LUBRICATION MANAGEMENT PRODUCTS TO REDUCE CARBON EMISSIONS (ESG) AND IMPROVE EQUIPMENT OPERATIONAL RELIABILITY

(LUBRICATION MANAGEMENT IMPLEMENT PRODUCT)

Intelligent choice for the Earth and the future LubricationPlus Purifier.
Facility reliability improvement Earth environment protection.



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LUBRICATION PLUS

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REMOVE AND DETECT AND MANAGE CONTAMINANTS (PARTICLES, WATER, VARNISH) THAT CAUSE EQUIPMENT FAILURE.

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ESG

Expected Impact and Carbon Neutrality



01

Carbon Neurality

CO_2

- Extending lubricant life
- Lubricant regeneration

ESG Management

- Waste reduction
- Environmental protection

Failure Prevention

- Equipment failure prevention
- Improving operational reliability

Lifetime Extension

- Waste reduction
- Environmental protection

02

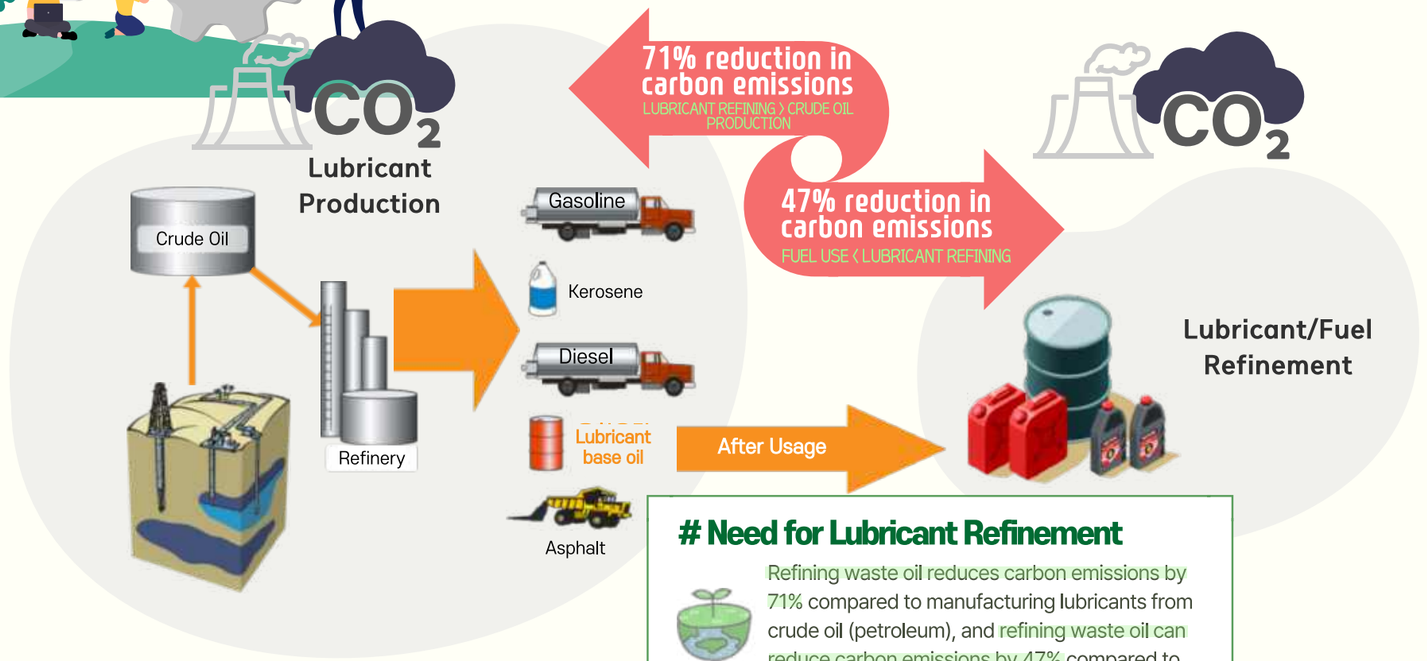
For the planet and your future
LubricationPlus's Refiners are a smart choice!

Improve equipment operational reliability
Protect the planet



Expectations for Using Refiners

Carbon Neutral and Lubricant Refinement



 # Need for Lubricant Refinement

Refining waste oil reduces carbon emissions by 71% compared to manufacturing lubricants from crude oil (petroleum), and refining waste oil can reduce carbon emissions by 47% compared to using it as fuel.

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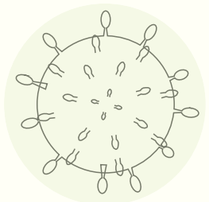
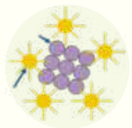
Causes of Lubricant Degradation (General Industry vs. Power Generation)

* General industry: refineries, petroleum, steel, cement, etc. - Contamination



Contamination

- Particle contamination (SAE, ISO, NAS)
- Water contamination (ppm)



Additive Consumption

- Ruler (antioxidant remaining level)
- RPVOT (Oxidative life stability)
- MPC (Varnish)



Oxidative Degradation

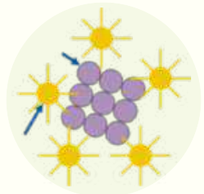
- Viscosity
- Acid value
- Demulsibility
- Foaminess
- MPC







* Power generation: oxidation, loss of additives



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- Ruler (antioxidant remaining level)
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Oxidative Degradation

- Viscosity
- Acid value
- Demulsibility
- Foaminess
- MPC



Contamination

- Particle contamination (SAE, ISO, NAS)
- Water contamination (ppm)

#01. Cause of Degradation?

