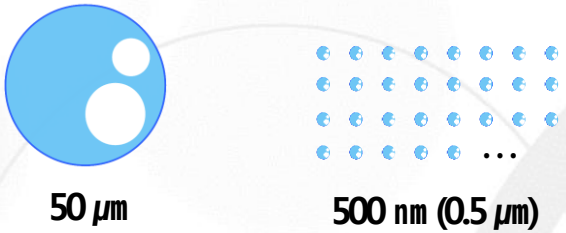




Major technologies (NB)

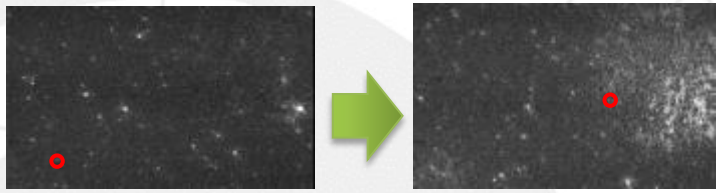
1. Generation of nanobubbles
2. Confirmation of the existence
3. Characterization of nanobubbles
4. Development & application

Surface area (at same volume)



- Air volume : 1 : 1
- Surface area : 1 : 100
- Number : 1 : 1,000,000

Rising Velocity



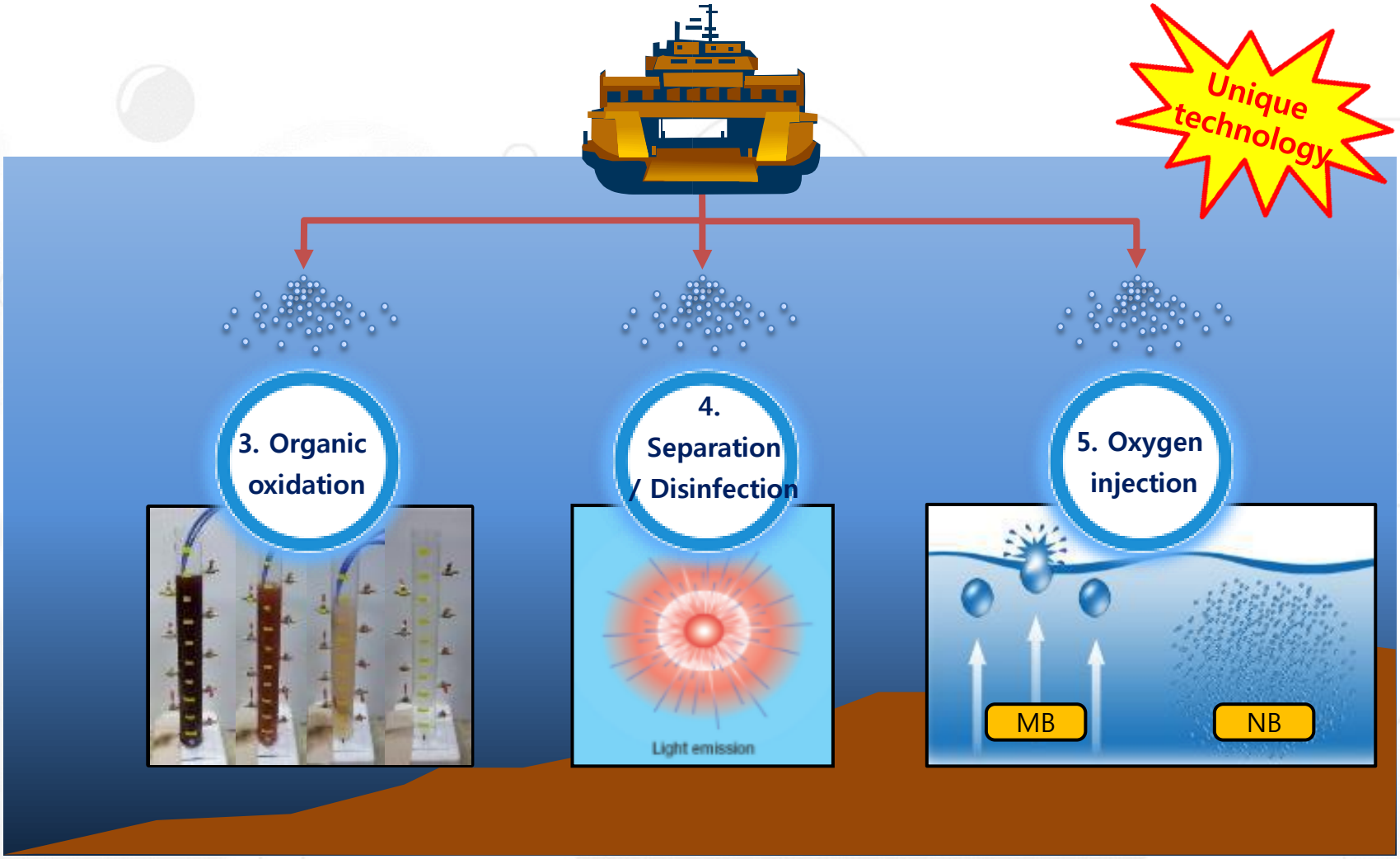
- Size : about 500 ㎚
- Rising velocity : 4.58×10^{-7} m/s ≒ 0
- Theoretical rising velocity : 7.5 ㎜ rising per day

