Building the Case for Contamination Control

DES-CASE™

Introduction

Maintaining clean oil is one of the best investments a company can make, yet contamination often remains an overlooked factor behind premature machinery failure and diminished lubricant life. With increases in the cost of oil, increased desire to minimize usage and waste, and the need to prolong the life of equipment, the economic case for protection – from the time oil enters a facility until it leaves – is stronger than ever.

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The Problem: The Presence of Contaminants

Two primary types of contamination are dirt and water.

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

If the atmosphere is particularly humid or has frequent temperature fluctuations, the oil is probably moisture-laden and lubricant quality is compromised. Oftentimes, plant wash down activities are responsible for inducing conditions that lead to moisture ingression and corrosion.

The good news is that these factors, which work together to threaten equipment reliability, can be effectively controlled with some preventative maintenance techniques. The best and easiest way to exclude contaminants is to avoid practices that risk exposing lubes to contaminants.

A multi-faceted program that includes some simple proactive steps can help conquer contamination.

The Goal: Setting the Right Targets

Every application is unique – and what's right for someone in one environment isn't what's needed for someone else with finer tolerances or a more critical application or a different type of equipment.

There are a number of sources to refer to in order to get a bit of help. Noria Corporation (www.noria.com) offers a wide variety of published and training materials that can get you well on your way, including a general guide on ISO cleanliness codes, what the numbers mean, and a few thoughts on targets based on pressure and equipment type.[1]

Filtration Options

It has been said that the best cure is prevention. Ideally, all of us would have a brand new plant and machinery and begin with a solid program of preventative measures that would ensure the longest life for our equipment and oil. That, of course, rarely happens. Once you know how big the problem is, you can combine several options to help bring the current situation in line with your cleanliness targets, and add components that will help keep your oil clean and "dry".

Reservoir filters

Today's options for restricting the ingression 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 ingression of airborne contaminants.

1. Badal, L., Minnick, T., Whigham, J., "The Importance of ISO Cleanliness Codes." Retrieved March 30, 2009, from *http://www.noria.com/learning_center/category_article.asp?articleid=800&relatedbookgroup=Lubrication2*

Table 1: Reservoir Filter Options

Option	Description/Comments
Open Port	• Although less common 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	• 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	• 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	• Ratings from 1 to 3 µ • Higher airflow ratings • Not as effective if humidity is a concern • Hydrophobic/"deliquescent" membrane breathers are effective at stopping free water, but not humidity
Oil Coalescence	• Help prevent plant emission byproducts, as well as prohibit 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 indicators allow for condition-based monitoring.
Desiccant Breather	• Designed to prevent atmospheric moisture ingression 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 adsorbing agent, changing color as it becomes saturated, indicating the need for a condition-based replacement. • Some incorporate both hydrophobic and oleophobic media. This type of dual protection breather keeps free water out of the system and oil mist contained within the headspace (where it belongs).
Hybrid Desiccant Breather	• Next generation breathers being widely used in exceptionally wet and humid environments. • Incorporate an air filter, water adsorbing desiccant, and an expansion chamber, allowing for changes in lubricant and headspace volume caused by temperature changes. • Pressure and vacuum relief valves activate when air displacement exceeds the volume capabilities of the expansion chamber. The outside air is allowed into the headspace only after passing through particulate and moisture filters. • Considered an alternative to installing a costly closed loop system - closes a system under normal operating conditions while continuously protecting the headspace from dirt and moisture and safeguarding against pressure changes.

The breather filter continues to be at the top of the list for preventative maintenance and conquering contamination.

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 breathers will provide 24/7 protection against uninvited contaminants, both dirt and water (see *Table 2*). Clean lubricants extend the life of equipment, and lower the total cost of ownership with lower oil, repair, downtime and maintenance costs (visit *www.noria.com* and search "Life Extension Table" for more information).