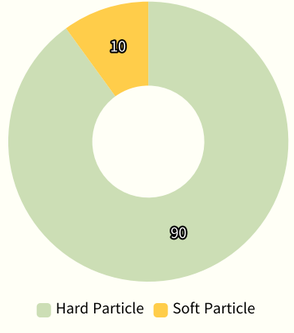
In the general industry, lubricants are replaced within one or two years, so contamination is mostly a problem rather than additive consumption or oxidative degradation. Most of the particles are hard particles. (Physical contamination)

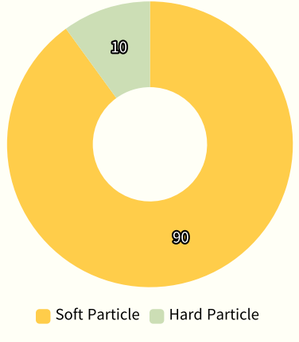


#02. Particle Distribution

Most of the particles are external ingress contaminants, wear particles, in other words, it is a hard (solid) particle. It is necessary to block external inflow and prevent wear.
Hard particle removal is required.







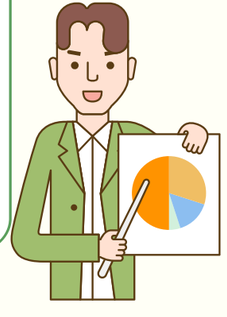
#01. Cause of Degradation?

In the power generation industry, the concept of substitution rather than total replacement of lubricants is used, and most of the varnish problems are caused by soft particles due to oxidative degradation and additive consumption rather than solid particle contamination due to long-term use for more than 10 years.



#02. Particle Distribution

Most particles are oxide particles, or soft particles, resulting from additive oxidation and base oil oxidation. Particle count may vary with temperature. It requires online analysis. Soft particle generation prevention and removal is required.



Lubrication Plus SOLGE

Integrated Purifier(TOMs-F)

TOTAL Oil Management System (TOMs-F)

- **"Excellent Procurement Product" registered by Korean Goverment**
- **Particle/Water/Varnish/Acid removal**
- **Oil Condition Monitoring**



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▪ Product Features

1. Removal of Particle Contaminants
- Perfect removal of fine solid particles (absolute filtration with a beta ratio of 4,000 or more, high-performance filter applied)
- Removal of fine carbides of sub-micron (Electrostatic filter)

2. Water Removal
- Removes all three types of water (free, emulsified, dissolved)
- Excellent removal and prevention of Water for EHC Oil (phosphate ester oil)

3. Degradation by-products removal
- Sludge Varnish Removal
- Soluble Contaminant Removal
- Acid removal

4. Real-time oil condition monitoring
- Cleanliness level
- Water
- Color (Optional)



▪ Product Specifications

Model	Flux(LPM)	Size(mm)	Item Number	Note
TOMs-F-T-01-52	52	1,000×1,490×1,687H	23774145	T: General mineral oil (turbine oil)
TOMs-F-T-M-52	52	1,000×1,490×1,687H	23774147	PE: Phosphate ester oil
TOMs-F-PE-01-34	34	900×1,330×1,457H	23774149	01: Without monitoring
TOMs-F-PE-M-34	34	900×1,330×1,457H	23774150	M: With monitoring
TOMs-F-T-KDHC-42	42	1,000×1,490×1,690H	23774151	* The last figure is flow rate (lpm)

Water Removal Purifier (EX-DRI)

Excellent Dry

- **New Product (NEP) designation**
- **Innovative product**
- **Trial purchase product**
- **Available for public sector contracts**
- **Water removal of high viscosity oil**



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▪ Product Features

- Can remove all 3 types of water (free, emulsified, dissolved)
- Can remove fine solid particles by applying a microfiltration filter
- Excellent Water removal for high-viscosity oil (Existing purifiers cannot be applied to high-viscosity oil)
- Water can be removed without loss of additives
- The equipment is simple with few failures
- Low consumables cost
- Water contamination status can be monitored in real time (Optional)
- Can quickly remove large amounts of free water (Optional)
- Can remove sludge and varnish (Optional)



▪ Product Specifications

Model	Flux(LPM)	Size(mm)	Item Number	Note
EX-DRI-10	10	1300x900x1650H	24206648	CO : A large amount of free water removal VR : Sludge & varnish removal
EX-DRI-35	35	1715×1000×1650H	23858227	
EX-DRI-50	50	1715×1000×1650H	23858228	
EX-DRI-CO-35	35	1640×1250×1650H	23858229	
EX-DRI-VR-35	35	1640×1250×1650H	23858230	
EX-DRI-CO-50	50	1640×1250×1650H	23858231	
EX-DRI-VR-50	50	1640×1250×1650H	23858232	

Water Removal Purifier (EX-DRI)

Excellent Dry

- New Product (NEP) designation
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- Trial purchase product
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▪ Comparing Products





Category	EX-DRI	Vacuum Dehydrator
Main Components	- Nitrogen Purging Module - Rotating Disk Module - Feeding Motor & Pump	- Vacuum Pump - Vacuum Valve - Oil Heater - For Transfer Motor & Pump
Features	- All of free, emulsified and dissolved Water can be removed - Applicable to high viscosity oil - Less failure factors and excellent durability - No risk of loss of additives - Can remove solid particles	- All of free, emulsified and dissolved water can be removed - Can remove dissolved gas - Can remove solid particles - Additive volatilization probability - A lot of possible failures - Can not apply high viscosity oil - Possibility of oil degradation by heating
Remark	* After Laundry, there are dehydration and drying to remove Water from the fabric. Dehydration is a method of squeezing out water by applying physical force, and continuous use may damage the fabric. However, the drying method completely removes Water without damaging the fabric. Ex-Dri adopted the drying method, whilst vacuum dehydrator adopted the dehydration method.	