Mass transfer efficiency ↑ (Aeration efficiency)

→ Surface area ↑ / Rising velocity ↓ →

Nanobubble

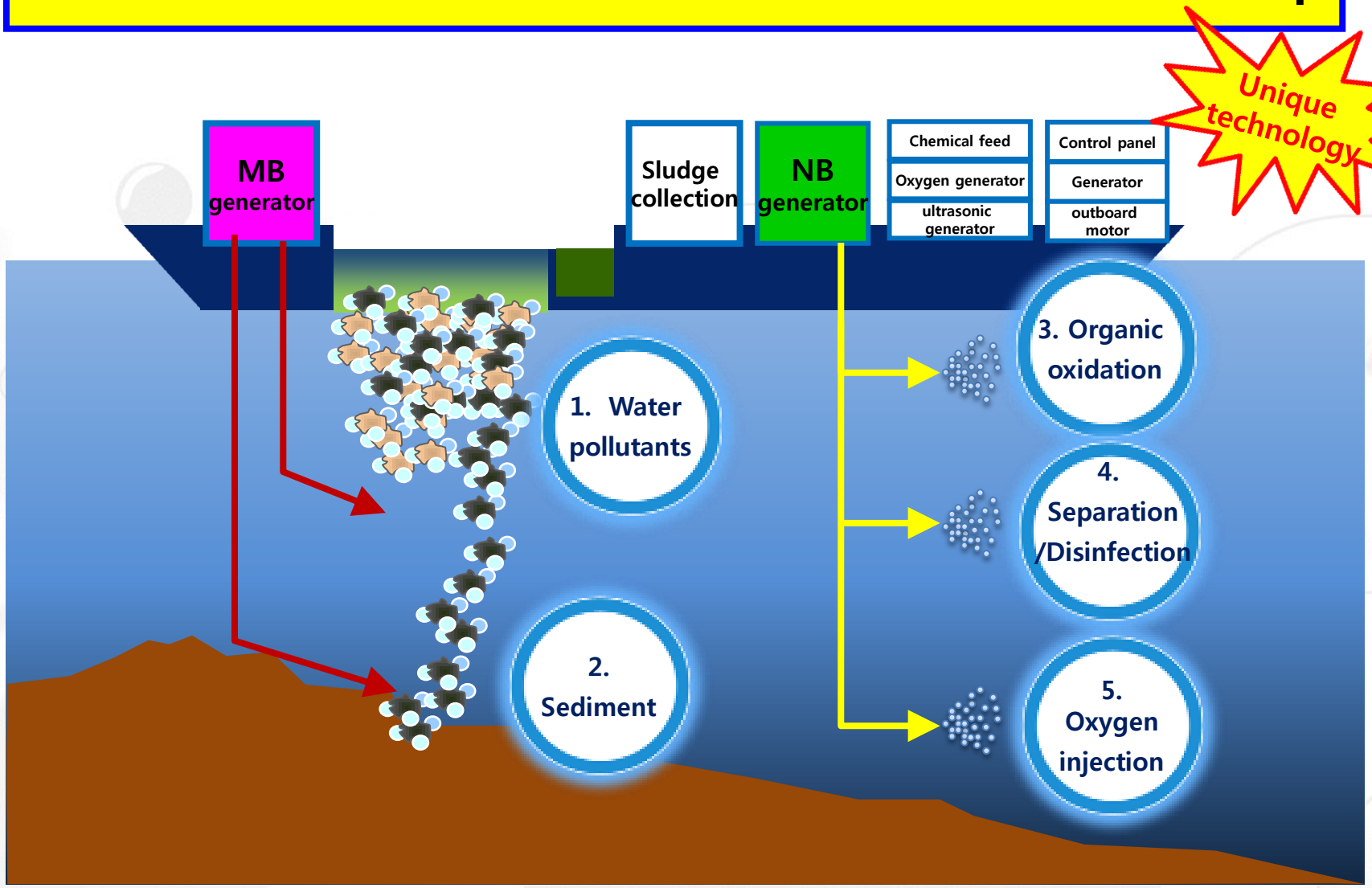
Removal of natural water pollutants



3. Application cases

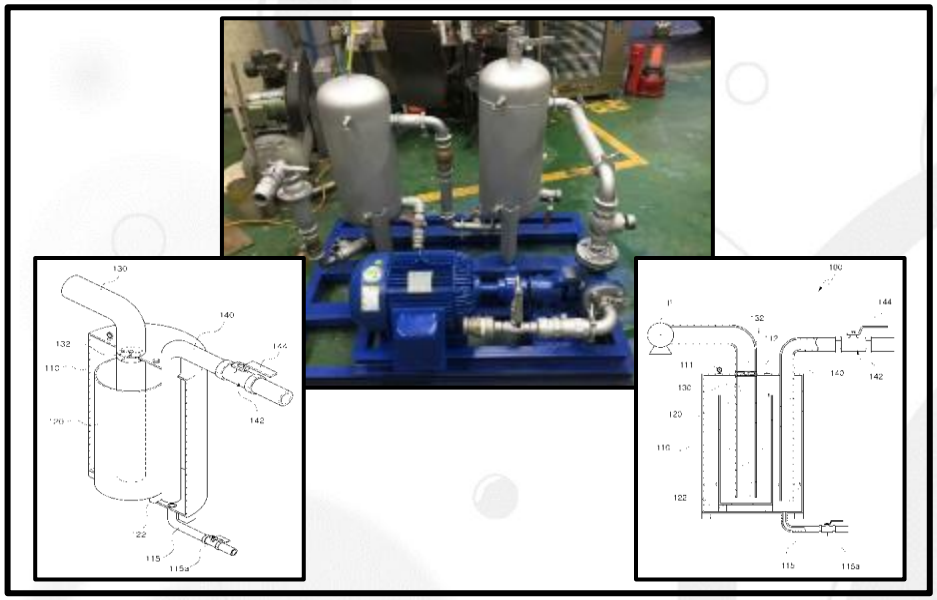
（Multifunctional bubble treatment ship）

Overview - Multifunctional bubble treatment ship

