

White Paper



**Desiccant Breathers: A Front Line Defense
in the War on Contamination**

Introduction

Are you losing the battle on extending equipment life? Are you changing your oil too often or having machine failures? Most companies are now realizing that maintaining clean oil is one of the best investments they can make, with contamination at the core of premature machinery failure and diminished lubricant life. But many companies don't know where to start in preventing contamination or how to build the case for it to get approval in the budget. This white paper will assist you in better understanding how a desiccant breather can be used as a first line of defense in preventing contaminants from ruining your equipment and what the right metrics are to show a return on your investment.

The problem: lubricant contamination

If the atmosphere is contaminated (and most are to some degree), the oil is probably dirty and lubricant quality is compromised. Even new oil isn't delivered clean.

There are two primary types of contamination.

DIRT

If the atmosphere is contaminated, oil will become dirtier and lubricant quality becomes compromised. Particulate contamination, once inside an operating system, will accelerate the generation of new contaminants due to machine wear. These contaminants damage critical components and act as a catalyst for oxidation, further degrading the condition of lubricants.

WATER

If the atmosphere is humid or has frequent temperature fluctuations, the oil is probably moisture laden and lubricant quality is compromised. Often times, plant washdown activities are responsible for inducing conditions that lead to moisture ingress and corrosion.

The solution: a desiccant breather

The good news is that dirt and water can be effectively controlled with some preventative maintenance techniques. The desiccant breather filter continues to be at the top of the list for preventative maintenance and conquering contamination—a low cost option that proves a significant return on investment.

As nearly all gearboxes, reservoirs and storage tanks are designed to breathe, allowing only clean, dry air to enter the system is essential to extending the life of your equipment. Replacing standard breather/filter caps with a desiccant breather immediately prevents moisture and moves particle filtration from 40 micron to 3 micron or less.

What is a desiccant breather?

A desiccant breather is a unique air filter and water vapor removal system. It replaces the standard breather or ventilation system on virtually all types of industrial equipment that contain hydrocarbon and other non-aqueous fluids. It also prevents contamination of products in storage and process tanks. Many other applications exist, including the reduction of pump downtime for vacuum chambers, adaptation to air breathers for off-road vehicles, and more.

Desiccant breathers combine a drying media with a combination of filters to prohibit water and microscopic particulates from entering the system, and to remove water from the reservoir to prevent condensation. A large variety of sizes, desiccants and options allow you to select the right solution for your application.

Why is a desiccant breather necessary?

Today’s options for restricting the ingress of contaminants are a far cry from yesterday’s open tube turndown pipes that did little more than keep the birds out (Table 1). Proper installation and maintenance of contamination control breathers can significantly reduce ingress of airborne contaminants.

OPTION	DESCRIPTION/COMMENTS
Open Port	<ul style="list-style-type: none"> Although uncommon in most facilities today, you might be able to walk through a facility and find a reservoir open to the air. Not quite as uncommon is a similar scenario with a shop rag acting as a filter—especially after the original cap was lost or misplaced
Turndown Pipe	<ul style="list-style-type: none"> In some cases, older units can be found that have a 'snorkel tube' opening vented to the atmosphere Prevents entry of large objects into the reservoir
Typical OEM Cap	<ul style="list-style-type: none"> Typically mesh type strainer that captures particles down to 40µ Captures insects and large dust particles Does not effectively control most clearance size particles and the many forms of contamination that cause the most damage to bearings, pumps or valves
Low Micron Filter/ Breather	<ul style="list-style-type: none"> Ratings from 1 to 3µ Higher airflow ratings Not as effective if humidity is a concern Hydrophobic membrane breathers are effective at stopping free water
Oil Coalescence	<ul style="list-style-type: none"> Helps prevent plant emission byproducts, and prohibits entry of contamination into machines Captures oil mist and recycles oil back into the system Can be incorporated with desiccant Non-desiccant versions ideal for continuous operation (24/7) machinery Pressure/vacuum relief valves and sight glass indications allow for condition-based monitoring
Desiccant Breather	<ul style="list-style-type: none"> Designed to prevent atmospheric moisture ingress by stripping the air of moisture before it enters the system Typically incorporate filtration media for capture of particulate matter Color-indicating silica gel is commonly used as the water-absorbing agent, changing color as it becomes saturated, indicated the need for a condition-based replacement Some incorporate both hydrophobic and oleophboic media. This type of dual protection breather keeps free water out of the system, and oil mist contained within the headspace (where it belongs)

Table 1: Reservoir Filter Options

Conventional vent ports or breather caps provide little or no protection. They are typically rated at 40 micron and offer no means of capturing moisture. Retrofitting these ports with desiccant breathers will provide 24/7 protection against uninvited contaminants—both dirt and water. Clean lubricants extend the life of equipment and lower the total cost of ownership with lower oil, repair, downtime and maintenance costs.

