MICHIGAN
TECHNOLOGY

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Leads the future technology

MICHIGAN
TECHNOLOGY

MVP-ION

MISSION

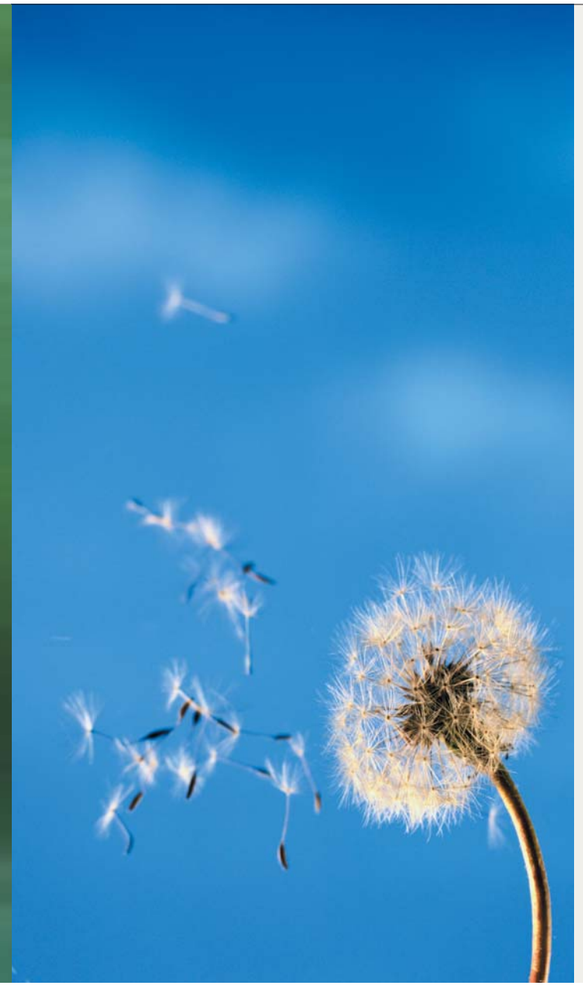
Enterprise responsible for restoration of the environment from contamination
Enterprise committing its best endeavors into keeping sustainable clean environment

VISION

Enterprise bearing visions for realizing better environments in the future
Enterprise targeting development of future-oriented environmental technologies

PASSION

Enterprise keeping passions for solving any problem of the environment
Enterprise with never-stopping spirit of challenging for realizing the better future



Michigan Technology was established for the purpose of developing environmental technologies for the future, and has been committing its best endeavors into value management through unique and sustainable technology development.
The ever-continuing efforts of the company for realizing healthy environment have succeeded in creating different solutions for the environments with its 'Missions of Restoring the Environments from Contamination, Visions for Better Environments in the Future, and Passion for Providing Solutions for Environmental Problems.'
The company introduced a brand new concept in the water treatment industries to preserve environmental solutions proprietary to the company based on the technologies developed based on the new concept.
Michigan Technology will grow an enterprise realizing the vision of returning to the clean environments in the past with its passion and missions for developing technologies based on the philosophy, "Environmental Technologies Toward the Future, and Natural Environments Restored to the Level in the Past."

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MICHIGAN TECHNOLOGY

Corporate History

2002.03	Michigan Technology Founded
2002.05	Firm Registration for Equipment Supply and Construction on Water and Wastewater Treatment (a registration number : Ulsan Namgu 2002-13-02)
2005.10	Designated No. 143 of New Envrionmental Technology, and No.85 of Verified New Environmental Technology from Ministry of Environment, KOREA
2006.06	Certified on a venture capital business (No. 061235035-1-00167)
2007.08	Founded R&D Center of Michigan Technology (No.20074348)
2008.07	Registered as a toxic material sales business (No.6512-0804)
2014.04	Designated No.436 of New Envrionmental Technology from Ministry of Environment, KOREA
2017.02	Certified on an INNO-BIZ enterprise (No. 7024-4693)
2018.11	Registered as design and construction business of wastewater reuse facility (No.2018-01)

Intellectual property rights of the company

2002. 01. 10	Patented the water treatment method and water treatmentsystem employing both of the technologies of electric cohesion and dissolved air floatation (DAF) (patent registration No.0321799)
2002. 01. 10	Patented the water purification method employing the technology of dissolved air floatation (DAF) (patent registration No. 0321800)
2002. 09. 30	Acquired a utility model right of the dual-pipe spraying system of pressurized water (No. 0289287)
2005. 10. 23	Developed Advanced treatment process for water discharged from sewage treatment plants with the technology of cohesion and dissolved ozone floatation'designated No. 143 of New Environmental Technologies, and No. 85 of Validated Environmental Technologies
2006. 11. 09	Patented the waste water treatment system composed of the dissolved ozone floatation bath (DOF bath), the pressurized ozone oxidation basis (PO1 bath) and the dissolved ozone oxidation bath (DO2 bath), and the waste water treatment methods using the system (patent registration No. 0646861)
2007. 03. 26	Patented the oxidative gas-pressurized system (patent registration No. 0702198)
2007. 04. 16	Patented the sewage and waste water treatment system and the methods employing the system composed of the technologies of dissolved ozone floatation, pressurized ozone oxidation and raw water treatment (patent registration No. 0710488)
2007. 08. 27	Patented the water treatment system of composite oxidation mode, and the water treatment method with the system (patent registration No. 0754526)
2007. 06. 08	Developed the oxidizing gas pressurization system (patent pending in foreign markets: U.S., Europe and China)

Core technologies for water treatment

DOF™ PROCESS [Dissolved ozone floatation process]

DOF = DAF + Ozone

Dissolved Ozone Flotation Dissolved Air Flotation Ozone

◎ Overview of technologies

- Floatation separation method of excellent flocculated liquid separation, and ozone-treatment integrated technology with strong oxidation
- Treatment of organic materials, phosphorus, chromaticity, turbidity and bacilli (e.g., coliform bacilli and common bacteria) by introducing pressurized ozone water produced at high pressure (4 to 8 kgf/cm2) into the floatation bath through the micro-bubble generator
- No. 143 of New Environmental Technologies, and No. 85 of Validated Environmental Technologies

◎ Advantages of technologies

- Larger application scope, improved treatment efficiency and more differentiated applications than conventional processes of filtration, membrane separation, or ultraviolet sterilization
- Cost reduction of sterilization for ozone-treatment facilities thanks to higher ozone consumption efficiency higher than 96%
- Optimization of water quality improvement at water discharged areas and sewage recycling through higher treatment efficiency of organic materials, phosphorous, chromaticity, and bacteria
- Integration of deodorization systems for ozone discharged from the DOF processes
- Excellent treatment efficiency for waste water containing decomposition-resistant materials

◎ Applications of DOF process

- Advanced physiochemical treatment process at sewage/waste water treatment plants
- Water recycling process (gray water)
- Chromaticity and COD treatment process of industrial waste water generated from dying / pigment industries
- Advanced downstream treatment process of raw water from livestock night-soil
- Processing process of materials causing foul taste/smell, and decomposition-resistant materials
- Advanced treatment process of local sewage andsmall waste water treatment facilities