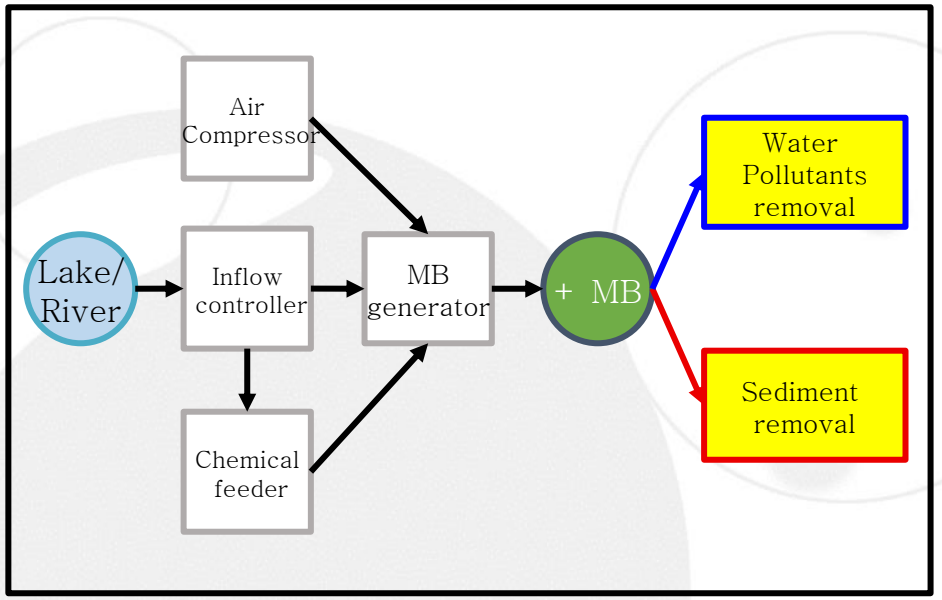


Technical detail 1. Micro bubble

MB generator + Chemical feeder



Process Flow Diagram

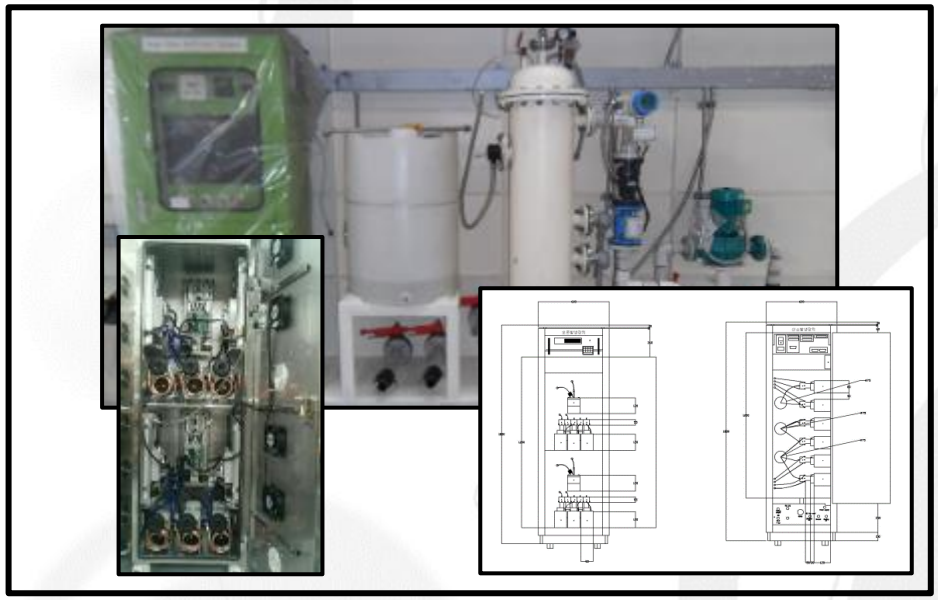


- Low cost & high efficiency bubble generator
- No clogging nozzle
- Tailoring MB generator
- Automatic injection control system