Traditional desiccant breathers include both a mechanical filtration system to strip particles from the air down to 3 microns or less and a desiccant stage to lower the relative humidity of the air to a level that prevents condensation and even removes water from the oil in many cases.

Why is water contamination a problem?

As the fluid level decreases, it draws air into the reservoir. This air enters at ambient temperature and balances the pressure with the outside air. The heating of the air to unit operating temperature allows the partial pressure of the heated air to retain atmospheric moisture in vapor form.

As the air in the reservoir cools down, it loses its ability to retain the water vapor and condenses. This condensed water forms droplets on the inside surfaces of the reservoir. The water droplets group together and enter the fluid, resulting in contamination. The water mixes with the oil in the circulating pump or working zone of the equipment and results in:

- Reduced lubricating ability
- Blocked filters
- Sludge formation
- Increased oxidation of the oil
- Equipment failures

Water remains on the inside of the reservoir and causes corrosion. This corrosion contaminates the oil with abrasive oxides (rust and others) and speeds up the wear process in the equipment. Water contamination of the lubricating oil dramatically shortens the life of the lubricant and strips additives. This results in accelerated wear of the component.

How does a desiccant breather get and keep your equipment dry?

The breather is filled with a hygroscopic agent (water adsorbing) that traps and adsorbs moisture contained in the air entering the filter. Adsorption is when material sticks to the surface of a substance.



The desiccant in breathers attracts and holds onto water molecules. It does this so well that a single grain of silica gel can adsorb 40% of its weight in water.

It also removes moisture from within the reservoir as the unit breathes out. As the reservoir heats up, water contained within the reservoir becomes water vapor. As the vapor is forced out through the breather, it is removed by the drying agent.

Water in oil can increase oxidation rate by more than 10 times. By controlling moisture both outside and inside the reservoir, all of the problems typically caused by water contamination are prevented.

Why is particulate contamination a problem?

The most damaging particles for lubricated machinery are those that are approximately the same size as the oil film.

COMPONENT	CLEARANCE (MICRONS)	COMPONENT HYDRAULICS	CLEARANCE (MICRONS)
Element Bearings	0.5-5	Vane Pump Vane Slides	5-13
Journal Bearings	0.5-100	Vane Pump Vane Tips	0.5-1
Engine Ring / Liner	0.3-7	Piston Pump Bore	5-40
Engine Rod Bearing	0.5-20	Piston Cylinder / Plate	.05-5
Engine Main Bearing	0.8-50	Servo Valves	1-4
Engine Valve Train	0.0-1.0	Actuators	50-250

How much does it take to contaminate your equipment?

Particulate size is measured in microns, so how big is a micron? A .001” particle is 25.4 microns, and a particle measuring as small as 5 microns can do extensive damage to your equipment. To put this in perspective, a strain of human hair measures approximately 65 microns in diameter.

One teaspoon of dirt in a 55-gallon drum yields a particle count of 19/17/14. This means there are about 1 billion particles in the drum which are greater than 4 microns in diameter.

How does a desiccant breather filter out dirt?

Most quality desiccant breathers have a multi-level filtration system to keep dirt out of your equipment.

- As air enters the unit from outside, it contacts a low-density foam filter element.
- The air then passes through a woven polyester filter element.
- For added protection, some desiccant breathers also provide a second foam and polyester filter.

What to look for in a quality breather

There are many variations of breathers to choose from. Here are a few things to look for when choosing a quality breather:

1. Integrated nylon standpipe— this key feature provides excellent vibration resistance and dissipates impact throughout the unit, eliminating weak points. It also allows even airflow distribution throughout the unit, preventing inaccurate readings of desiccant saturation. Many breathers that do not have this key feature will also have oil saturation problems in the desiccant due to splashing or oil mist, causing the breather to spend very quickly.