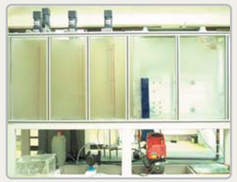

환 경 신 기 술 지 정 서

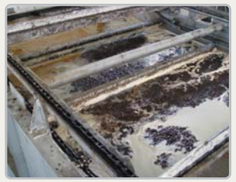
환 경 부 장 관


환 경 기 술 검 증 서

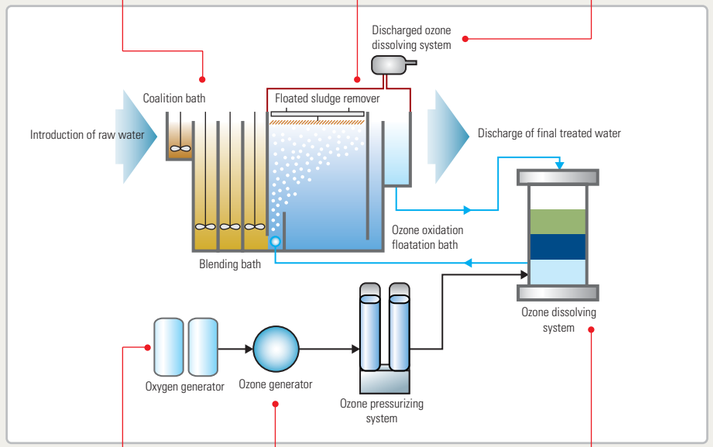
환 경 부 장 관

◎ DOF™ Process


Coalition/blending/floatation basis


Sludge remover


Ozone dissolution system




Oxygen generator


Ozone generator


Ozone dissolving system

Functions of unit DOFTM process

- Coalition bath
  - Introduction of raw water
  - Injection of coalition agents and coalition-assisting agents
  - Rapid lapping
  - Staying duration: 1 to 2 minutes
- Blending bath
  - Forming plug through slow lapping after coalition
  - Staying duration: 20 to 30 minutes
- Ozone oxidation floatation bath
  - Introduction of raw water formed with plug
  - Floatation of contaminants through reaction with micro-bubbles
  - Oxidation from micro-ozone bubbles
- Sludge remover
  - Removal of floated contaminants from the ozone oxidation floatation bath
  - Rotary and reciprocation model
- Discharged ozone dissolving system
  - Treatment of residual ozone gas within ozone oxidation floatation bath
  - Thermal-decomposition and catalyst-reaction type
- Ozone dissolving system
  - Circulation of part of finally treated water
  - Injection of ozone gas with high pressure (4 - 8 kgf/cm^2)
  - Ozone-pressurized water generated and introduced into the ozone oxidation floatation bath


Automatic control panel

PO2 PROCESS [Pressurized ozone oxidation process]

◎ Overview of technologies

· The higher pressure rises, the more dissolution of gas grows. This water treatment technology utilizes this principle to treat chromatic and decomposition-resistant materials by dissolving ozone into high concentration in a tank of higher pressure.

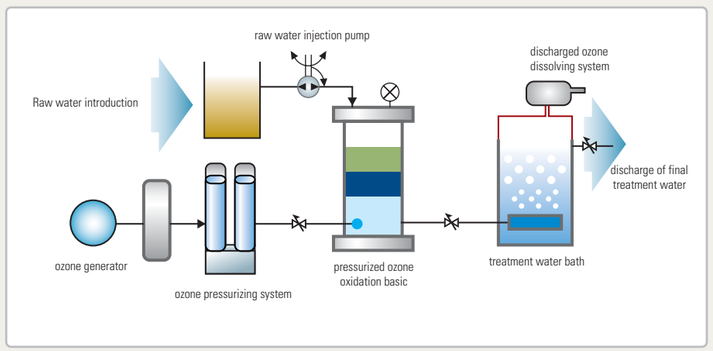
◎ Advantages of technologies

· Relatively short staying duration demanding least footprint
· Excellent capability of organic material removal, and sterilizationand disinfection
· High efficiency for removal of decomposition-resistant materials and chromaticity -inducing materials
· Lower ownership costs for removal of chromaticity than process employing decolorant and active carbon
· No side-product generated

◎ Applications of PO2 process

· Treatment of decomposition-resistant materials: Treatment of organic decomposition-resistant materials and material of higher chromaticity
· Secondary advanced process such as water recycling
· Post-treatment of biological treatment process of industrial/livestock night soil waste water or leachate
· Separation of ozone treatment process from water purification processes: Excellent efficiency and cost effectiveness

◎ PO2 Process



Intellectual Property Rights

· Treatment systems and methods of chromatic materials anddecomposition -resistant materials by making use of pressurized ozone oxidation (PO2) technology
(patent pending No. 2004-0033887)

· Waste water treatment system composed of the dissolved ozone floatation basin (DOF basin), the pressurized ozone oxidation basis (PO1 basin), and the waste water treatment methods using the system
(patent pending No. 2006-0016437)

· Water treatment systems and methods of advanced pressurized ozone oxidation process utilizing filler of optical catalyst coated with titanium dioxide, ultraviolet ray, penton oxidation and high-concentrated ozone
(patent pending No. 2006-0053753)

MIDAF PROCESS [Dissolved air floatation process]

◎ Overview of technologies

· Enough air is dissolved in water through applying high pressure, and the air- dissolved water is injected into raw water to dissolve. Supersaturated air in water reduced of pressure forms micro-bubbles and is combined with plug in water to treat. This combination of the bubble and plug rapidly rises to the water surface to separate flocculated liquid.

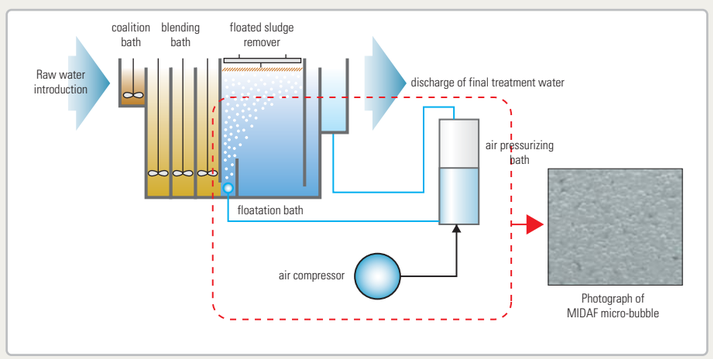
◎ Advantages of technologies

· Relatively shorter coalition duration demanding smaller area of coalition facilities
· Higher water surface loads requiring rapid treatment duration and smaller footprint
· Securing water of good quality in relatively short duration allowing fast recovery to normal operation
· Low specific gravity allowing shorter filtration duration, and excellent alga removal efficiency
· Effective for removal of detergent, oil and heavy metalIn particular, efficient removal of odor and volatile organic contaminants
· Removal of alga and bacteria to reduce THMFP
· Floated sludge obtained from floatation separation process has solid concentration and dehydration characteristics higher than precipitated sludge, and it is more efficient to remove and treat sludge.

◎ Applications of MIDAF process

· Replacement of gravitational settling basin of the water purification process
· Process of alga treatment in river, lake and swamp water
· Biological pre-treatment process for flocculated liquid separation from waste water of high concentration
· Process of sludge concentration from sewage and waste water
· Separation process of water and oily material such as detergent and oil

◎ MIDAF Process



Intellectual Property Rights

· Patented the water treatment method and water treatment system employing both of the technologies of electric cohesion and dissolved air floatation (DAF)
(patent registration No. 0321799)

· Patented the water purification method employing the technology of dissolved air floatation (DAF)
(patent registration No. 0321800)

DOF-PO2 PROCESS [Highly concentrated decomposition-resistant material processing process]

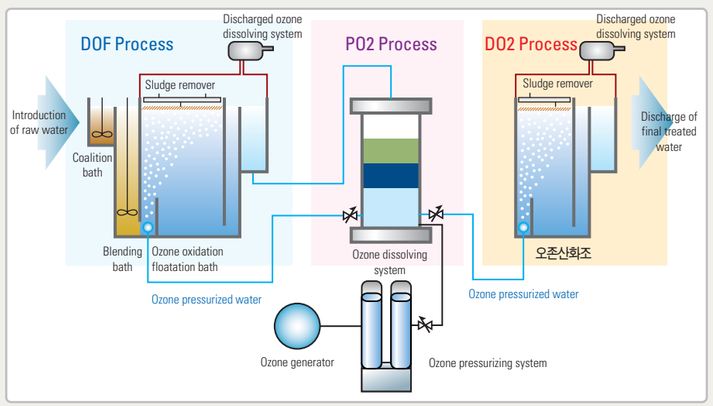
◎ Overview of technologies

· The technology applies to the pre-treatment (flocculated liquid separation) process and the biological post-treatment process. Three unit processes of DOF, PO2 and DO2 is configured in a single facility to remove decomposition-resistant organic materials, phosphorus and chromatic materials, which the biological process fails to remove. The technology pressurizes and treats ozone beyond constraints of ozone oxidation process or other AOP processes.