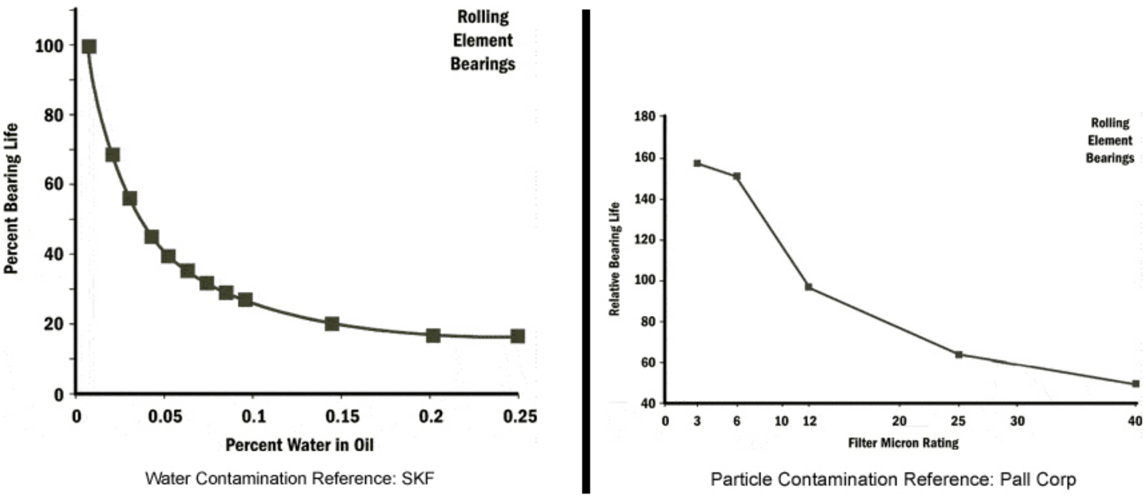
Table 2. Comparison of several breather types.

Applications	**Hydraulic reservoirs, gearboxes, storage tanks, electrical transformers, etc.**	
Operating Hours	**Less than 24 hours per day or long shutdown period**	**Operating continuously (24/7)**
Problem #1	The presence of water in systems using biodegradable lubricants presents many problems: Temperature variations → condensation → rust, corrosion, and overconsumption of inline filters and lubricants. A waste of money for curative maintenance.	Little condensation, but may be subject to moisture ingress through washdowns
Problem #2	Ambient air surrounding machines can become contaminated with airborne particles. Dirt, especialy clearance size particles, is detrimental to the health of lubricants and equipment. Dirt accumulation → friction → severe debris entrainment, scoring, abrasive wear, cavitation, potentially leading to system shutdown if not removed or controlled. Costs 10x more to remove contaminants than to keep them out in the first place.	
Solutions	**Desiccant breathers**	**Hybrid** / **Hydrophobic / Oleophobic**
Features/Benefits	• Stop dust using filtration media • Stop humidity with silica gel to prevent and protect against condensation. • Wide variety of applications	• Stop dust and free water/oil mist • Oleophobic media captures and recycles oil in heavy mist applications, prevents contamination of working environment • Does little to stop humidity
	Hybrid: Breather/diaphragm combination creates virtually-closed system design. Ideal for high humidity, steam quenching and frequent washdown applications where increased breather life is required. Examples include: outdoor environments, coastal, offshore and oil platforms, food and beverage plants, minimal airflow applications, et cetera.	

Breathing starts the same day the machine is built or a static tank is filled. The correct approach to preventing dirt and moisture damage is to proactively control ingression points. Since the most common point of entry is the conventional vent port, installation of desiccant breathers is imperative throughout the life of a machine.

Breathers are essential to the health of machines and lubricants. A properly fitted and maintained breather is a critical step toward reliability optimization. Combining breather use with other contamination control tools, such as mechanical seals, proper sampling techniques, downstream filters and appropriate lubricant storage/dispensing systems will increase the overall level of maintainability and increase the chances of meeting or even exceeding life expectancies (*Figure 1)*.

Figure 1. Dirt and water effects on life expectancy.



In-line / Off-line filtration

In-line and off-line filtration (sometimes referred to as bypass, kidney-loop, or auxiliary filtration), consists of a motor, pump, filters, and proper hardware connections. Fluid is continuously pumped out of the reservoir, through the filter(s), and back to the reservoir. In-line is, of course, a permanent part of the overall system. An off-line filtration loop has the extra advantage of being relatively easy to retrofit on an existing system that has insufficient filtration. Also, the off-line filtration device can be serviced without turning off the main system.