Water Removal Purifier (Flocculation Dehydration)

Fast Large Cost Unit

- **Purify large amount of water**
- **For turbine oils, compressor oils, and fuel oils**
- **Rapid separation of free water**



Lubrication Plus SOLGE

▪ Product Features

- Rapid removal of large amounts of water (free water separation)
- Fine solid particles can be removed with microfiltration filters
- Applicable to systems in production or operation
- Water removal without loss of additives
- Simple equipment and fewer failure points
- Low cost of consumables
- Equipped with sampling port before and after purification (easy sample collection)
- Can refine diesel fuel oil
- Can be made explosion-proof



▪ Product Specifications

Category	Detail	Note
Pump Capacity	8,15, 35,42,70,212 LPM	Capacity negotiable
Motor	1.5kw ~ 3.7kw, 440V,220VThree phase, single phase selectable	Power specifications negotiable
Filtering	- 1'st : Fine Filtration Particle Removal Filter - 2'nd : Coalesce & Separator Filter	Selectable filter filtration process Filter quantity and configuration can be adjusted
Features	- High efficiency microfiltration particle filter (beta rate 4,000) - All SUS Housing (depending on model) - Equipped with leakage sensor - Explosion-proof model available - Portabe type production (fixed type also available) - Large capacity processing system available	Custom specification models can be built to meet customer needs

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Water Removal Purifier (Flocculation Dehydration)

Fast
Large
Cost Unit

- Purify large amount of water
- For turbine oils, compressor oils, and fuel oils
- Rapid separation of free water



▪ Water Removal Principles



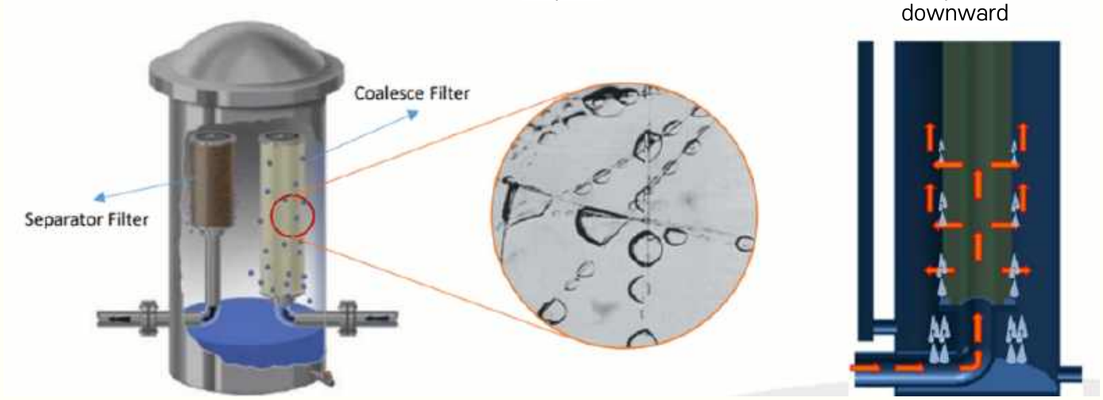
Water droplet adsorption



Aggregate and grow droplets



Separate aggregated droplets downward



▪ Free Water Discharge



▪ Application Examples

Before & After Purification



Hose before & after filter



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General Oil Purifier (OFU)

Oil Filtration Unit

- **Compact design**
- **Simple operation**
- **Excellent purification performance**
- **Low purchasing cost**



▪ Product Features

- Fitted with high-performance, high-efficiency absolute filter element with beta ratio over 4,000
- Various filter sizes available (0.9, 1, 3, 6, 12, 25㎛)
- Real-time monitoring of cleanliness level/water/oxidation (degradation) is possible by installing an online sensor (optional)
- Easy to move and handle with ergonomic design
- Control panel mounted for easy operation and monitoring
- Water can be removed by installing a Water filter



▪ Product Specifications

Category	Detail	Note
Pump Capacity	8, 15, 21, 35, 42, 70 LPM	∗ Can be customized to the customer's requirements ∗ Explosion proof type available
Motor	- 220V (Single phase, three phases), 380,440,480V (three phases) - 0.75, 1.5, 2.2kw	
Housing	- Single, Dual - Serial, Parallel	
Filter Element	0.9, 1, 3, 6, 12, 25, 75㎛	
Optional	- Magnetic Filter - Particle Counter - Water Sensor - Iron Sensor	

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Compact Purifier (Panel Unit)

Panel Unit

- **Compact Size**
- **Powerful Purification**
- **Easy to move**
- **Convenient Filter Replacement**



▪ Product Features

- Indicate filter replacement timing through differential pressure indicator
- Rremoval of both particle and Water with the dual filter system (Can select filter)
- Fitted with a microfiltration filter with beta rate of 4,000 or more
- Can select particle filter of 1, 3, 6, 12, 25㎛ and Water filter
- Wheels available for transport
- Requires small space for installation