◎ Advantages of technologies

Technological features	· Excellent in efficiency for removal of floated materials and phosphorus through coalition and floatation processes, and chromatic and decomposition-resistant materials through pressurized ozone oxidation process. · High resistance to impact load allows guaranteeing stable water quality against variation in quality of biologically treated water caused by characteristics of significant load alteration of livestock night-soil waste water. · Perfect treatment and recycling of discharged ozone (foul odor removal and recycling) · Introduction of biological treatment process in subsequent processes optimizes organic material removal and denitrification. · Preserving know-how on optimal coalition conditions. · PLC automation of the entire processes.
Cost effectiveness	· Advanced removal of solid materials through coalition, and improvement of ozone efficiency through pressurized ozone oxidation. Reduction of ozone facility costs thanks to low injection of ozone (1/2 to 1/3 of equivalent COD removal efficiency) · Reduction of facility area by accommodating pressurized floatation and ozone oxidation into a single process. Reduction of facility construction costs through elimination of necessity for separate floatation bath, and reduction of facility area · Smaller ozone facilities reducing ownership costs (costsof oxygen and power for ozone generation)
Ease of construction	· Small dimensions of the steel-structure system for livestock night-soil waste water available of installation on ground and underground · Compact reaction system (short stay duration) demanding small footprint, and versatile of installation at any field location

◎ DOF-PO2 Process



· DOF Process (Dissolved Ozone Flotation Bath)

Coalition agent and coalition-assistant agents are injected in to raw water to form plug, which, in turn, contacts with micro-ozone bubbles to remove floated materials and to allow ozone oxidation.

· PO2 Process (Pressurized Ozone Oxidation Bath)

Ozone is injected into water treated in the DOF process under high pressure to remove decomposition-resistant organic materials and chromatic materials by making use of high-concentrated ozone oxidation.

· DO2 Process (Dissolved Ozone Oxidation Bath)

The process uses dissolved ozone and micro-ozone bubbles to remove additionally oxidized materials and

FIDAF PROCESS [On-site lake/swamp water purification process]

◎ Purpose of water purification

· Stagnant lake water causing contamination
· Reduction of self-purification capability of lakes
· Increase of biological activities caused by eutrophic materials generated from the bottom of lakes
· Excessive eutrophication due to increase of contaminants
· Damage of functions of amenity due to increase of foul odors and turbidity
· Efficient and consistent management demanded
· Election of direct water purification processing engineering dependent upon targets of water quality
· Improvement of hydrophilic space functions through employing environment-friendly engineering

◎ Features of technologies

· Shorter stay duration demanding smaller area
· Excellent performance of removing alga, floating materials and odor-causing materials
· Excellent efficiency in removing organic materials and phosphorus contaminant-causing materials
· Long-term lake water purification technology
· Easy operation due to automated process
· Stable treatment with reserved settlement-floatation systems

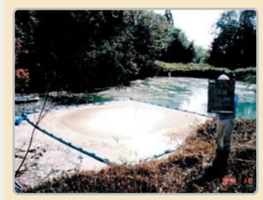
◎ Comparison between technologies

Technology	Dissolved air floatation (non-circulation type)	Oxidation (circulation type)	Rapid coalition settlement filtration (circulation type)	Dissolved air floatation (circulation type)
Advantages	- Excellent treatment efficiency for short period - Excellent performance of floated - Temporary elimination of foul odor	- Strong sterilization - Oxidation of alga and odor	- Easy operation - Excellent settlement force - Combination of blending and coalition	- Excellent performance of floated material treatment - Excellent performance of taste and odor treatment - Excellent treatment efficiency of alga - Small footprint
Disadvantages	- Temporary treatment effect - Reduction of working efficiency due to site treatment - Unpleasantness caused by treatment of lake surface - Difficult recovery of floated sludge	- Side product (THMs) generated - Increase of Clconcentration - Problem of residual ozone - Poor function for organic material removal - Sludge treatment facility demanded	- Reduced removal efficiency of alga - Poor performance of taste and odor treatment - Excessive dose of coalition agents - Reverse cleaning problem upon high load - Sludge treatment demanded - Large area demanded	- Higher power consumption - Sludge treatment demanded
Processing efficiency	- Floating materials: 90% - Alga and odor 85% - Organic materials:70%	- Floating materials : Not feasible of treatment - Alga and odor 80% - Organic materials : Not feasible of treatment	- Floating materials: 85% - Alga and odor 70% - Organic materials: 60%	- Floating materials: 95% - Alga and odor 95% - Organic materials:70%
Required area	None	150%	300%	100%
Cost effectiveness	- High treatment efficiency for short period - Low treatment efficiency for long period - Low operation costs	- Low chemicals cost - Medium system & facility costs - High operation costs	- Medium chemicals cost - High facility (site) costs - Medium operation costs	- Low chemicals cost - Medium facility (site) costs - Medium operation costs
Remarks	○	X	△	◎

Circulation type,

Recirculation,
combined treatment of lake/swamp water and water flowing into lakes

Non-circulation type,

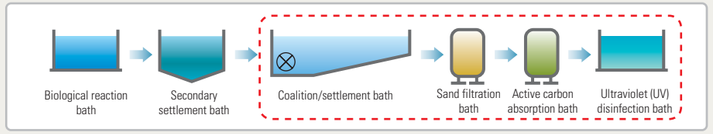


Sewage treatment

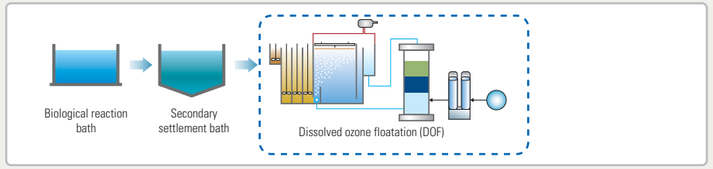
◎ DOF™ PROCESS

●Improvement of sewage advanced treatment process

· Current designed process (--- Process prior to modification)

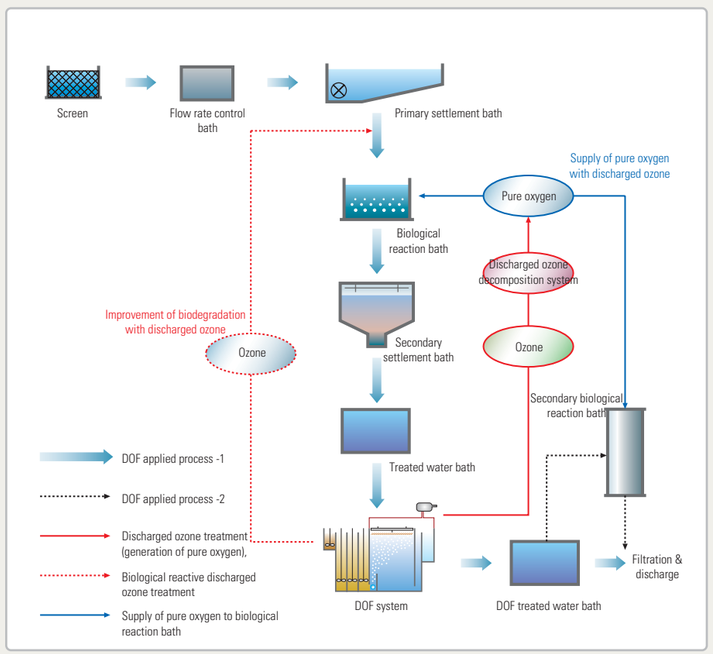


· Modified designed process (--- Process after modification)