A filter cart is a portable, off-line filtration system when used to filter fluid inside the reservoir. It is a transfer cart when used to move lubricants from a drum to a reservoir. In either mode, it is an economical solution to offline filtration requirements. Filter carts should be used to remove particles and moisture, thereby preserving the working life of the oil. They are not just a tool for emergency remedial measures when dealing with contaminated lubricants and hydraulic fluids. To avoid cross-contamination of fluids, make sure there is a dedicated filter cart for each type of lubricant in use. Filter carts should be fitted with quick disconnects and with particle removal and water –absorbing filter elements.   Filter carts should be part of a routine that includes filtering new oil as well as transferring and dispensing oils.[2]

2. Grimstad, G. and Grimstad, C., "Reservoirs of Opportunity." Machinery Lubrication Magazine, July 2003. Retrieved August 29, 2005, from *http://www.machinerylubrication.com/article_detail.asp?articleid=515&relatedbookgroup=Hydraulics*

New oil filtering, you may ask? Many plant personnel feel new oil is clean enough to use right away. However, many new fluids have initially high contamination levels. Fluids should always be filtered before being put into service. Contamination, both particulate and water, may be added to new fluid during processing, mixing, or handling. This contamination can be removed with the use of a filter cart. They are the ideal way to prefilter and transfer fluids into reservoirs.

Choices, Choices

Fluid handling products come in a variety of shapes other than filter carts – and units vary greatly in their options. There are a number of manufacturer's guides to selection as well as some on line, customizable alternatives that can help you with getting what's right for you. Consider some of the following basic questions as you look for the right choices for your plant or application:

- "Where do I need the filtration?"
  This will influence whether you want to look at a fixed unit, a traditional cart on wheels, or some of the newer, more compact units.
- "What do I need to filter?"
  This will influence the number of units you need (to reduce cross contamination), the type of filters you want to use (filter media, micron rating, water removal, etc.), and the materials you need in the construction of the filtering apparatus (material compatibility, electrical or air connections).
- "How often do I need to filter?"
  If you have an application that is in need of filtration for the first time, a general rule is to filter the oil through 7 passes to ensure that nearly all of the oil in the reservoir has been adequately cleaned. However, if the oil is able to be completely removed from the system, one or two passes should suffice, depending on the speed with which you filter the oil. After the initial cleaning, consider the criticality of the application, the sensitivity it has to contaminants, and the ingression rate of contaminants (through seals, from the environment and internal abrasiveness) in setting the schedule for filtration.

Where Should You Look? Money Can Be Saved Everywhere

Area #1 – Storage

Many improvements to your storage procedures can be made with minimal cost. A little time spent simply reviewing your current storage and handling procedures can be informative and useful.

A few ideas:

- Stored oil should be kept indoors
- Add breathers to vented storage containers
- Controlling temperature is important for proper drum storage. Drums "breathe" as the internal pressure increases and decreases with temperature variations. Moisture and other contaminants are forced into the drum when the internal pressure decreases. It is recommended to store drums or containers in enclosed, temperature-controlled storage facilities.
- Shielding storage containers from dirt and moisture is another procedure that will keep your cleaned and filtered oil in good condition. Be as careful with pumps and transfer containers as with your storage containers. This will minimize the chances of cross-contaminating with other lubricants and introducing contaminants into machines when filling.
- Consider a lubricant management system for your lube room, combining filtration, storage, and breather technology in one solution.

Area #2 – Handling

Some simple procedures to improve handling maintenance operations:

- Transfer hoses should be equipped with quick-connects to prevent contamination of the hose from the environment, provide leak-free connections to tanks and reservoirs and allow a method for off-line filtration.
- All oil-dispensing equipment, including tanks, drums, pails, hoses and reels, should be clearly labeled to avoid cross-contamination of products. Color-coding is helpful in avoiding cross-contamination.
- The use of an industrial filter cart is one of the most economical ways to protect your system from destruction caused by contamination.

Area #3 – Equipment

Nearly every industrial application is a candidate for a contamination control solution. Gear drives, pumps, turbines, transformers, hydraulic systems…all of them can be looked at as an opportunity to save money through the reduction of downtime, increased oil life (and decreased oil replacement and disposal costs), and increased machinery life and reliability. Examining seals, ensuring the application has the correct sized breather for the application and environment, and the regular filtration of oil can extend the life 2, 3, or 4 times what a non-systematic approach would yield, saving tens (if not hundreds) of thousands of dollars.

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.

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 titration 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)

There is an inverse relationship between lubrication quality and maintenance costs. Financial gains can be made by implementing procedures which maximize lubrication effectiveness.

Noria Corporation has extensively researched the relationship between moisture and particle contamination reductions and the extension of lubricant life. Tables that you can use to help build your business case for contamination control can be found in the previously mentioned article[3] as well as within Noria's Oil Analysis courses.