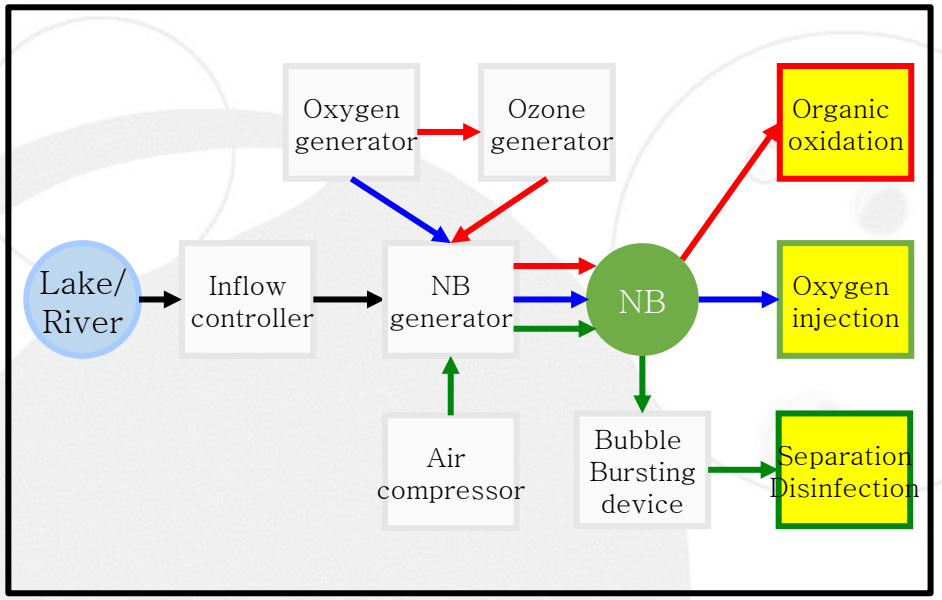
Technical detail 2. Nano bubble

Unique technology

NB generator + Organic oxidation device + Bubble bursting device + Air compressor



Process Flow Diagram



Unnecessary facilities to eliminate ozone

NB residence time : 6 days

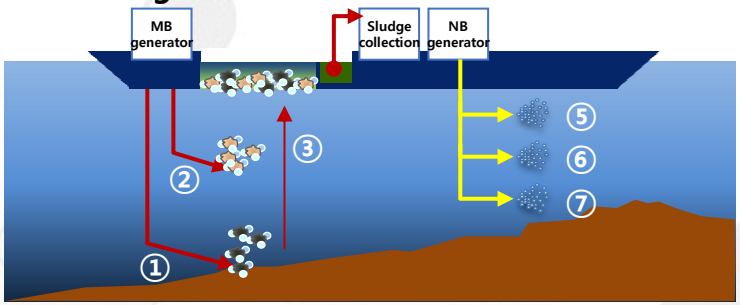
Medium/Large NB generator

PFR AOP

Operation and Maintenance

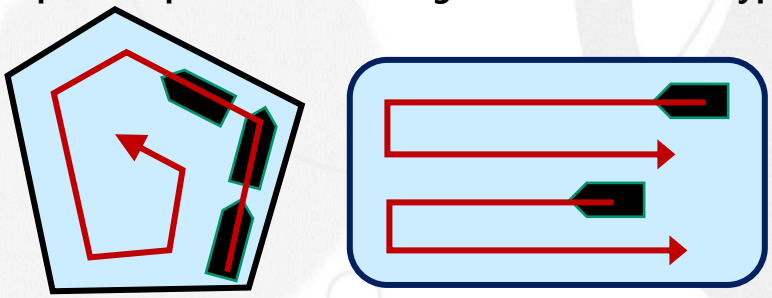
Operation method

- **Processing order** ④



Item	Time	Item	Time
① Sediment	1.5 min	⑤ Organic oxidation	2 min
② Water pollutant	1.5 min	⑥ Separation & Disinfection	2 min
③ Floating	5 min	⑦ Oxygen injection	2 min
④ Sludge collection	2 min	**Total time**	**6.5 min**

- **Optimal operation according to river and lake types**



Operating Specification

Item	Content
Mean velocity	0.05 $Knot$ (1.5 m/min)
Maximum velocity	0.06 $Knot$ (1.5 m/min)
Operator	2 (Engineerier1, assistant1)
Operating distance	300 m/hr (width 3.0 m)
Average surface area treated per day	**7,728** m^2/d
Average daily throughput	1,1592 m^3/d, 483 m^3/hr
Sludge Storage	3.0 m^3
Power consumption	25.2 kW
Chemical feed	8 ppm
Fuel	**Diesel, Gasoline**

* River width : 20 m, Depth : 1.5 m, Length : 10 km

[Large size] Multifunctional bubble treatment ship

R lake, Jeollabuk-do

S lake, Seoul

- ✓ Removal of pollutants in water (turbid water, algae, etc.)
- ✓ Non-powered dehydration
- ✓ Field assembly and installation
- ✓ Daily throughput : 2,113 m^3/hr
- ✓ Pretreatment of water purification plant
- ✓ Cityscape improvement

P lake, Gyeonggi-do

[Medium size] Multifunctional bubble treatment ship

S lake, Jeollanam-do

Before

After

- ✓ Removal of pollutants in water (algae, agricultural wastewater, etc)
- ✓ Sediment removal
- ✓ Reduction of algae current cycle
- ✓ Daily throughput : 1,200 m^3/hr
- ✓ Field assembly and installation

