How to Use Fluid Cleanliness Standards to Drive Cost Control

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In today's competitive economy, businesses are challenged to identify ways to increase profit margins without significant capital investments. For facility managers, cost control can be supported by raising maintenance standards to a Total Level Cleanliness program that controls costs by extending the life cycle of fluids and, in turn, of hydraulic systems that they support.

Facility maintenance professionals can see greater returns on their cost control efforts by working closely with their service providers, such as oil reclamation companies, to establish clear agreements on maintenance practices that support such a program.

Program Benefits

An oil cleanliness program offers several benefits to a facility-wide cost control program. Each benefit produces measurable cost reductions.

1) Reduction in downtime and lost production: We're always in battle against equipment breakdowns that result in lost production, but contaminated fluid is often the ultimate enemy. The initial investments of resources into a rigorous Total Level Cleanliness program yield benefits that significantly outweigh the costs of downtime. In a paper mill, for example, an hour of lost production can cost $12,000. Factor in the costs of equipment repair or replacement over time and it's easy to see that oil decontamination is a worthy investment.

2. Extend fluid life: This benefit boils down to a simple fact: Dirty fluid must be disposed of and replaced. There's a clear cost benefit to maintaining cleanliness standards rather than enacting frequent wholesale oil replacement.

3) Reduction in wasted materials and supplies: Raising cleanliness standards can reduce other system costs. Maintaining cleaner fluid will ultimately extend filtration element service life and reduce the frequency of changeouts. In addition, each filter change produces a 5 to 10 percent fluid loss, which carries additional costs of fluid replacement and associated labor.

4) Reduction in maintenance labor costs: Although it may seem counterintuitive on the surface, a cost analysis can show that maintaining higher standards will reduce costs associated with complete oil changes, element changes and other labor-intensive activities. These activities often create larger or less predictable blocks of downtime, which produce an additional chip at your bottom line.

5) Reduction in energy costs: Pumping clean fluid requires less energy (another operations expense) than pumping contaminated fluid. Contamination affects pressure (delta p). It increases the fluid's viscosity, which forces the pumps to work harder. In addition, it causes the element to load more quickly and produces a faster increase in pressure. As contamination builds, the system demands and energy consumption increase. Once cleaner fluid is in the system, the pressure across the filter takes longer to build, thus reducing strain on pumps.

Implementing a Little TLC

To maximize the value of a Total Level Cleanliness program, your implementation approach should include several critical steps:

1) Evaluate and set fluid cleanliness targets using ISO codes for fluid and equipment.

Begin your cleanliness program by identifying and documenting target cleanliness standards for fluid, with each corresponding piece of equipment using ISO Code ISO4406-1999, the Method of Coding the Level of Contamination by Solid Particles. Equipment manufacturers should be able to provide you with codes that will yield optimal performance.

The ISO standard quantifies particulate contamination levels per milliliter of fluid at three sizes: 4µ[c], 6µ[c] and 14µ[c]. The code itself includes three "scale numbers" that represent a range of particle counts per milliliter for each particle size, as shown in Figure 1. Collectively, these counts are combined into a single code number. Note that each time a code increases, the quantity range of particles doubles. What may seem like a minor shortfall in achieving the target code actually creates a significant impact in achieving the desired cleanliness.

Number of particles per milliliter		Scale number
More than	Up to and including	
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
0.005	0.01	0
0.0025	0.005	0.9

Figure 1. Allocation of Scale Numbers

Maintenance pros may be tempted to develop variations on the standards, but doing so immediately undermines their purpose. To gain the greatest value from establishing cleanliness level targets using ISO codes, it's imperative that all parties responsible for fluid cleanliness (including service providers) follow the standards to the letter. Allowing variations to enter the process will invariably lead to requirement misinterpretations among maintenance personnel and service providers. As a result, the total cleanliness program will bring little to no financial rewards.

If maintenance leaders find it challenging to adopt ISO standards for every system component simultaneously, then they should plan a step-by-step approach to standard adoption rather than allow variations throughout the system. Begin with a section of the system and develop good maintenance practices around that section. As good habits are developed, challenges are corrected and results are tracked, you can expand your program to other areas. Your bottom-line improvements will increase substantially with each initiative.

2) Choose the right filter media for the job.

Once you establish your cleanliness level targets, you can develop a plan to cost-effectively achieve and sustain them. Focus on the cost analysis of the required work effort, with an eye on the equipment used to complete the task.

Filter µm Rating (β = 1000)	Typical ISO 4406 Cleanliness Code
1	12/10/07 - 14/12/10
3	14/12/10/ - 16/14/12
6	16/14/12 - 17/16/13
12	17/16/13 - 19/17/14
25	19/17/14 - 21/19/17

Figure 2. Filter Rating vs. Cleanliness Targets

The filtration ratings shown in Figure 2 provide a guide for specifying filter media to support your cleanliness program's target ISO codes. In addition, your filtration evaluation criteria should include fluid compatibility, pressure flow drop, dirt capacity and other technical requirements as shown in Figure 3.