Bottom Line Benefits of Filtering Oil

Tribological losses can be greatly reduced through proper lubrication maintenance which effectively starts with breather protection, off-line filtration, and oil sampling. In today's competitive market, it is more important than ever to maintain system integrity and extend equipment life.

By utilizing options outlined above and implementing several contamination control techniques as a 'best practice', maintaining clean dry lubricants—and gaining the profitability that goes along with it—is easier than ever.

3. Badal, L., Minnick, T., Whigham, J., "The Importance of ISO Cleanliness Codes." Retrieved March 30, 2009, from *http://www.noria.com/learning_center/category_article.asp?articleid=800&relatedbookgroup=Lubrication2*

Business Case Worksheet

One should be completed for each type of equipment – a more complete electronic version of this can be requested from Des-Case at sales@descase.com.

Results may vary – illustrative purposes only

A. Improvement Factor Calculation

1.	Type of Equipment (hydraulic, gearbox, pump)	1. ______________
2.	Current ISO Cleanliness Level:	2. ______________
3.	Target ISO Cleanliness Level:	3. ______________
4.	Particulate Life Extension Improvement Factor (use line A2 and A3 – see charts on page 10):	4. ______________
5.	Current moisture level in ppm:	5. ______________
6.	Target moisture level in ppm:	6. ______________
7.	Moisture Life Extension Improvement Factor (use line 5 and 5 – see charts on page 11 – use "journal bearing" chart as default):	7. ______________
8.	Multiply Line 4 and Line 7 (this is Expected Life Improvement):	8. ______________

B. Repair / Downtime Cost Calculation

1.	Number of units	1. ______________
2.	Total annual number of repairs on units in line B1	2. ______________
3.	Estimated parts costs per repair	3. ______________
4.	Estimated man hours per repair	4. ______________
5.	Estimated hourly labor rate per repair man hour	5. ______________
6.	Estimated downtime per repair (in hours)	6. ______________
7.	Estimated cost per hour of downtime (idle worker expenses plus lost / delayed sales due to downtime)	7. ______________
8.	Calculate: (Line B2 x Line B6 x Line B7) + (Line B2 x Line B3) + (Line B2 x Line B4 x Line B5)	8. ______________

C. Implementation Costs

1.	Cost per breather:	1. ______________
2.	Breathers estimated per year (can use 1.33 as an estimate for Des-Case breathers)	2. ______________
3.	Cost of other implemented improvements (e.g. improved seals, labeling, improved storage, filtration equipment)	3. ______________
4.	Hours of labor	4. ______________
5.	Estimated hourly labor rate per repair man hour	5. ______________
6.	Calculate: (Line C1 x Line C2) + Line C3 + (Line C4 x Line C5)	6. ______________

D. The Payoff

1.	Calculate Gross Savings, year 1: Line B8 - (Line B8 / Line A8)	1. ______________
2.	Calculate Year 1 Net savings: (Line D1 - Line C6)	2. ______________

Note: Most calculations show a savings in year 1. If your calculations yield a different result, the more complex electronic worksheet may prove more beneficial to your projects. Please contact Des-Case at (615) 672-8800 to learn more about calculating the savings for your company.

Appendix

Particulate Life Extension Improvement Factor

Life Extension Table Hydraulic Reservoirs

New Cleanliness Level (ISO Code) / Current Machine Cleanliness (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	7	9	10	10	10	10	10	10	10	10
25/22	4	5	7	9	10	10	10	10	10	10	10
24/21	3	4	6	7	9	10	10	10	10	10	10
23/20	2	3	4	5	7	9	10	10	10	10	10
22/19	1.6	2	3	4	5	7	8	10	10	10	10
21/18	1.3	1.5	2	3	4	5	7	9	10	10	10
20/17	1	1.3	1.6	2	3	4	5	7	9	10	10
19/16	1	1	1.3	1.6	2	3	4	5	7	9	10
18/15	1	1	1	1.3	1.6	2	3	4	5	7	10
17/14	1	1	1	1	1.3	1.6	2	3	4	6	8
16/13	1	1	1	1	1	1.3	1.6	2	3	4	6
15/12	1	1	1	1	1	1	1.3	1.6	2	3	4
14/11	1	1	1	1	1	1	1	1.3	1.6	2	3
13/10	1	1	1	1	1	1	1	1	1.4	1.8	2.5