●Improvement of sewage advanced treatment process of energy circulation type

DOF pilot plant for validating new environmental technologies



● Efficiency of sewage advanced treatment process

· Analysis of DOF process treatment efficiency for water discharged from the secondary settlement basin at H Sewage Treatment Plant

(Results of validation of new environmental technologies: Environmental Management Corporation)

· DOF process treatment efficiency

Item	Raw Water	Effluent	Removal Rate
BOD (mg/L)	9.0(4.0 ~ 15.4)	1.9(1.0 ~ 3.7)	76.7(56.6 ~ 91.2)%
COD_{Mn} (mg/ ℓ)	10.5(7.8 ~ 13.2)	6.8(4.5~10.8)	35.6(18.3 ~ 44.8)%
COD_{Cr} (mg/ ℓ)	29.3(20.0 ~ 54.5)	20.9(15.0 ~ 32.0)	27.4(7.5 ~ 55.0)%
SS (mg/ ℓ)	5.2(3.2 ~ 8.8)	2.7(1.3 ~ 4.0)	45.4(16.3 ~ 70.5)%
T-N (mg/ ℓ)	7.6(3.2 ~ 12.2)	6.3(2.6 ~ 10.3)	16.0(0.8 ~ 32.2)%
T-P (mg/ ℓ)	0.85(0.25~ 2.38)	0.15(0.04 ~ 0.52)	82.2(68.0 ~ 95.3)%
Color (CU)	25(18 ~ 32)	4(2 ~ 7)	84.1(75.0 ~ 93.3)%
Turbidity (NTU)	2.3(1.0 ~ 4.3)	0.59(0.23 ~ 0.96)	70.0(33.0 ~ 90.0)%
UV-254 (ABS)	0.139(0.098 ~ 0.183)	0.051(0.013 ~ 0.085)	63.9(45.4 ~ 88.8)%
Coliform bacilli (MPN/m ℓ)	316(20 ~ 1,170)	3(0 ~ 31)	99.4(93.0 ~ 100)%
Common bacteria (CFU/m ℓ)	13,537(210 ~ 93,000)	26(0 ~ 78)	99.5(97.2 ~ 100)%

● Ozone consumption efficiency

Item	Max.	Min.	Avg.
Quantity of injected ozone (mg/min)	648	1,692	1,062
Quantity of discharged ozone (mg/min)	3.4	133.2	35.6
contact efficiency(%)	92.1	99.7	97.0

● Efficiency of sewage advanced treatment process

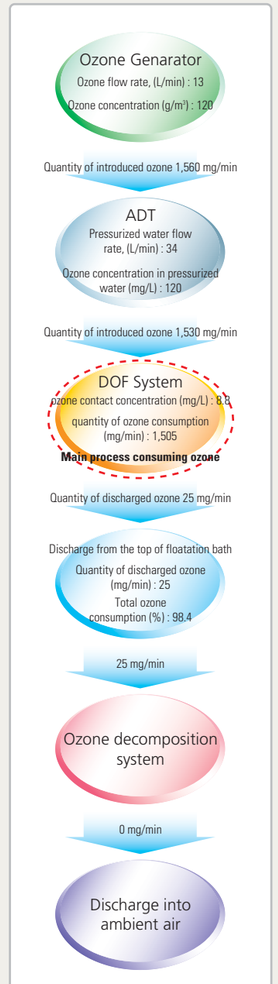
(Results of the in-house testing)

· DOF process treatment efficiency

Item	Raw Water	Effluent	Removal Rate
UV-254 (ABS)	0.164	0.057	65%
Color (CU)	27	7	73%
Turbidity (NTU)	6.95	0.91	87%
SS (mg/ ℓ)	15.4	2.9	81%
COD_{Mn} (mg/ ℓ)	10.8	4.7	57%
T-N (mg/ ℓ)	8.743	5.824	33%
T-P (mg/ ℓ)	0.533	0.043	92%
Coliform bacilli (MPN/m ℓ)	TNTC	1.9	100%
Common bacteria (CFU/m ℓ)	677	0	100%

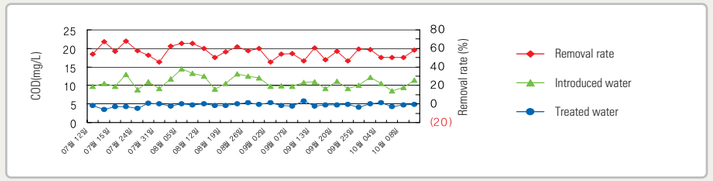
● Ozone Mass Balance

(Results of validation of new environmental technologies: Environmental Management Corporation)

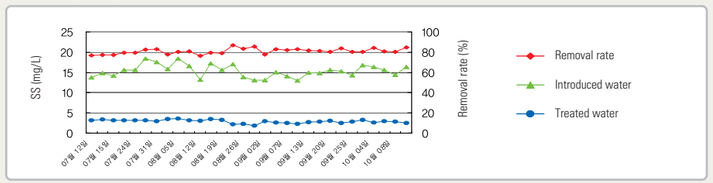


Applications of water-treatment technologies

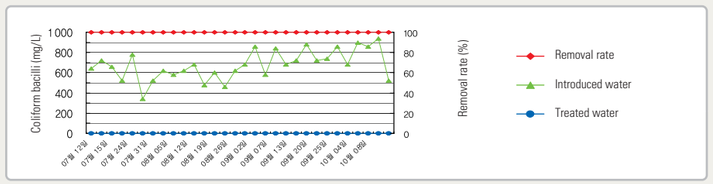
· Chemical oxygen demand (COD)



· Total phosphorus (T-P),



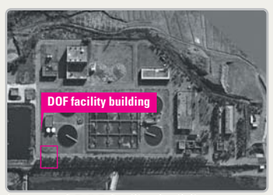
· Count of coliform bacilli



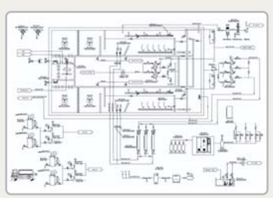
● Case of application of sewage advanced treatment

· Name of construction:
Installation of advanced treatment facilities at Hweya Sewage Treatment Plant (Ulsan City)

· Facility capacity: 32,000 tons/day



layout of DOF facility building at Hweya Sewage Treatment Plant

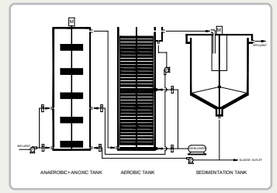


DOF facility P & ID at Hweya Sewage Treatment Plant

◎ MAFAS PROCESS

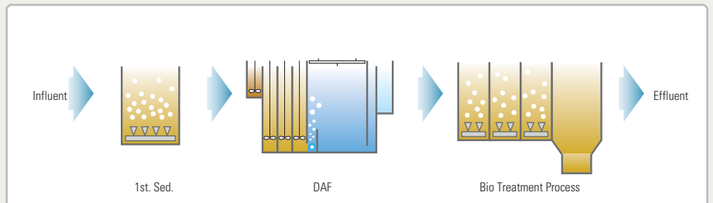
● Overview of process

· Pre-treatment by dissolved air floatation (DAF) process for improving treatment efficiency decomposition-resistant materials.
· Pre-treatment process of sewage advanced treatment process utilizing DAT process.
· Applying sewage and waste water advanced treatment (post-treatment) through recycling treated water
· Process for eliminating floating materials, phosphorus, chromatic materials and odor from water discharged from the secondary settlement basin of raw water treatment process.