▪ Product Specifications

Category	Detail	Note
Pump Capacity	8, 15, 21 LPM	∗ Can be customized to the customer's requirements ∗ Explosion proof type available
Motor	- 220V(single phase, three phases), 380,440,480V(three phases) - 0.75kw, 1.5kw	
Housing	- Single - Dual in serial	
Filter Element	9" Filter (0.9, 1, 3, 6, 12, 25, 75㎛)	
Size	About 520(L) ∗ 580(W) ∗ 1044(H)	

Purifier With Cooler (Cool-F)

Cooling Filtration System

- **Both cooling and purification possible**
- **Can apply for high viscosity oil**
- **Various filters available**
- **Recommend for harsh environment application**



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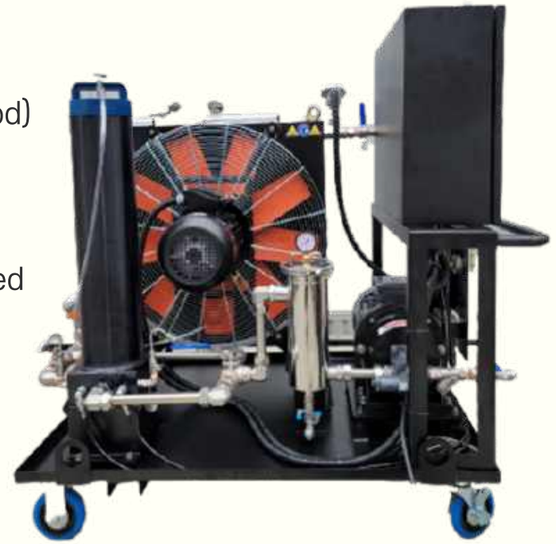
▪ Product Features



- Can remove fine ferrous wear particles (high-performance magnetic rod)
- Washable and reusable mesh filter
- Microfiltration filter (Bypass possible)
- Rapid oil temperature drop by built-in large sized cooling fan
- Can apply in harsh industrial sites due to simple operation and enhanced durability
- Safe operation with oil leak sensor and differential pressure switch
- Easy to move by solid cast
- Applicable to high viscosity oil (~ 680cSt)

▪ Product Specifications

Category	Detail	Note
Pump Capacity	8,12,21 LPM	Can adjust capacity
Motor	2.2kw, 220V (three phases), 6 pole	Can adjust power specifications
Filtering	- 1'st : 200 mesh + Magnetic rod - 2'nd : 25μm Microfiltration filter (beta ratio 4,000)	Can adjust filtrartion specification
Cooling Fan	- Motor : 2.2kw 220V three phases - Port Size : PF ½" - Maximum Flow Rate : 350 LPM	* Can be customized to the customer's requirements
Safety Device	- Leak Sensor - Differential Pressure Switch - Thermometer	
etc	- Fitted with cast for movement - Microfiltration filter bypass available - All SUS pipe	

Oil Fill/Drain/Refine Systems (FDF)

Filling Drain & Filtration

Lubricant Storage/Fillage/Drainage Refining



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▪ Product Features

- New oil refining filling possible
- Used oil refining storage possible
- Quantitative supply (with oil meter)
- Quickly drain used oil
- Equipped with precision filtration system (beta rate >1,000)
- Equipped with safety operation devices such as leakage sensor and differential pressure switch
- Easy to move due to solid casting
- Precision filtration dehumidification type Air Breather applied
- Refining



▪ Product Configuration

- Oil Storage Tank
- Microfiltration Filter
- Transparent Housing Magnetic Filter
- PreSet Oil Meter
- Precision FiltrationWet Air Breather
- Motor & Pump
- Other Safety Devices

▪ Product Specifications

Category	Detail	Note
Pump Capacity	8,12,21 LPM	Capacity negotiable
Motor	1.5kw, 220V three-phase, 4-pole	Power specifications negotiable
Filtering	- 1'st : Transparent housing Magnetic Filter (optional) - 2'nd : 6 micron precision filter (beta rate 1,000)	Optional filter filtration process
Tank	- Inspection Window - Rheometer - Precision Filtration Dehumidification Air Breather - All SUS 304	* Customization available
Safety Features	- Leak sensor - Differential pressure switch - Manometer	
Others	- Cast attachment for moving - Electrical panel for operation - All SUS Piping	

Oil Mist Removal System (Oil Mist Separator)

Oil Mist Separator

- **Environmental protection**
- **Reduce lubricant usage**
- **Mist removal**



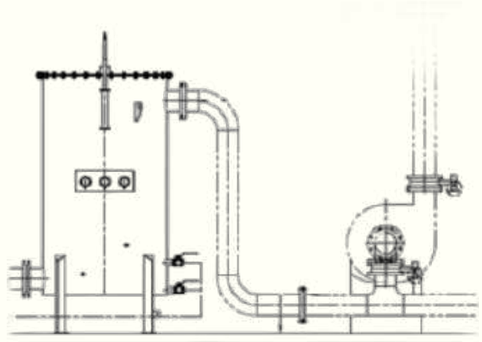
▪ Product Features

- Remove mist from turbine or compressor tanks
- Each component is made of materials with strong compatibility with lubricants and water to ensure durability
- Developed as a national task to prove performance and durability
- Flexible application as it can be designed and changed to meet field conditions



▪ Product Specifications

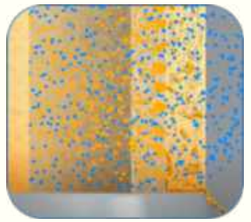
- Design and build to site facility specifications