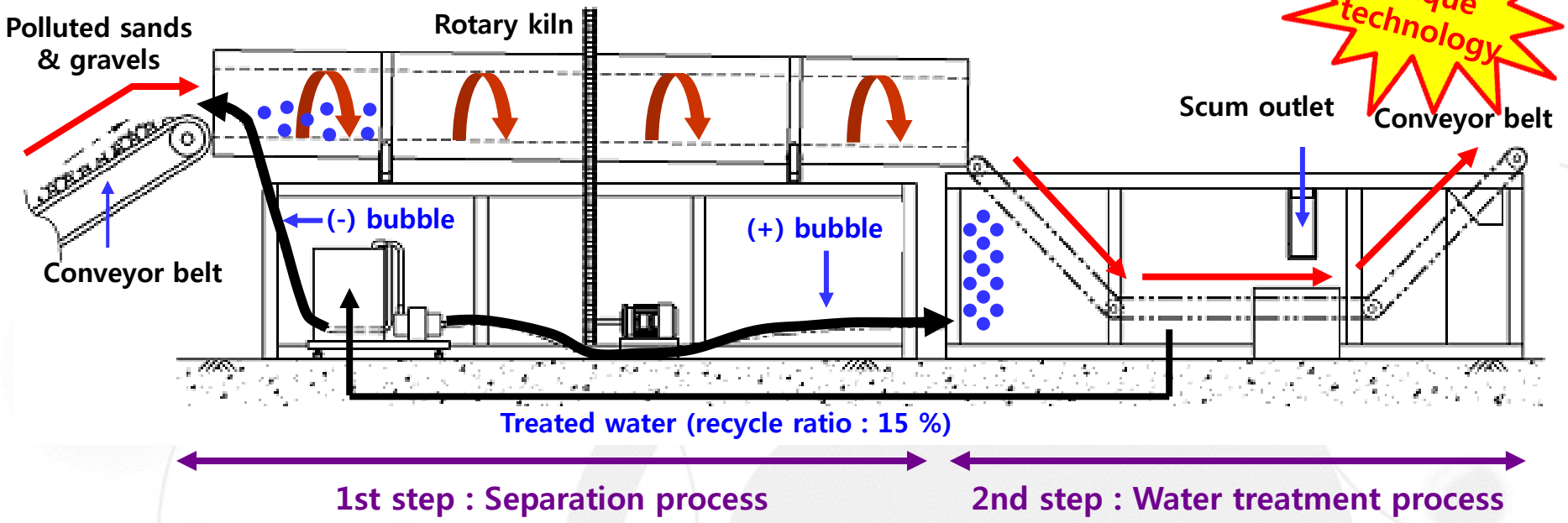
[Small size] Multifunctional bubble treatment ship

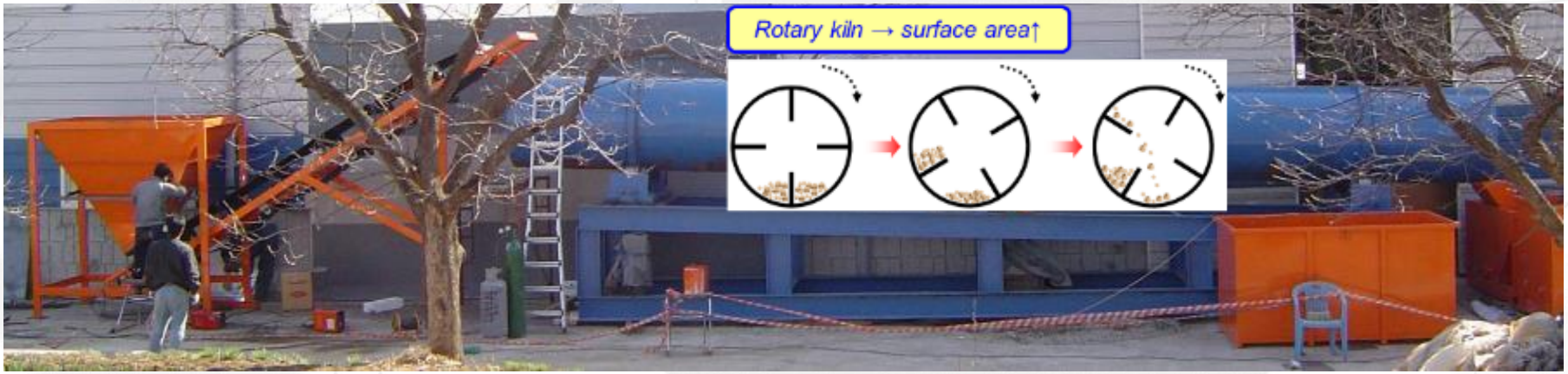
C lake, Gyeonggi-do

- ✓ Removal of pollutants in water (algae, wastewater, etc.)
- ✓ Drum type scum collection(throughput ↑)
- ✓ Organic oxidation
- ✓ Oxygen injection
- ✓ Daily throughput : 512 m^3/hr