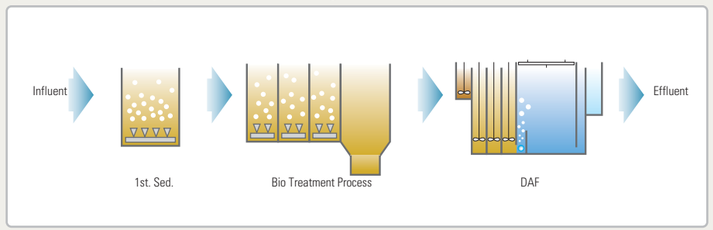


● Configuration of process

· DAF system for pre-treatment of biological treatment process



· DAF system for post-treatment of biological treatment process



● Treatment efficiency of waste water from apartment buildings

Item	Sewage raw water	Biologically treated water	Treatment efficiency
COD_{Mn} (mg/ ℓ)	83	13.8	83%
$SCOD_{Mn}$ (mg/ ℓ)	32	8.6	73%
BOD_{Mn} (mg/ ℓ)	138.9	17.4	87%
$SBOD_{Mn}$ (mg/ ℓ)	59.4	11.0	81%
T-N (mg/ ℓ)	33.67	14.56	57%
T-P (mg/ ℓ)	2.668	0.784	71%

· The data represents average value during the measurement period.
· Raw water Sewage raw water from apartment buildings

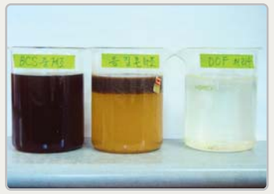
Applications of water-treatment technologies

Treatment of livestock night-soil waste water

◎ DOF-PO2 PROCESS

· Guaranteeing quality water independently discharged from livestock night-soil waste water, concentration decomposition-resistant waste water.
· Total oxidation process (TOP) beyond treatment threshold of unit process.
· Reduction of subsequent processes of complex biological treatment: Improving treatment efficiency and cost effectiveness.

Pocheon Livestock Waste Water Treatment Plant



Results of operation of Pocheon Livestock Waste Water Treatment Plant

Boryeong Livestock Waste Water Treatment Plant

● Treatment of livestock night-soil waste water

· Pocheon Livestock Waste Water Treatment Plant
- Facility capacity: 170m³/day (20-hours' operation/day)
- Facility dimensions: 4m X 4m
- Ozone generation: Electric discharge type (liquefied oxygen)
- Designed water quality

Item	DOF introduced water	DOF treated water	Treatment efficiency
BOD (mg/ ℓ)	207.8	50.0	75.9%
COD_{Mn} (mg/ ℓ)	588.0	87.9	85.1%
SS (mg/ ℓ)	431.7	50.0	88.4%
T-P (mg/ ℓ)	76.6	4.0	94.8%
T-N (mg/ ℓ)	157.5	125.8	20.1%

- Results of operation of Pocheon Livestock Waste Water Treatment Plant

Item	DOF introduced water	DOF treated water	Treatment efficiency
COD_{Mn} (mg/ ℓ)	619.9	63.0	89.8%
SS (mg/ ℓ)	409	22	94.7%
T-P (mg/ ℓ)	27.04	0.35	98.7%
Chromaticity	850(CU)	42(CU)	95.1%
Common bacteria(CFU/m ℓ)	많음	0	100.0%

· Boryeong Livestock Waste Water Treatment Plant
- Facility capacity: 120m³/day (20-hours' operation/day)
- Facility dimensions: 4m X 3.5m
- Ozone generation: Electric discharge type (oxygen generator)
- Designed water quality

Item	DOF introduced water	DOF treated water	Treatment efficiency
BOD (mg/ ℓ)	311.7	75.3	75.8%
COD_{Mn} (mg/ ℓ)	484.9	86.0	82.3%
SS (mg/ ℓ)	392.5	39.4	90.0%
T-P (mg/ ℓ)	57.7	5.8	89.9%
T-N (mg/ ℓ)	119.9	96.8	19.3%

- Results of operation of Boryeong Livestock Waste Water Treatment Plant

Item	DOF introduced water	DOF treated water	Treatment efficiency
BOD (mg/ ℓ)	161	52	67.7%
COD_{Mn} (mg/ ℓ)	641	72	98.8%
SS (mg/ ℓ)	411	10	97.6%
T-P (mg/ ℓ)	126	49	61.1%
T-N (mg/ ℓ)	30	0.5	98.3%

Results of operation of Boryeong Livestock Waste Water Treatment Plant

● Treatment of night-soil waste water

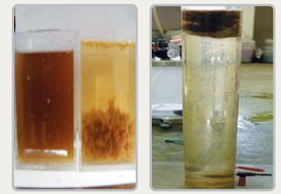
· Pocheon Night-Soil Waste Water Treatment Plant
- Facility capacity: 90m³/day (20-hours' operation/day)
- Facility dimensions: 3.8m X 3.5m
- Ozone generation: Electric discharge type (liquefied oxygen)
- Designed water quality

Item	DOF introduced water	DOF treated water	Treatment efficiency
BOD (mg/ ℓ)	95.6	10.5	89.0%
COD_{Mn} (mg/ ℓ)	216.0	37.5	82.6%
SS (mg/ ℓ)	91.0	12.0	86.8%
T-P (mg/ ℓ)	56.0	5.0	91.1%
T-N (mg/ ℓ)	170.0	52.0	69.4%

- Results of operation of Pocheon Night-Soil Waste Water Treatment Plant

Item	DOF introduced water	DOF treated water	Treatment efficiency
COD_{Mn} (mg/ ℓ)	250	34	86.4%
SS (mg/ ℓ)	256.7	6.2	97.6%
Chromaticity (mg/ ℓ)	666(CU)	20(CU)	97.0%
Common bacteria (CFU/m ℓ)	많음	0	100.0%

▶ Raw water: After night-soil waste water biological treatment process
▶ Treated water: DOF-PO2 process treated water



Pocheon Night-Soil Waste Water Treatment Plant

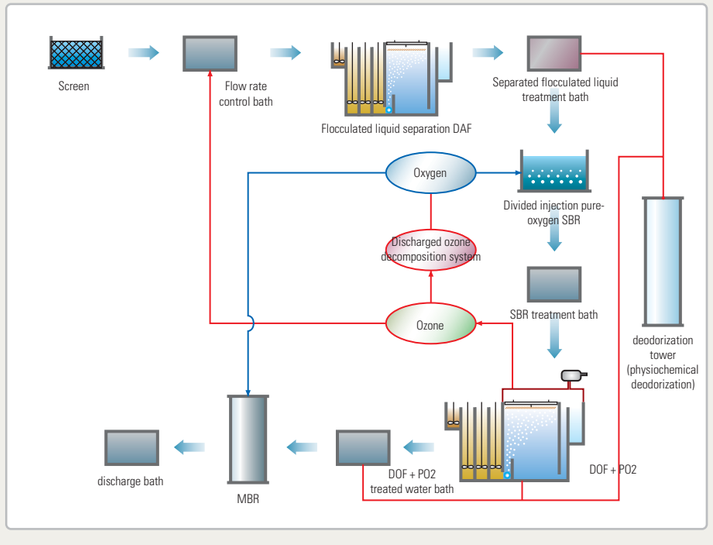
Pocheon Night-Soil Waste Water Treatment Plant

Industrial waste water treatment

● Design and construction of livestock night-soil waste water treatment process combined with biological treatment

· Configuring DAF process as pre-treatment and DOF-PO2 process as post-treatment, and then introducing divided injection pure-oxygen SBR process as biological treatment process for completing full livestock night-soil waste water treatment processes

Technological features	- Discharged ozone generated from the DOF-PO2 process is dissolved to generate oxygen, which is utilized as oxygen source for the biological reaction bath. - Improving treatment efficiency through applying divided injection pure-oxygen SBR technology. - Reduction of blower facility thanks to utilization of oxygen and ozone of high pressure (4~8 kgf/cm²) the PO2 process. - Discharged ozone generated from the DOF-PO2 process is utilized for treating ozone prior to introduction into the biological reaction bath. - Improvement of deodorization efficiency by introducing ozone discharged to the top after ozone pre-treatment into the deodorization tube.
Cost effectiveness	- Reduction of costs of air-supply facility including blower. - Significant reduction of power costs for blower facility. - Reduction of footprint of biological reduction bath through introduction of pure-oxygen process.