▪ Mist Removal Order

- Flow is formed in the In to Out direction
- Air passes through and oil mist agglomerates on the filter
- The agglomerated mists get tangled together
- Mists become larger in size
- The enlarged mists return to the Tank





▪ Air

▪ Oil Mist

▪ Research and Development Certificate



Module Type Air Breather (MBB)

Magic Block Breather

- **Preventing external contaminants from entering**
- **Preventing external water ingress**
- **Innovative product**
- **Outperforms other manufacturers**



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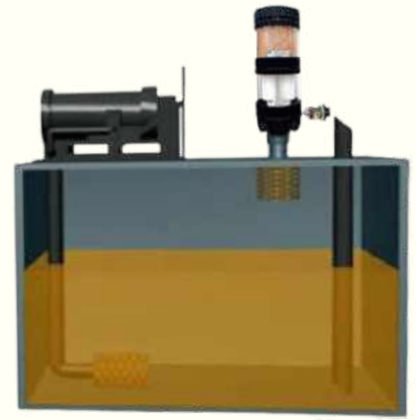
▪ Product Features

- Can remove a large amount of fine particles (3 ㎛ pleated filter applied)
- Water removal by silica gel
- Direct discharging air via check valve extends the life span of the water module
- Available in various sizes (module assembly)
- Can replace the module that have reached the end of their lifespan
- Can identify replacement time of water module by changed color silica gel from Orange → Navy Blue
- Applied silicagel non-harmful to human body



▪ Product Specifications

Model	Size	Amount of SilicaGel	Aeration	Division
PSWS-XI	256/130	360	550	
PMWM-XI	336/130	620	550	
PSWX-XI	175/130	N/A	1,415	
PMWX-XI	215/130	N/A	1,086	
PXWS-XX	175/130	360	550	
PXWM-XX	215/130	620	550	
PXWL-XX	301/130	1,400	550	
M3-MV	181/92	420	200	
M3-SV	134/92	200	220	
M3-MX	160/90	420	250	
M3-SX	104/90	200	250	

Connection : 1" Female PF
Particle Filter : 3㎛

* P/N Check

- P : Particle Module
- W: Water Module
- S : Small
- M : Midium
- L : Large
- I : Differential Pressure Indicator
- V : Built-in Check Valve
- M3 : All-in-one

Lubrication Plus SOLGE

ESG

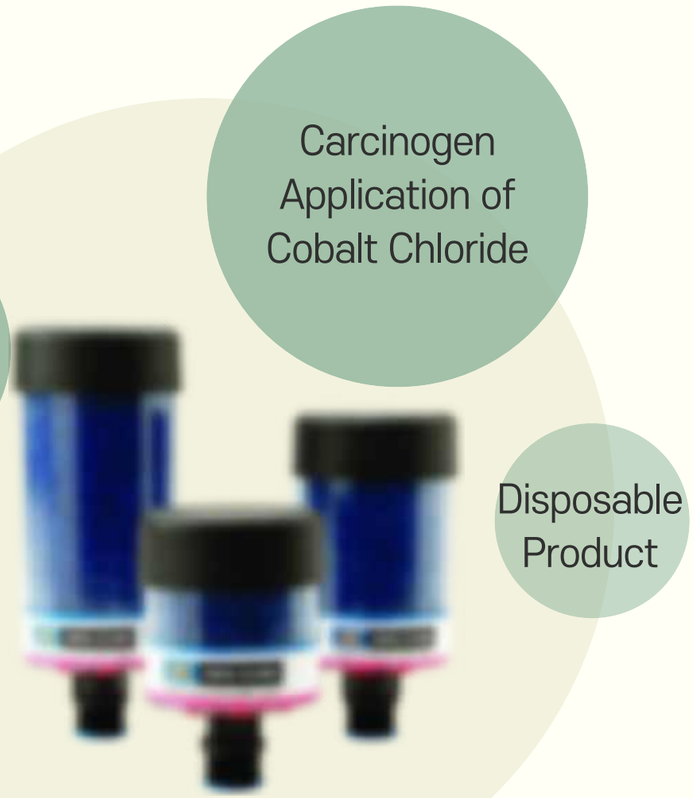
Magic Block Breather

"SOLGE for Client Success"

Choose the MBB Air Breather from LubricationPlus, certified by the South Korean government for performance and innovation



- Harmless Silica Gel
- Designed and Produced in Korea
- Company specialized in Lubrication Management



Medium & Large Module Type Air Breather



Air-Intake
(Check Valve)

Water Removal
Module

Particle Removal
Module

Differential
Pressure
Indicator

Air-Outlet
(Check Valve)



PMWM-XI



PXWL-XX



PXWM-XX



PMWX-XI



Hydraulic System Tank



Heavy Equipment Manufacturers



Hydraulic System Tank



Cement Company Bearing Housing

M3 Medium Sized Air Breather

M3 Breather Applications

We recommend to install the M3 air breather when encountering difficulty to install MBB breather due to small space on site, and it can be applied to hydraulic and lubrication facilities where the air flow of the facility does not exceed 550 LPM.


M3-MV


M3-SV


M3-MX


M3-SX



Motor Manufacturer Storage Tank


Ropeway Gearbox


Chemical Company Gearbox


Power Plant Hydraulic System

M2 Small Sized Air Breather

M2 Breather Applications

M2 (Micro Micron) Breather provides optimal performance for the equipment with low flow or oil bath type equipment with a lot of dust scattered around.
The M2 (Micro Micron) Breather can extend the life of equipment and oil by preventing the penetration of micron-sized contaminants with its small micro size.