4. Additional Technologies

Soil washing process using bubbles(1) - overview



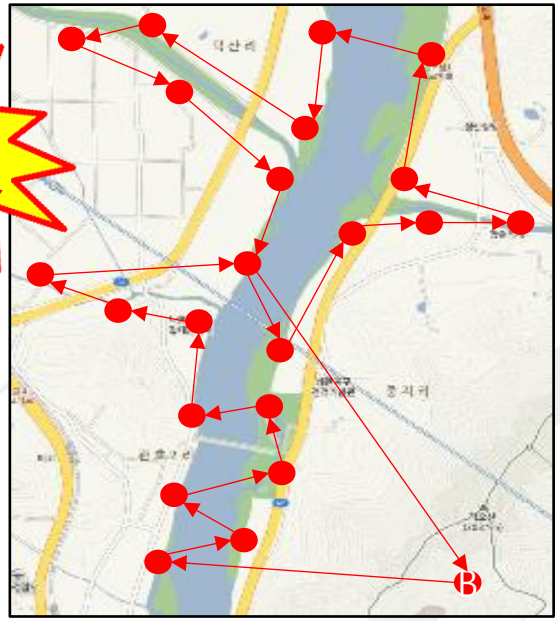


Soil washing process using bubbles(2) - Results

	Raw sample	Water	(+) & (-) bubble
Treated water			
Treated sands			

Natural water management using Drone

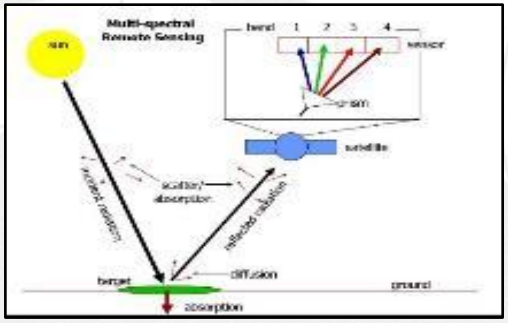
Unique technology



1. GIS electronic map for drone

Unique technology

2. Autopilot



3. Image analysis technique using satellite

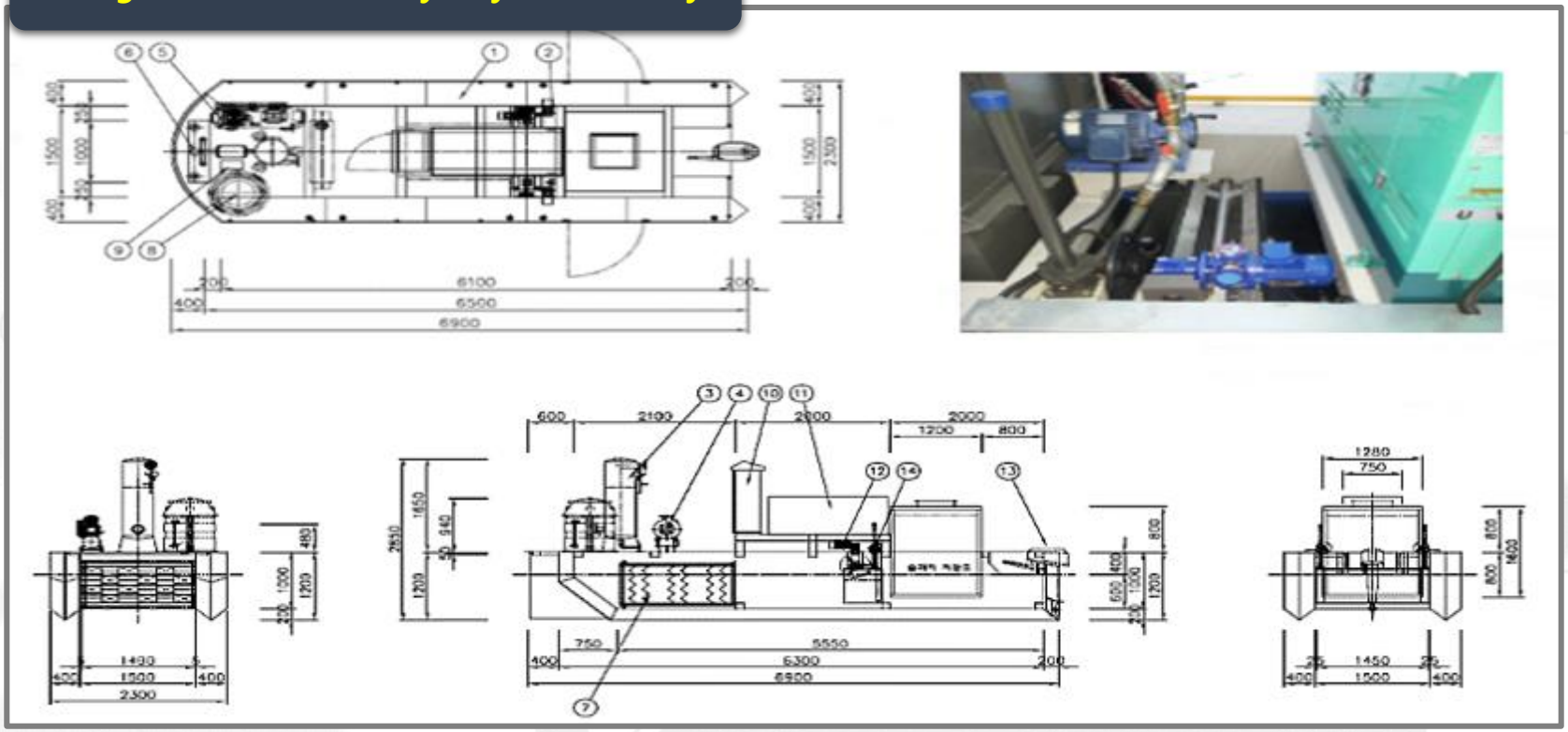
4. Pollution analysis and monitoring / alarm