◎ PO2 PROCESS

● Treatment of pigment waste water

· Removal of chromatic materials and organic materials (COD) from pigment waste water.

· High ownership costs due to consumption of powder active carbon, and inefficient treatment caused by increase of floating materials.

· Reduction of costs of disposal of powder active carbon, coalition agents and dehydration by introducing PO2 process.

Reaction stay duration(second)	Chromaticity			COD (mg/L)		
	raw water	treated water	Treatment efficiency	raw water	Treated water	Treatment efficiency
40	1,076	74	93.1%	50	33	34.0%
80	910	66	92.7%	48	33	31.3%
160	860	48	94.4%	45	34	24.4%

▶ raw water: Biologic reaction bath treated water, ▶ treated water : PO2 treated water

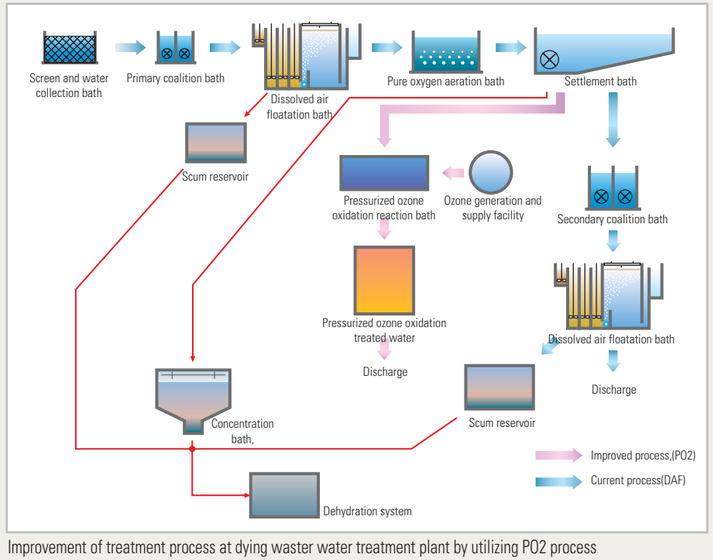
● Treatment of pigment waste water

· Applying the process to the final process of biologic treatment at dying waste water treatment plant.

· Solving difficulties intreatment of decomposition-resistant chromaticity-induced material from discharged water.

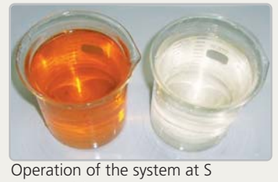
Item	raw water	treated water	Treatment efficiency
Chromaticity	498	35	93%
COD	35.2	20.4	42.0%
SS	11.8	9.8	16.9%

▶ raw water: Biologic reaction bath treated water, ▶ treated water : PO2 treated water



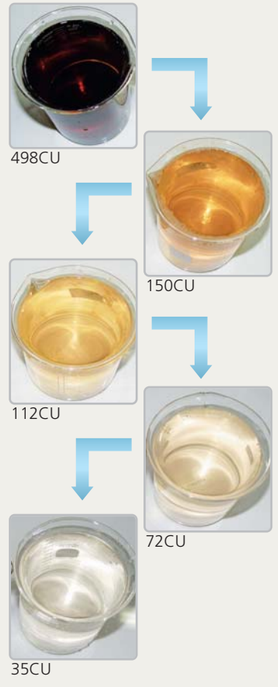
Improvement of treatment process at dying waster water treatment plant by utilizing PO2 process

Installation and operation of the system at S Chemical for treating pigment waste water.



Operation of the system at S Chemical for treating pigment waste water.

Quality of treated dying waste water



Applications of water-treatment technologies

◎ DOF PROCESS

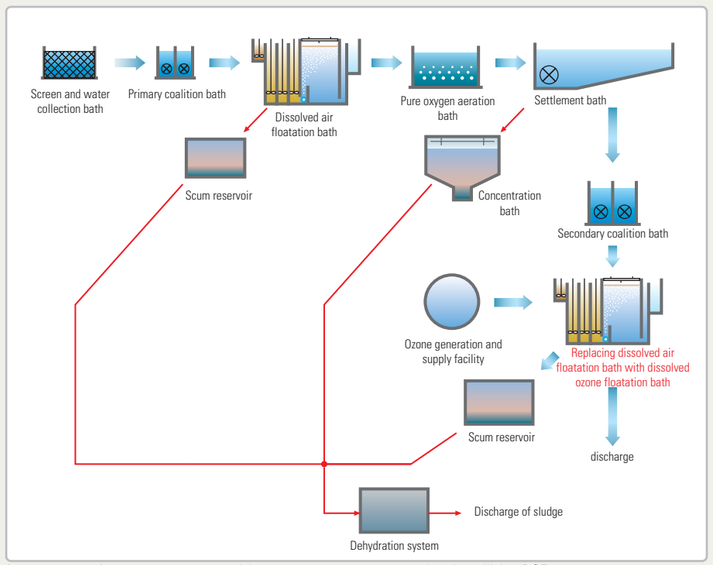
● Treatment of pigment waste water

- Excellent treatment efficiency for decomposition-resistant chromaticity-induced materials in water discharged from dying waster water treatment plant.
- Removal of floating materials and phosphorus components from induced water.
- Improvement of facilities through recycling the current dissolved air floatation processes.

Chemicals	Chromaticity			COD (mg/L)			Ozone supply concentration 15ppm Return rate of pressurized water 20%
	raw water	treated water	Treatment efficiency	raw water	treated water	Treatment efficiency	
A	449	27	94.0%	40	18	55.0%	
B	344	32	90.7%	44	17	61.4%	
C	512	49	90.4%	49	21	57.1%	
No chemical	481	59	87.7%	52	28	46.2%	
Site operated process	477	299	37.3%	52	52	0%	

▶ raw water: Biologic reaction bath treated water, ▶ treated water : PO2 treated water

Chemicals A : 449CU-27CU | Chemicals B : 344CU-32CU | Chemicals C : 512CU-49CU | No Chemicals : 481CU-59CU



Improvement of treatment process at dying waster water treatment plant by utilizing DOF process

◎ MIDAF PROCESS

MIDAF process is a pre-treatment process of the biologic treatment for waste water treatment, and widely employed for separation of flocculated liquid. This process is employed at the final process of biologic treatment for high concentration waste water to remove floating materials and phosphorus components.

● Treatment of livestock night-soil waste water

- Overview of technology

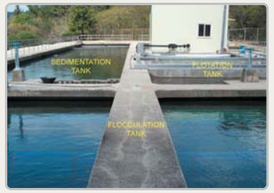
Flocculated liquid separation process for reducing load of floated materials prior to inducing waste water into biologic reaction bath. This water treatment process injects air bubbles into the waste water to rapidly raise plug coalition to the water surface for separating flocculated liquid. This pre-treatment process for flocculated liquid separation is ideal for treatment of livestock night-soil waste water with less floating materials in the waste water.