Chemical Company Installation Case













M2 Small Sized Air Breather

∗ Robust housing made of sturdy and shock absorbing engineering plastics



Connection part
Easy installation

∗ Particle ingress control
∗ 1 micron filter element



Water Control
Prevents water permeation by using hydrophobic filter media

▪ Product Features

- Fine filtration for particles of 1 micron or bigger
- Sealed by O-ring, no additional sealant is required
- Durable, corrosion-resistant body (nylon)
- Adopted hydrophobic filter media to prevent Water penetration in outdoor facilities or water or water spray environments
- Prevent environmental pollution and oil loss by preventing oil mist generation
- Recommend to replace vent plug with M2 air breather

▪ Product Specifications

Division	Detail
Part.No	SE-M2-1
Size	Ø45 ∗ 35(H)
Connection Size	3/8”(PF)
Operating Temp.	-40℃ ~ 100℃
Flow Rate	65.1 L/Min @1psig
Filtration	1㎛ media (Hydrophobic material)
Housing Material	Engineering plastic

Multipurpose Adapter (Multilube Adapter)

Multi Lube Adaptor

- **Sampling point**
- **Tablet return point**
- **Air breather connections**



▪ Product Features

- Sampling Port : Allows homogeneous oil samples to be taken at a constant location
- Quick Coupler : Oil can be filled and refined under sealed conditions
- Equipped with precision filtration dehumidification breather
- Differential pressure indicator : Check the life of the air breather



▪ Product Specifications

Category	Detail
Product number	SMLA2S100
Size (mm)	112(H) * 77(OD) Excludes Breather and Piping
Material	- Body : Aluminum - Tube : SUS304 - Differential pressure indicator : Acrylic - Sampling Port : Galvanized Steel
Configuration	- Adaptor Body - Microfiltration Dehumidification Breather - Quick Coupler - Sampling Port - Differential Pressure Indicator





Motorized sampling pump (EZ-SAM)



Dry Gas Purging System (GooD-N / GooD-A)

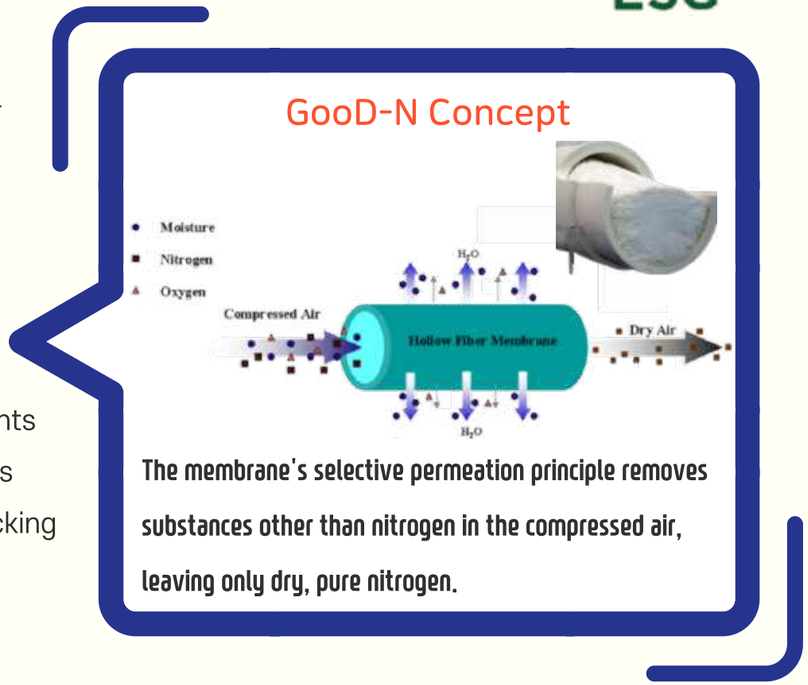
Great Water Dryer

- Dry nitrogen and dry air generation
- Semi-permanent lifespan
- Low maintenance costs



▪ Product Features

- Generate a continuous stream of dry gas (nitrogen or air) to enter the reservoir
- Can use regular utility air without instrument air
- Continuous operation controls the introduction of external contaminants during equipment operation
- Removes internal water
- Semi-permanent life with no rotating parts and few failure elements
- Low maintenance cost with only shear filters as consumable parts
- Significantly reduces oil oxidation and delays deterioration by blocking oxygen (GooD-N model)
- Extends life of breather desiccant when used in conjunction with existing dehumidifying Air Breathers



▪ Product Specifications

Category	GooD-N(fixed)	GooD-A(fixed)	GooD-N-P(movable)
P/N	SGD-N	SGD-A	SGD-N-P
Generated Gas	Dry Nitrogen	Dry Air	Dry Nitrogen
Dew Point (℃)	Max - 60	Max - 40	Max - 60
In/Out	1/2" PT		
Size (mm)	450(D) * 175(D) *985(H)	340(D) * 175(D) *700(H)	645(D) * 500(L) * 1160(H)
Air Consumption (@100psi)	118LPM	14.2L/Min	118LPM
Nitrogen Concentration (@100psi/21℃)	> 97%	N/A	> 97%

ESG

Water Detection Emitter (WATECTOR)

Bottom Sediment & Water

- **Free Water Intrusion Detection**
- **Visually inspectable**
- **Freeze protection system (double structure)**
- **Almost no space restrictions**