2. Resilient polycarbonate casing— shock-absorbing, clear casing provides reliable service, easy visual maintenance, and UV resistance
3. Multi-layer filtration— such as polyester filters and foam pads to protect against migration of desiccant dust or oil mist, providing maximum efficiency
4. Water vapor adsorbent silica gel— adsorbs water from incoming air and can hold up to 40% of its weight
5. Check-valves— specifically high-quality umbrella check-valves that won't clog or stick for added protection from washdown environments. Check-valves isolate equipment from ambient conditions, prolonging breather life, and protecting system integrity



The payoff: money in the bank (and the budget)

Contamination control is the single greatest opportunity for gains in the average lube program. Significant gains in machinery reliability can be made with minimal investments.

To date, industry has treated the symptoms of oil contamination by filtering the lubricant, replacing the oil sooner than necessary, and rebuilding or replacing failed components at a very high cost.

Studies show it costs about 10 times as much to remove contamination as it does to exclude it.

The benefits of treating the cause of abrasive and corrosive contamination are:

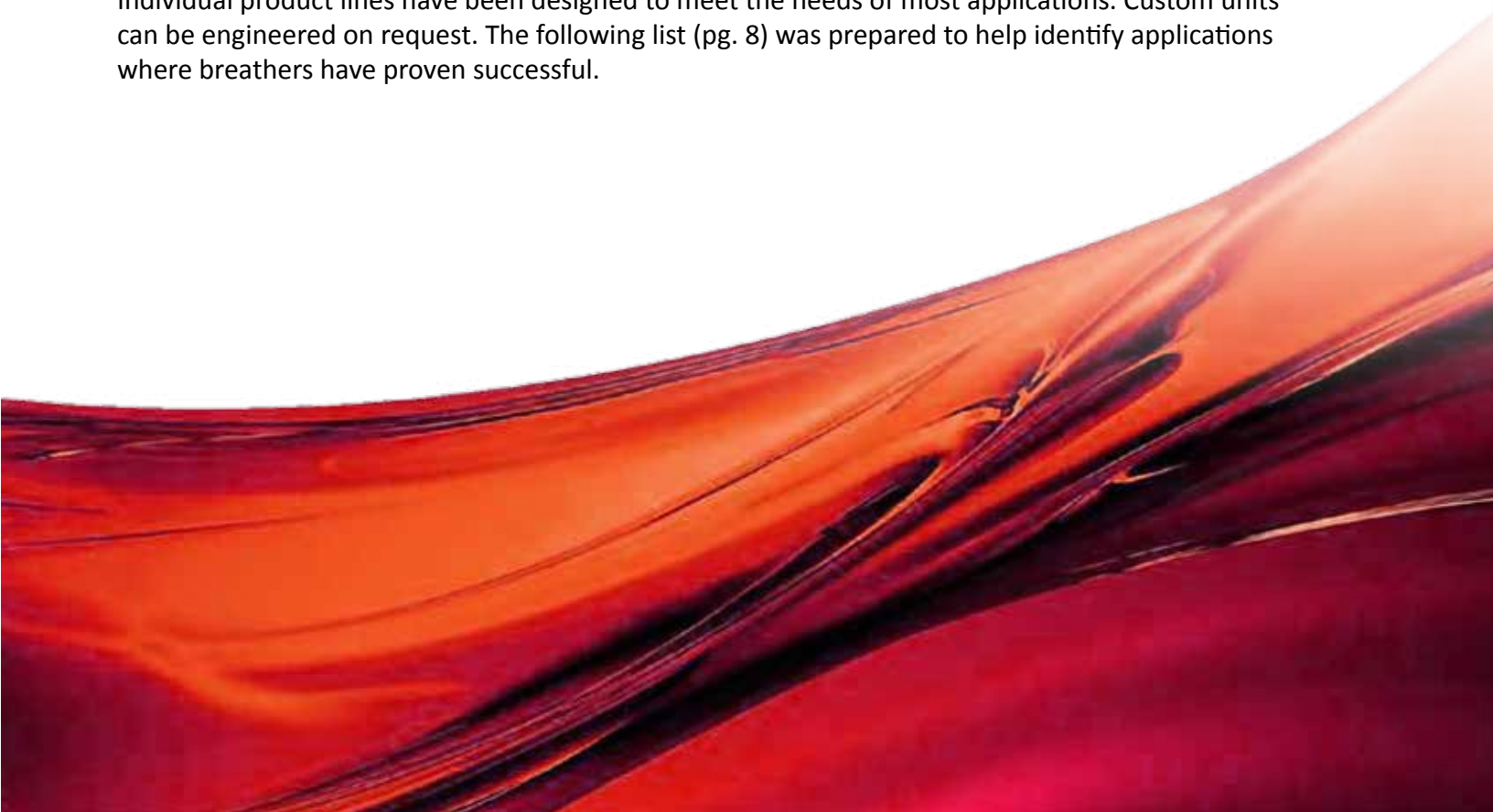
- Elimination of water contamination through the breather
- Removal of water contamination of the reservoir
- Prevention of rust and corrosion
- Increased oil life
- Improved lubricant performance
- Increased oil filter life
- Reduced abrasive wear
- Reduced rebuild/replacement costs
- Reliable production from equipment
- Reduced machine downtime