Technological features	- Maximizing removal efficiency of floating materials through generation of micro-air bubbles. - Removing granular materials (colloid and floating materials) only Prevention of eutrophicated materials for biologic treatment eliminates necessity for carbon source for adjustment of COD/TN ratio. - Guaranteeing stable water quality in spite of large impact load unique to livestock night-soil waste water subject to significant load variation - Preserving operation know-how on optimal coalition conditions. - PLC automation of the entire processes.
Cost effectiveness	- Increased floating efficiency through micro-bubbles reducing consumptionof coalition agents. - No demand for chemicals including surfactant. - Reducing maintenance costs through facility stabilization.
Ease of construction	- Compact design of reaction system demanding small footprint. - Short staying duration demanding smaller facilities comparing to treatment capacity.

Applications of water-treatment technologies

Water purification

● Construction of reforming settlement basin at filtration plant



Reforming settlement basin I to MIDAF

floatation bath of size of one tenth of settlement basin

removal of floated sludge

◎ MIDAF PROCESS

●Water purification treatment process

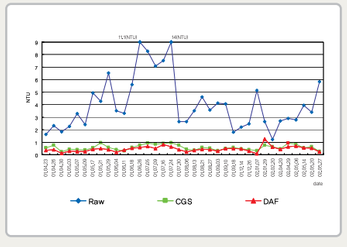
- Flocculated liquid separation process at newly constructed filtration plants.
- Improving treatment efficiency through reforming current gravity-type settlement basin.
- Treatment of materials of low gravity such as alga.
- Ideal for small installation areas of efficient water purification processes.

●Results of operation of filtration plant

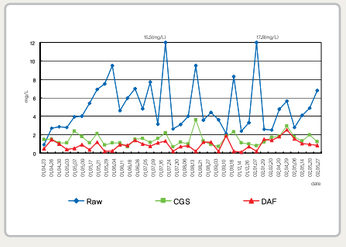
Item	Raw water	Gravity-type settlement basin	DAF
Turbidity (NTU)	3.84	0.93	0.47
SS (mg/L)	5.11	2.59	1.5
Color (CU)	11.5	2.83	0
$KMnO^4$ (mg/L)	10.01	5.662	4.74
UV254 (ABS)	0.069	0.052	0.044
Chlorophyll-a (μg/L)	21.62	3.118	1.495

▶ Raw water: Water flown into blending bath prior to application of chemicals
▶ Gravity-type settlement basin - Effluents from current gravity-type settlement basin
▶ DAF: Effluent from MIDAF replacing settlement basin

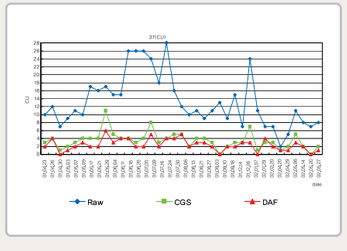
· Turbidity



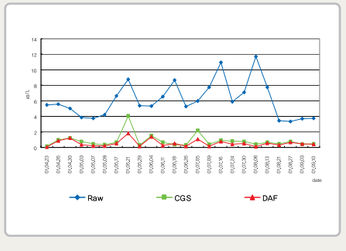
· Suspended Solid



· Color



· Chlorophyll-a



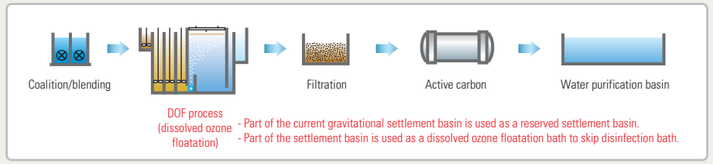
◎ DOF PROCESS

●Advanced water purification treatment process

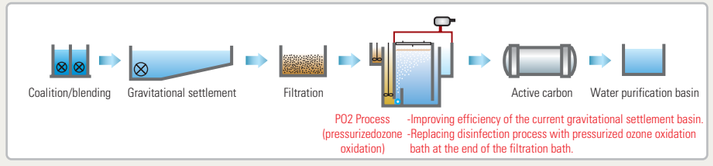
· Current water purification treatment process

· Current water purification treatment process

- Advanced water purification treatment after reforming settlement basin



- Super-high water purification treatment



●Comparison between ozone contact oxidation technologies

Item	Acid radical mode (phase 1 contact)	Dissolved ozone floatation (DOF)
Block diagram	Figure 1.	Figure 2.
Ozone consumption rate (%)	50 ~ 60	90 ~ 97
Overview of technology	· Contact water depth : 3 ~ 3.5m · Bubble size 3 ~ 6mm · Acid radical mode : Plug flow · Application: Typical large capacity	· Contact water depth:Surface load ratio 5 ~ 20m^3 / m^3 -hr · Bubble size: 10 ~ 40μm · Acid radical mode : Specially designed diffuser gusting mode · Application: Typically, all of capacities
Advantages /disadvantages	· Ideal for large-capacity facility · Simple facilities · Low ozone contact efficiency due to large bubble · Excessive discharged ozone due to large bubble	· Ozone facility capacity smaller than aid radical-type ozone contact · Higher ozone consumption efficiency by employing micro-bubbles · Simultaneously removal of some of floating materials in treated water · Smaller discharged ozone because of higher ozone consumption efficiency

●Results of application of process to water purification process

Item	Raw water	DOF treated water	Treatment efficiency
Turbidity (NTU)	4.1	0.7	83.7%
Color (CU)	10	1	90.5%
Consumption of potassium permanganate (mg/L)	8.01	2.91	63.6%
chlorophyll-a	8.405	0.537	92.9%
UV-254 (ABS)	0.084	0.029	66.2%

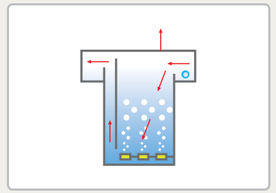


Figure1)
block diagram of acid radical mode

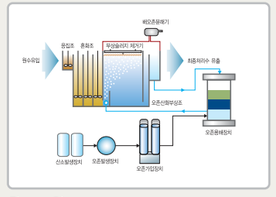
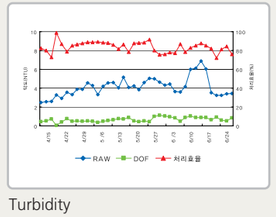
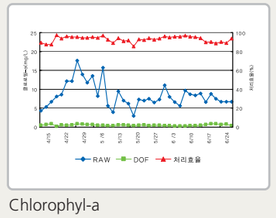


Figure2)
block diagram of dissolved ozone floatation mode



Turbidity



Chlorophyl-a

Environment Technology Consulting

◎ Noise & vibration

· Environmental dispute consulting for various fundamental environmental facilities, and common noise and vibration, and providing measures for reducing level of noise and vibration through environment review and modeling.

◎ Foul odor

· Survey and analysis of VOCs and different foul odor-generating materials, and reduction of them through modeling.

◎ Water quality

· Consulting on water quality analysis and reduction of contaminants.

◎ Natural environments

· Natural water purification, lake/swamp water, river preservation and restoration, and underground water control.