THANK YOU
FOR YOUR ATTENTION

ULIM CONSTRUCTION CO., LTD.

Technical detail 3. Body of a ship, etc.

Sludge collection + Buoyancy + Electricity



Drum type scum collection→ Small size → Container

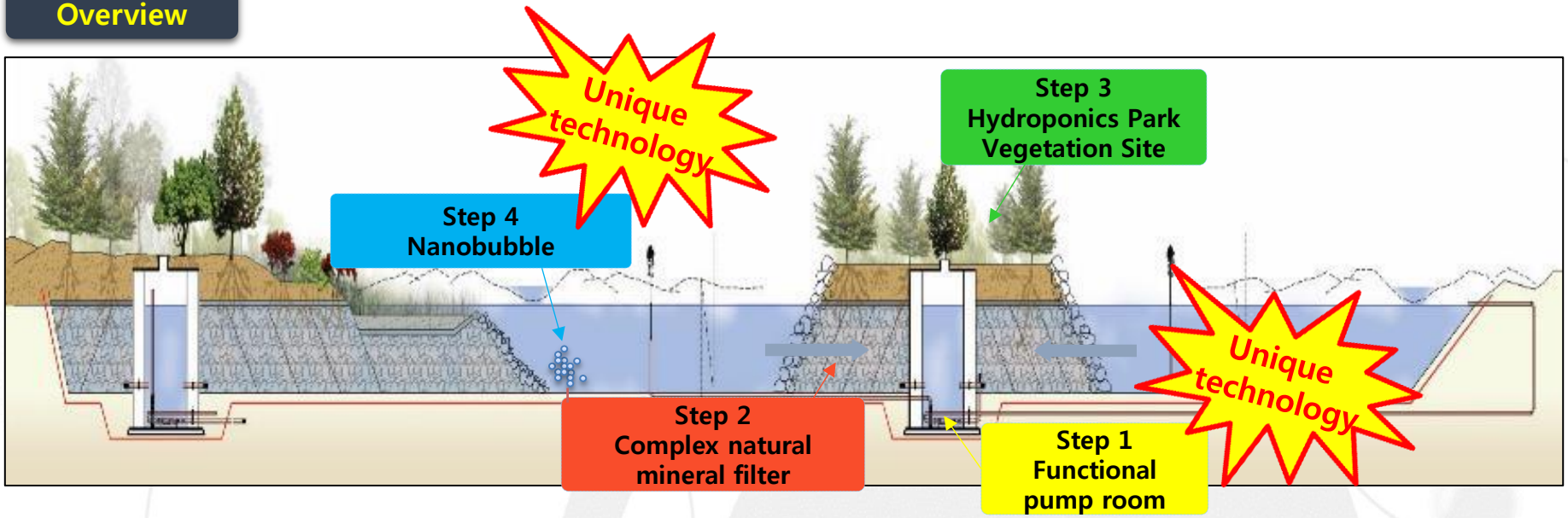
Drum type scum collection → throughput ↑

Catamaran → Secure space

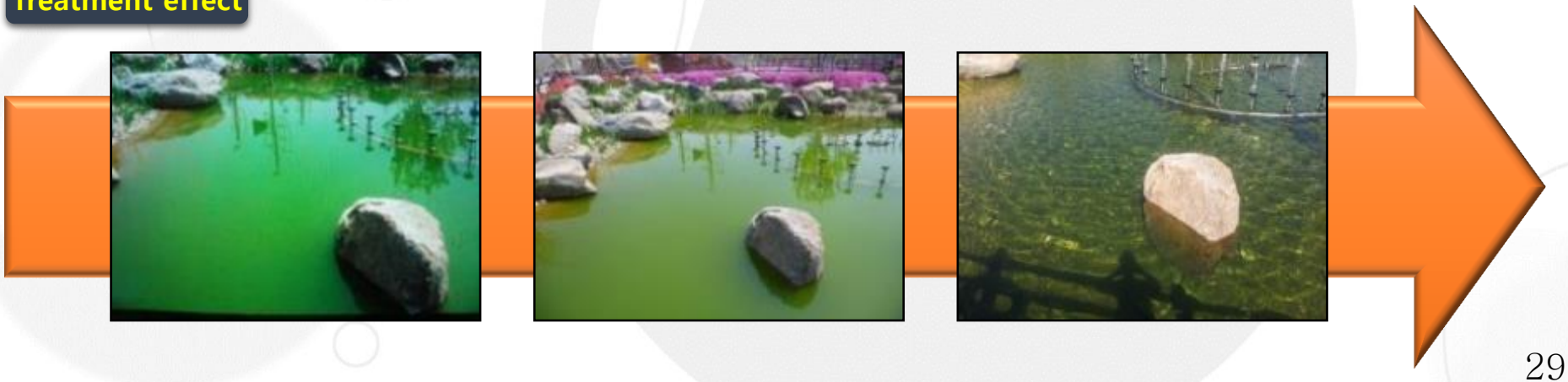
Non-powered mixer

Water quality management using filtration & bubbles

Overview



Treatment effect



Sludge Composting

Sludge

Additive

Unique technology

Dry molding

Unique technology

Plasticity

Potassium silicate fertilizer

Demonstration project budget (Proposal)