Your program's effectiveness can be measured through the following metrics:

- Maintenance of targeted ISO cleanliness codes
- Reduction in moisture levels (% or ppm) measured by Karl Fischer filtration tests
- Lubricant life extension, extended drain intervals
- Extension of MTBF (mean time between failures), decreased unscheduled downtime
- Cost savings (e.g. reduced component repair, decreased oil disposal expense, decreased oil purchases/machine or part produced)

Industries benefiting from breathers

The breather is used to protect any industrial or commercial system that breathes in and expels air. Individual product lines have been designed to meet the needs of most applications. Custom units can be engineered on request. The following list (pg. 8) was prepared to help identify applications where breathers have proven successful.



INDUSTRY	COMMENTS
Aluminum Extrusion Forging & Rolling Mills	These operations are almost exclusively oriented to hydraulic equipment.
Appliance Manufacturers	Stampings—look for large hydraulic presses and some gearboxes.
Automotive Industries	This industry is intensively equipped with hydraulic machinery, gearboxes & robots.
Large Transformer & Switch Gear Mfg.	Use a large amount of insulating oil (transformer oil), which can easily get contaminated. Reclamation common.
Aerospace & High Tech Welding	Associated hydraulics are susceptible.
Day Tanks on Diesel Powered Generators	Found in almost every large building. Moisture contamination is a big problem because they are seldom used.
Paper & Pulp Mills: Particle Board & Sawmills (Forest Products)	Mill applications like gearboxes, hydraulic turbines, paper machines, calendars, & presses often are contaminated with water or airborne particles. Environments such as board mills, wood yards, & roll handling areas of paper mills are also good applications for desiccant breathers.
Oil Drill Industry	Hydraulics on the mobile equipment, gearboxes. Equipment in the field is subject to substantial dust contamination.
Acid & Chemical Storage	Moisture and dirt alters the fluid.
Food Processing Plants	Washdown of equipment makes moisture a real problem for hydraulic reservoirs & gearboxes. One of the best applications.
E.D.M. Die Making	Electro-discharge machining is a process that produces contaminated oil.
Food Products; Oils, Grains, Syrups	Contamination prevention is particularly important during fill/empty operations.
Off Road Vehicles	Filtering moisture and dirt from air going to differentials, transmissions, loader cylinders, etc.
Automatic Screw Machine	These are high production lathes, which often use petroleum-based cutting oils.
Chemical & Petro Chemical Plants	Micronic filtration of the process stream. Lube oil degassing and conditioning; turbine & seal oil.
Jet Fuel Storage at Large Airports	Water or dirt contamination results in loss of entire product.
Plastic Injection Molding	Big user of hydraulic equipment.
Power Plants & Utilities	Filtration application is on the main steam turbines, boilers, feed pumps and any peaking units. Transformer oil treatment is another obvious application.
Steam & Gas Turbine Manufacturers & Users	Paper mills, petrochemical plants, refineries & distilleries are turbine users. Off-shore oil drilling platforms use gas turbines as main electrical generating power source.
Steel Rolling Mill & Forge Plants	A typical steel rolling mill has two stories of hydraulic equipment beneath the roll stands. They periodically contaminate this hydraulic oil with water-based rolling fluids. A desiccant breather could prevent the contamination of moisture that gets in through the breather cap.
Mining Companies	Hydraulically powered equipment exposed in a very dirty environment.