Survey/analysis of water environments	Survey of applicable laws	Site survey	Survey areas Design
- Site survey and measurement - Sampling and classification - Quantitative water quality analysis	- Noise & vibration control act - Water contamination prevention act - Other applicable laws and regulations	- Measurement of noise & vibration - Sampling foul odor materials - Quantitative analysis of foul odor materials	- Filtering - Design - Decoration

- Modeling
- design of reduction ways

- Establishing preventive measures,
- LCC/VE/LCA analysis

REPORT & DISCUSSION

Major Tasks

◎ Survey of noise, vibration, foul odor, and ambient air environments

◎ Modeling of noise, vibration, foul odor, and ambient air environments

◎ Consulting on survey of water environments and preventive measures

◎ Consulting on water treatment process diagnosis and preventive measures, if required

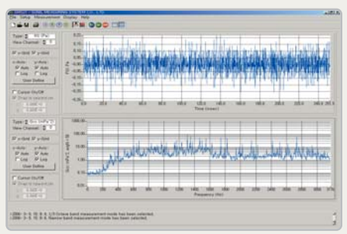
◎ Analysis of LCC/VE/LCA

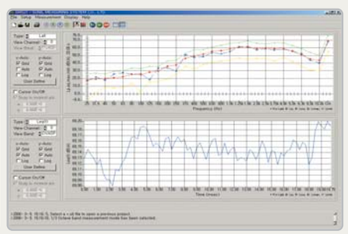
Site survey and modeling results

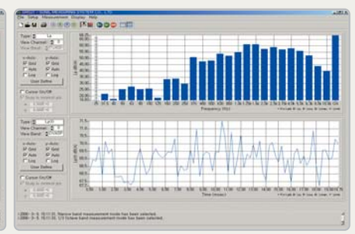
Site survey of environmental noise

Site survey of environmental vibration

Sampling foul odor materials

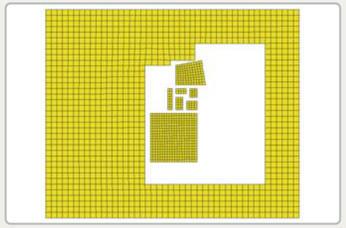




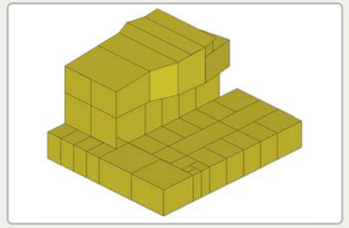


Result analysis of survey of noise and vibration

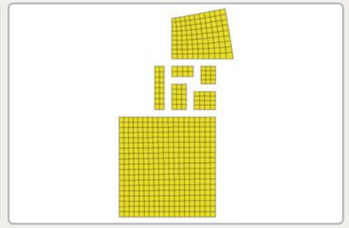
◎ Design of businesses generating noise & vibration



Noise within boundary modeling design

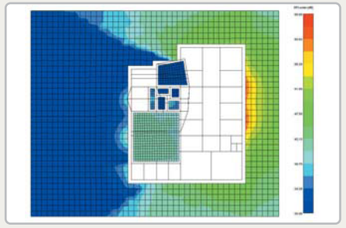


3D rendering of noise within boundaryRoom noise modeling design

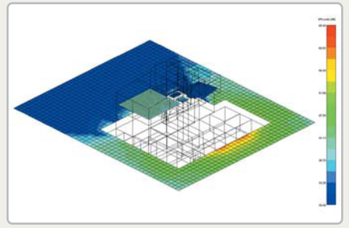


Room noise modeling design

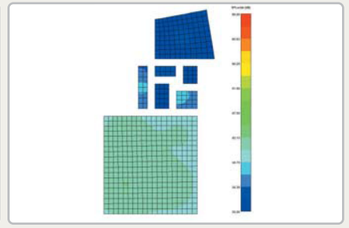
◎ Result of actual measurement and modeling of survey of noise and vibration



Noise within boundary modeling design



3D rendering of noise within boundaryRoom noise modeling design

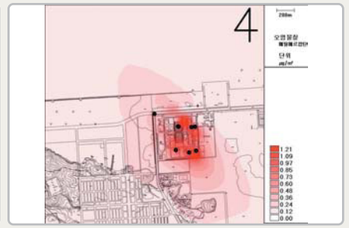


Room noise modeling design

◎ Results of measurement of odor site, and modeling results after preventive measures

Distribution of odor prior to measures for reduction

Distribution of odor after measures for reduction (linear)



Distribution of odor after measures for reduction (planar)

◎ Results of analysis of LCC/VE/LCA cost effectiveness

- Workability
- Stability
- Maintenance
- Planning
- Environmental Aspects
- Economics Aspects
- Facility Cost
- Maintenance Cost
- Total LCC (35years NPV, billion won)
- Alternative 1
- Alternative 2

Records of Applications

MICHIGAN TECHNOLOGY

Drinking water

Construction	Applied technology	Development	Facility capacity (tons/day)
Filtration facility renovation at Bangeojin water work, Ulsan	MIDAF	Shutdown	6,500

Domestic Wastewater

Construction	Applied technology	Development	Facility capacity (tons/day)
Advanced Treatment Plant at Hweya in Ulsan	DOF	Under operation	32,000
Advanced Treatment Plant Hwayang in Cheongdo	DOF	Under operation	7,600
Advanced Wastewater Treatment Plant for Reuse at Cheongbuk in Pyeongtaek	DOF	Under operation	2,700
Advanced Wastewater Treatment Plant at Munsan in Jinju	MIDAF	Under operation	7,100
Advanced Wastewater Treatment Plant at Sabong in Jinju	MIDAF	Under operation	2,500
Advanced WAstewater Treatment Plant at Undong in Busan New Port	DOF	Under operation	8,000
Sewage Treatment Plant at Seocksu in Anyang	MIDAF	Under operation	13,000
Water recycling facility at Yangsan WWTP in Yangsan	DOF	Under construction	22,000
Phosphorus removal system at Kijang WWTP in Busan	MIDAF	Under construction	13,500

Industrial wastewater

Construction	Applied technology	Development	Facility capacity (tons/day)
Advanced wastwater treatment plant of industrial complex at Wolnong in Paju : 1st plant	DOF	Under operation	9,000
Advanced wastewater treatment plant in Jeongchon	MIDAF	Under operation	2,250
Advanced wastewater treatment plant of industrial complex at Wolnong in Paju : 2nd plant	DOF	Under operation	8,000
Advanced wastewater treatment plant of agricultural & industrial complex at Gokyung in Youngcheon	MIDAF	Under operation	150
Advanced wastewater treatment plant in parking station of Honam rapid train, Gwangju	MIDAF	Under operation	180
Advanced wastwater treatment plant of industrial complex at Sinpyung in Pocheon	MIDAF	Under operation	19,350
WWTP in industrial park at Weolnae in Yeosu	MIDAF	Under operation	70,000
Advanced Wastewater Treatment Plant of PPEC in Eumseong	MIDAF	Under operation	1,500
National WWTP (east region) in Kyungsan	MIDAF	Under operation	100,000
WWTP of CJ Foodville in Eumseong	MIDAF	Under construction	500

Livestock night-soil wastewater

Construction	Applied technology	Development	Facility capacity (tons/day)
Advanced treatment plant of public livestock night-soil wastwater in Pocheon City	DOF-PO2	Under operation	170
Advanced treatment plant of public livestock night-soil wastwater in Boryeong City	DOF-PO2	Under operation	120

Lake

Construction	Applied technology	Development	Facility capacity (tons/day)
Dongtan(2) district water cycle system	MIDAF	Under operation	16,000

Environment consulting

Construction	Project	Development	Remark
Services of technology diagnosis of construction project, measurement of environmental quality and computing analysis the Second Sewage Treatment Plant of Osan, and mea	Environmental quality measurement Computing analysis	2004. 10. 11	KNT
Services of fundamental design of the construction of the second sewage treatment plant of Osan	Survey and analysis of soil contamination	2004. 11. 01	GS Construction
Services of execution design and process design of construction of the second sewage treatment plant of Osan	Review and testing entire processes	2005. 04. 28	GS Construction
Services of fundamental design of construction of relay pumping station for sewage pipe BTL project of Masan	Survey and modelingof odor	2005. 08. 12	Geonhwa Engineering
Services of survey and analysis of fundamental design of turn-key construction for advanced treatment of the sewage	Process diagnosis and simulation	2005. 08. 23	Bugang Tech
Services of T/K fundamental design of construction of automatic collection facility in Soha, Gwangmyeong	Ambient air modeling Measurement of noise and odor LCC/VE/LCA	2005. 08. 26	Yooshin Corp
Services of fundamental design of expansion of the sewage treatment plant (region II) at upstream of Namgang Dam	Survey and modeling of noise/vibration	2005. 12. 26	Geonhwa Engineering