Description		Specification	Q'ty	Unit Price	Total price (KRW)	Total price (CNY)
MB generator, etc.	compressor	380V, Ø3, 2.2kW	1	850,000	850,000	5,185
	Voltex pump	9m3/hr, 60mH 380V, ø3, 5.5kW	1	800,000	800,000	4,880
	혼화장치	180 rpm	2	300,000	600,000	3,660
	Chemical dosing system	60mL/min, 10mH 380V, ø3, 60hz	1	650,000	650,000	3,965
	Base, pipe, elbow, socket, cap, tank valve.	PE, 200L	1	550,000	550,000	3,355
NB generator, etc. (Organic oxidation device , Bubble bursting device , Air compressor)	Mixing chamber Set	FRAME etc.	1	8,000,000	8,000,000	48,800
	Controlled volume pump	380V, Ø3, 60hz 1500, 1/5, 200W	1	153,000	153,000	933
	External case	220V, Ø2, 60hz, 100bar, 2.2kW	1	850,000	850,000	5,185
	Control panel	STS/GC200	1	500,000	500,000	3,050
	Oxygen demand regulator	STS304	1	1,000,000	1,000,000	6,100
	Flow meter	STS etc.	1	500,000	500,000	3,050
	Pipe, Hose	GD-25S(25KVA)	1	9,100,000	9,100,000	55,510
	AOP	15TML 15HP	1	2,980,000	2,980,000	18,178
Body of ship, etc. (Skimmer, generator, outboard Motor, etc.)	Ship body, skimmer storage tank, Hand Rai	SS400+STS	1	32,000,000	32,000,000	195,200
	Skimmer processing	SS400, STS	1	500,000	500,000	3,050
	Skimmer motor	NMRV040+1/100 +TXF002, 0.2kW	1	300,000	300,000	1,830
	Skimmer screw jack	UJ44-ICLFN500	2	440,000	880,000	5,368
	Sludge storage tank	SS400, 1.8m3	1	3,000,000	3,000,000	18,300
	Sludge transfer tank	50L/min, 10mH 380V, ø3, 4P	1	800,000	800,000	4,880
	Panitng	3m3/hr, 220V, 1.2Hp	1	1,000,000	1,000,000	6,100
	Pipe, Hose	STS304/rubber	1	500,000	500,000	3,050
	Assembly		1	4,000,000	4,000,000	24,400
	Local control panel	SS400 etc.	1	9,500,000	9,500,000	57,950
Production cost					79,013,000	481,979
Transportation cost					540,000	3.294
Operation & maintenance cost					22,000,000	134,200
Total cost					101,553,000	619,473

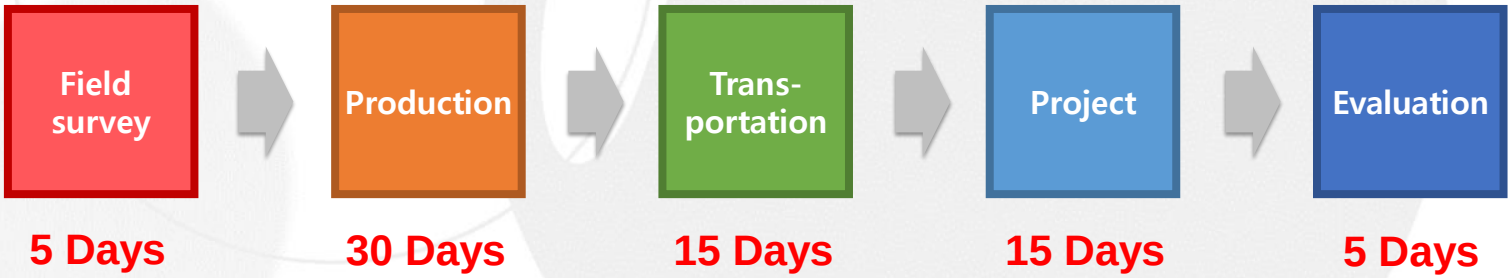
*** Conditions : FOB, Production in Korea, Period, Pretax cost, Water quality standard, Surface area treated, etc.**

Consultation & Expected schedule

Consultation

- Site selection: Lake or River (width:20m, depth:1.5m, velocity:0.2m/s)
- Determination of standard (River environmental quality standard; Turbidity, SS, chlorophyll -a, COD)
- Condition determination (Period, Cost, Length, etc.)
- Determination of application technology
- Consortium Composition

Schedule



4. Demonstration Project