Frequently asked questions

1. How long does a desiccant breather last?

This depends on the environment. Some guidelines follow, but these will vary with conditions.

Water Contamination

The disposable models contain silica gel that is visible through the plastic case. When the silica gel completely changes to a different color, the unit has reached 100% saturation and must be replaced.



If the system was not previously equipped with a desiccant breather, it is normal for the first unit to change color relatively quickly on the initial installation. This means the product is working to remove existing contaminants already in the gearbox or reservoir, and its life will be shorter than typical. Subsequent units will increasingly provide longer life.

If the environment is not unusually moist, the unit has the potential to last up to six months or longer before color change indicates required replacement.

Abrasives/Dust Contamination

The breather filter assembly has the ability to “back flush” itself when the system expels air, due to the unique woven loop design of the filter material.

Operational experience has shown that, in most applications, the unit will require replacement due to moisture saturation before the particulate filters require replacement. However, it is recommended that for an environment with very heavy airborne contamination, that the unit be changed every six months or 3,000 operating hours.

HELPFUL HINTS

- Note breather installation date directly on breather housing using a permanent marker.
- Include breather change-outs in equipment maintenance manual(s).

2. Where are breathers used?

Generally, any reservoir, tank, cabinet or piece of equipment that breathes in and expels air, and where water or dirt in that air would be detrimental to the contents or operation.

Suggested applications include:

- Gearboxes
- Hydraulic Systems – All Types
- Bearing Circulating Systems
- Robotic Hydraulic Equipment
- Transformers with Oil-Cooled Design
- Non-aqueous Chemical Process Storage/Handling Tanks
- Diesel Fuel Storage Tanks
- Mobile Earthmoving Equipment
- Agricultural Equipment
- Vacuum and Welding Chambers

3. Can I replace the element/desiccant?

No, not for the disposable models. The cost of the replacement filter pads and hygroscopic agent is approximately 70% of the total unit cost. The only salvageable parts would be the plastic case and cap, which are pressed together. If this tight fit were not achieved in the rebuild, abrasive materials and moisture could bypass the filter.

Once spent, these units—disposable models—should be disposed of just as any used oil or oil filter. Local, state and federal regulations should be consulted. For most European countries, disposal involves incineration.

Some companies have tried ‘baking’ the desiccant in used breathers in an attempt to turn it back to its original color. While this works in changing the color, each time the desiccant is baked, it loses at least 20% of its life. Additionally, once the breather is opened, both the desiccant and secondary filters have been further contaminated, resulting in insufficient protection of your machinery. Fully disposable breathers are recommended to ensure maximum protection.



4. How can I prevent saturation in very wet environments?

Mount the unit in the driest location. Use the remote mounting method to get the unit away from direct water spray.

For applications with frequent washdowns or high humidity, breathers that offer a fully sealed system with high-quality umbrella check valves prove the most effective.

5. Do I have to seal the unit?

All disposable breathers are outfitted with an O-ring to seal the breather to the application. It is recommended that a silicone sealer is used to mount the unit to the field adapter or threaded adapter, and that thread seal tape or silicone is used on the adapter threads.

6. If the unit is accidentally broken, will the desiccant enter the reservoir?

To avoid this issue, select a high-quality breather that has an impact-resistant polycarbonate casing and an integrated nylon standpipe.

7. What size do I need?

There are a number of different breather models and sizes. Fitting the smallest unit for economy of purchase price is not always the best option for the application. The unit should be sized by looking at the system's air flow requirements, environment, type and amount of lubricant, as well as desired amount of water adsorption.



Take action

When it comes to selecting breathers, the “one size fits all” approach is not really ideal. Today, there are many different designs available and there is definitely a best fit for each particular application. Breather selection is an important part of the process of developing a world-class lubrication program and should not be oversimplified. Visit www.LElubricants.com for more information

Acknowledgement

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