▪ Product Features

- Easily detect water ingress into lubricants
- Free water can be separately drained
- Visible lubricant degradation (transparent housing)
- Can be installed in narrow spaces (vertical, horizontal optional installation)
- Equipped with freeze protection function (double glazing system)
- Iron wear can be removed and visually inspected (built-in magnet)



Vertical installation



Horizontal installation

▪ Product Specifications

Category	WATECTOR
Product Numbers	NFW2019
Connection	PT ½”
Size (mm)	80 (H) * 45 (OD) excluding connection nipple and valve
Material	CoPolyester(Body)
Structure	Double Glazing, Air Vent Magnetic Rod, Drain Valve

Applicable Locations

- Cooler
- GearBox
- Reservoir
- Oil Tank
- Bearing Housing

Lubrication Plus SOLGE

Stereometer (3D X-Vision)

3D
X
Vision

- Checking the correct oil level
- Check for oil bubble issues
- Multiple options
- Safe construction

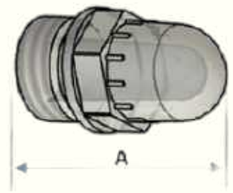


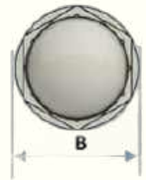
▪ Product Features

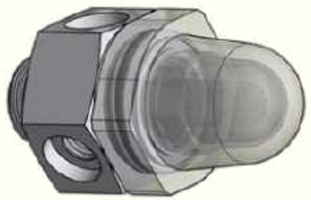
- Accurate oil level viewing from various angles
- Multifunctional ports: sampling port, wear capture (optional)
- Minimizes the possibility of leakage (double transparent window)
- Easy to clean
- Chemical and shock resistant
- Patented product (No.10-1539025)



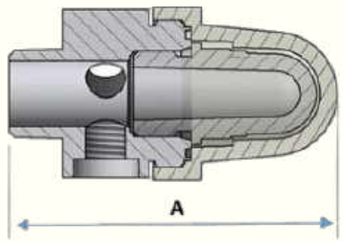
General Type

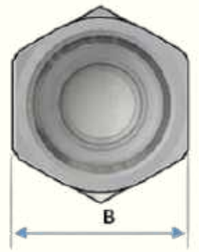






Multifunctional Type





▪ Product Specifications

Model Name		Components	Connector	Size(mm) A * B	P/N
General Type	Single Pane	Inner Window	½" NPT	44.5 * 25	XV0500NT
			½" BSPP	44.5 * 25	XV0500BP
			¾"NPT	50.5 * 42	XV0750NT
			¾" BSPP	50.5 * 42	XV0750BP
Multifunc-tional Type	Dual Pane	Adapter + Inner Window + Outer Window	1"BSPP	83 * 38	XV1000D
			1½"BSPP	83 * 38	XV1500D
	Special Type	Adapter + Single or Dual Pane + sampling port (optional) + magnetic rod (optional) + copper rod (optional)	1", 1½" (customizable)	83 * 38	Discuss

ESG

New Oil Storage & Protection System (Clean Oil Guard System)

Oil Storage Tank

- New oil clean storage
- New oil storage and purification possible
- Can put new oil



▪ Product Features

- Prevent contamination caused by internal corrosion by applying stainless steel tank
- Prevent ingress of external contaminants by applying particle and water removal air breather
- Easy oil injection with built-in motor & pump
- Robust and clean management by aluminum structure frame
- Improvement of oil contamination by application of microfiltration filter



▪ Functions and Expected Effects of Oil Storage Tank

Lubricant Storage

When the oil is stored in drum, it causes contamination of oil due to drum corrosion, but this system guanantees clean storage with a SUS tank.

Lubricant Purification

New oil in the storage system can be purified to reach the target cleanliness level

Lubricant Distribution

Can distribute purified oil easily without any contamination

Lubrication Plus SOLGE

Clean Oil Guard System

▪ **Product Features**

Model	Composition of Tanks	Size	Filter System	Common Specifications
SCOG253F	250 L * 3EA	245 * 84 * 200	Filter applied (3㎛,beta rate 4,000)	- Tank material : SUS304 - Cross Beam : Aluminum Alloy - Fitted with particle and water removal breather - Shelf for oil storage tools - Oil Drain Valve - Fitted with sight glass for water monitoring (WATECTOR) - Fitted with oil level gauge
SCOG253		185 * 84 * 200	N/A	
SCOG255F	250 L * 5EA	389 * 84 * 200	Filter applied (3㎛,beta rate 4,000)	
SCOG255		314 * 84 * 200	N/A	

*** Explosion-proof type available**

*** In addition to the models stated above, tank capacity and quantity can be customized to the customer's requirements**







Life Extension Table

New Cleanliness Level (ISO Code)

Current Machine Cleanliness (ISO Code)