Life Extension Table Pumps

New Cleanliness Level (ISO Code) / Current Machine Cleanliness (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	3	3.5	4	5	6	7.5	9	10	10	10	10
25/22	2.5	3	3.5	4	5	6	7	9	10	10	10
24/21	2	2.5	3	4	5	6	7	8	10	10	10
23/20	1.5	2	2.5	3	3.5	4	5	6	8	9	10
22/19	1.3	1.6	2	2.5	3	3.5	4	5	6	7	10
21/18	1.2	1.5	1.7	2	2.5	3	3.5	4	5	7	10
20/17	1	1.2	1.5	1.7	2	2.5	3	4	5	7	9
19/16	1	1	1.2	1.5	1.7	2	2.5	3	4	6	8
18/15	1	1	1	1.2	1.5	1.7	2	2.5	3	4.5	6
17/14	1	1	1	1	1.2	1.5	1.7	2	2.5	3	5
16/13	1	1	1	1	1	1.2	1.5	1.7	2	3.5	4
15/12	1	1	1	1	1	1	1.2	1.5	1.7	2	2.5
14/11	1	1	1	1	1	1	1	1.3	1.6	1.8	2
13/10	1	1	1	1	1	1	1	1	1.2	1.5	1.8

Life Extension Table Gearbox

New Cleanliness Level (ISO Code) / Current Machine Cleanliness (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	2.5	3	3.5	4	5	6.5	7	9	10	10	10
25/22	2	2.5	3	3.5	4	5	6	7.5	9	10	10
24/21	1.5	2	2.5	3	4	5	6	7	8	10	10
23/20	1.3	1.5	2	2.5	3	3.5	4	5	6.5	8.5	10
22/19	1.1	1.3	1.7	2	2.5	3	3.5	4	5	5.5	8.5
21/18	1.1	1.3	1.4	1.6	2	2.5	3	3.5	4	5.5	8
20/17	1	1.05	1.3	1.4	1.7	2	2.5	3	4	5.5	7
19/16	1	1	1.1	1.3	1.5	1.7	2	2.5	3.5	4.5	6
18/15	1	1	1	1.1	1.3	1.5	1.7	2	2.5	3.7	5
17/14	1	1	1	1	1.1	1.3	1.5	1.7	2	2.5	3.5
16/13	1	1	1	1	1	1.1	1.3	1.5	1.8	3	3.5
15/12	1	1	1	1	1	1	1.1	1.4	1.5	1.8	2.2
14/11	1	1	1	1	1	1	1	1.2	1.4	1.5	1.8
13/10	1	1	1	1	1	1	1	1	1.1	1.3	1.6

Source: Noria Corporation. Used with permission.

Moisture Life Extension Improvement Factor

Life Extension Table: Moisture Rolling Element

New Moisture Level (ppm)

Current Moisture Level (ppm)	10,000	5,000	2,500	1,000	500	250	100	50
50,000	2.3	3.3	4.8	7.8	11.2	16.2	26.2	37.8
25,000	1.6	2.3	3.3	5.4	7.8	11.2	18.2	26.2
10,000	1	1.4	2.0	3.3	4.8	6.9	11.2	16.2
5,000	1	1	1.4	2.3	3.3	4.8	7.8	11.2
2,500	1	1	1	1.6	2.3	3.3	5.4	7.8
1,000	1	1	1	1	1.4	2.0	3.3	4.8
500	1	1	1	1	1	1.4	2.3	3.3
250	1	1	1	1	1	1	1.5	2.3
100	1	1	1	1	1	1	1	1.4

Life Extension Table: Moisture Journal

New Moisture Level (ppm)

Current Moisture Level (ppm)	10,000	5,000	2,500	1,000	500	250	100	50
	Journal	Journal	Journal	Journal	Journal	Journal	Journal	Journal
50,000	1.6	1.9	2.3	2.9	3.5	4.3	5.5	6.7
25,000	1.3	1.6	1.9	2.4	2.9	3.5	4.6	5.5
10,000	1	1.2	1.5	1.9	2.3	2.8	3.5	4.3
5,000	1	1	1.2	1.6	1.9	2.3	2.9	3.5
2,500	1	1	1	1.3	1.6	1.9	2.4	2.9
1,000	1	1	1	1	1.2	1.5	1.9	2.3
500	1	1	1	1	1	1.2	1.6	1.9
250	1	1	1	1	1	1	1.3	1.6
100	1	1	1	1	1	1	1	1.2

Source: Noria Corporation. Used with permission.