	20/17		19/16		18/15		17/14		16/13		15/12		14/11		13/10		12/9		11/8		10/7	
26/23	5	3	7	3.5	9	4	>10	5	>10	6	>10	7.5	>10	9	>10	>10	>10	>10	>10	>10	>10	>10
	4	2.5	4.5	3	6	3.5	6.5	4	7.5	5	8.5	6.5	10	7	>10	9	>10	10	>10	>10	>10	>10
25/22	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	7	>10	9	>10	>10	>10	>10	>10	>10
	3	2	3.5	2.5	4.5	3	5	3.5	6.5	4	8	5	9	6	10	7.5	>10	9	>10	>10	>10	>10
24/21	3	2	4	2.5	6	3	7	4	9	5	>10	6	>10	7	>10	8	>10	10	>10	>10	>10	>10
	2.5	1.5	3	2	4	2.5	5	3	6.5	4	7.5	5	8.5	6	9.5	7	>10	8	>10	10	>10	>10
23/20	2	1.5	3	2	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	8	>10	9	>10	>10
	1.7	1.3	2.3	1.5	3	2	3.7	2.5	5	3	6	3.5	7	4	8	5	10	6.5	>10	8.5	>10	10
22/19	1.6	1.3	2	1.6	3	2	4	2.5	5	3	7	3.5	8	4	>10	5	>10	6	>10	7	>10	>10
	1.4	1.1	1.8	1.3	2.3	1.7	3	2	3.5	2.5	4.5	3	5.5	3.5	7	4	8	5	10	5.5	>10	8.5
21/18	1.3	1.2	1.5	1.5	2	1.7	3	2	4	2.5	5	3	7	3.5	9	4	>10	5	>10	7	>10	10
	1.2	1.1	1.5	1.3	1.8	1.4	2.2	1.6	3	2	3.5	2.5	4.5	3	5	3.5	7	4	9	5.5	10	8
20/17			1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4	9	5	>10	7	>10	9
			1.2	1.05	1.5	1.3	1.8	1.4	2.3	1.7	3	2	3.5	2.5	5	3	6	4	8	5.5	10	7
19/16					1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4	9	6	>10	8
					1.2	1.1	1.5	1.3	1.8	1.5	2.2	1.7	3	2	3.5	2.5	5	3.5	7	4.5	9	6
18/15							1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4.5	>10	6
							1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2	3.5	2.5	5.5	3.7	8	5
17/14									1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	6	3	8	5
									1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2	4	2.5	6	3.5
16/13											1.3	1.2	1.6	1.5	2	1.7	3	2	4	3.5	6	4
											1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.8	3.7	3	4.5	3.5
15/12													1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5
													1.2	1.1	1.5	1.4	1.8	1.5	2.3	1.8	3	2.2
14/11															1.3	1.3	1.6	1.6	2	1.8	3	2
															1.3	1.2	1.6	1.4	1.9	1.5	2.3	1.8
13/10																	1.4	1.2	1.8	1.5	2.5	1.8
																	1.2	1.1	1.6	1.3	2	1.6

Hydraulics and Diesel Engines	Rolling Element Bearings
Journal Bearings and Turbo Machinery	Gear Boxes and Other

Cleanliness Code

▪ NAS1638(Abolished in 2001)

NAS Class	Max particles/100mL in specified size range (μm)				
	5-15μm	15-25μm	25-50μm	50-100μm	>100μm
00	125	22	4	1	0
0	250	44	8	2	0
1	500	89	16	3	1
2	1,000	178	32	6	1
3	2,000	356	63	11	2
4	4,000	712	126	22	4
5	8,000	1,425	253	45	8
6	16,000	2,850	506	90	16
7	32,000	5,700	1,012	180	32
8	64,000	11,400	2,025	360	64
9	128,000	22,800	4,050	720	128
10	256,000	45,600	8,100	1,440	256
11	512,000	91,200	16,200	2,880	512
12	1,024,000	182,400	32,400	5,760	1,024

▪ SAE AS4059E

Size, ISO 440 2 Calibration, or Optical Microscope Count*		> 1 μm	> 5 μm	> 15 μm	> 25 μm	> 50 μm	> 100 μm
Size, ISO 11171 Calibration or Electron Microscope**		> 4 μm(c)	> 6 μm(c)	> 14 μm(c)	> 21 μm(c)	> 38 μm(c)	> 70 μm(c)
Size Code		A	B	C	D	E	F
Cleanliness Class	000	195	76	14	3	1	0
	00	390	152	27	5	1	0
	0	780	304	54	10	2	0
	1	1,560	609	109	20	4	1
	2	3,120	1,217	217	39	7	1
	3	6,250	2,432	432	76	13	2
	4	12,500	4,864	864	152	26	4
	5	25,000	9,731	1,731	306	53	8
	6	50,000	19,462	3,462	612	106	16
	7	100,000	38,924	6,924	1,224	212	32
	8	200,000	77,849	13,849	2,449	424	64
	9	400,000	155,698	27,698	4,898	848	128
	10	800,000	311,396	55,396	9,796	1,696	256
	11	1,600,000	622,792	110,792	19,592	3,392	512
	12	3,200,000	1,245,584	221,584	39,184	6,784	1,024

Cleanliness Code

▪ ISO4406

Particle Counting Example	
Size µm(c)	Number of particles @ > x µm(c)/ml
4	1,752
6	517
10	144
14	55
20	25
50	1.3
75	0.27
100	0.08

$R_4/R_6/R_{14}$

ISO 18/16/13

4µm	6µm	14µm	ISO Code
1,301	321	41	18/16/13
2,500	640	80	18/16/13
2,501	641	81	19/17/14
5,000	1,300	160	19/17/14

1 more particle

4 times more particles

Number of particles / mL		Range Number (R)
>	≤	
5,000,000	10,000,000	30
2,500,000	5,000,000	29
1,300,000	2,500,000	28
640,000	1,300,000	27
320,000	640,000	26
160,000	320,000	25
80,000	160,000	24
40,000	80,000	23
20,000	40,000	22
10,000	20,000	21
5,000	10,000	20
2,500	5,000	19
1,300	2,500	18
640	1,300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2.5	5	9
1.3	2.5	8
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1



PRODUCT INQUIRIES

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