Complete Specifications should include:
• β profile – βx =75,200,2000 - ISO 16889
• Clean DP (low and high visc) - ISO 3968
• Fluid compatibility - ISO 2943
• Flow fatigue resistance - ISO 3724
• Dirt capacity - ISO 4572
• Collapse pressure - ISO 2941

Figure 3. Hydraulic Filter Specification

When calculating the total cost assessment, include the costs of the number of elements and labor required to achieve the target codes. Media capable of filtering to your target codes more quickly can provide return on investment on a per job basis or over time. Media with superior service life further strengthens the ROI.

Establish a regular filtration evaluation system to help your business keep pace with improvements in filtration technology that can ultimately benefit your bottom line. Either independently or in partnership with your service providers, conduct a bi-annual review of filtration technology using clearly defined evaluation standards. The findings may reveal opportunities to improve the ROI of filtration media in ways that can benefit both the plant and the vendor.

3) Establish an oil analysis program and schedule of samples.

Managed correctly, a regularly performed oil analysis program will provide maintenance pros with three valuable indicators for a fluid cleanliness program: the current fluid cleanliness level; the efficacy of your contamination control system; and the presence of upsets or abnormal conditions in the system. This information will help you take the appropriate proactive or reactive steps to support fluid and system performance. The costs related to spectroanalysis are minimal in comparison to the expenses of fluid replacement or equipment repair.

Check fluids monthly and track the results. If budget or personnel limitations prevent monthly analysis, quarterly analysis and tracking can provide some benefit to your program. You can maximize the value of this information by tracking the data over time. Changes in element compounds such as iron or brass in the fluid may help you identify equipment wear that is entering (and contaminating) your system.

4) Filter all new fluids.

As shown in Figure 4, new fluids are not clean. Adding new fluids without filtration or with minimal filtration will undermine your cleanliness program. When it's necessary to add or replace fluid, conduct filtration to the minimal threshold of your established ISO standards, if not to one scale number above your target codes.

It's become common practice to bypass this work in an effort to cut costs. But the investment into high-quality, cost-efficient filtration up front will typically cost substantially less than the effects associated with placing contaminated oil into your system, including more frequent fluid replacement and downtime associated with fluid replacement or equipment damage. You can improve cost efficiency of this step by specifying high-performance filtration equipment that can quickly achieve your target codes. If you outsource this responsibility, talk to your service provider about the costs of cleaning new oil to achieve your target cleanliness standards, and conduct a joint review of their filtration equipment to assess the cost-effectiveness of their system following the guidelines in Step 2.

5) Seal all reservoirs and bulk tanks.

Air is filled with contaminants smaller than 40 microns that are not visible to the human eye. If your reservoirs and tanks aren't completely sealed, you are inviting these contaminants into your fluid and your system. The simple act of neglecting to replace the breather can directly impact your fluid cleanliness, which in turn compromises your fluid performance and system operating costs.

As you refine your maintenance routine to support Total Level Cleanliness, add this and other good housekeeping practices to your maintenance assignments.

6) Identify and minimize leaks.

Leaks in system or transfer lines that carry fluid create a double dip into your bottom line. Leaks cause two problems for your budget: fluid loss and access for contamination to enter the system. The cost to replace an O-ring is obviously much less than the cost to replace oil or damaged equipment.

Conducting a simple yet thorough monthly review of the system will create value for the program. By synchronizing this activity with your monthly oil analysis, you can efficiently assign responsibility and track successful completion of both tasks.

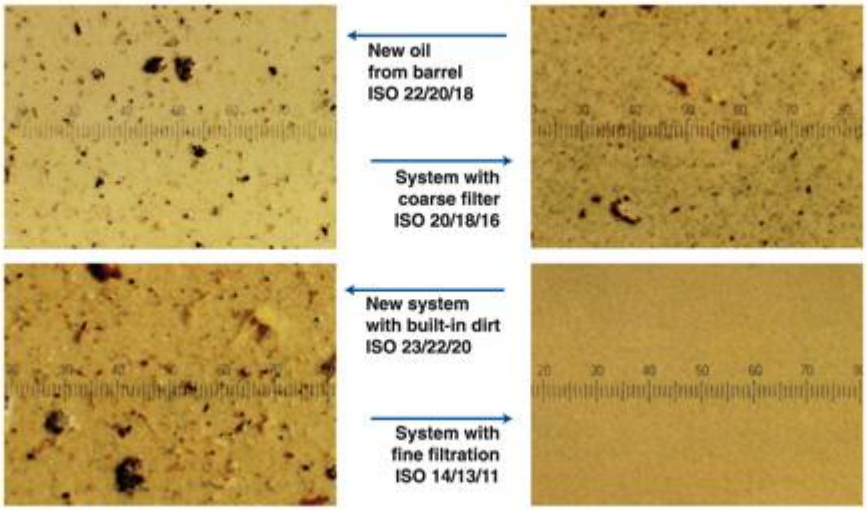

Figure 4. Contamination Level Comparisons

Benefits Outweigh Investment

With education, planning and a disciplined approach to oil decontamination practices, maintenance pros can improve their cost control efforts. In general, the benefits of proactive efforts to achieve and sustain ISO cleanliness codes can outweigh the investment into more stringent cleanliness standards. Today's economic climate provides even greater incentive for maintenance leaders to work in partnership with their vendors to create plans for protecting their shared interests in profitability.

About the Author

Ivan Sheffield is a Senior Partner, in a privately held company based in Nashville, Tenn. He has specialized in filtration technology for hydraulic systems since 1984, and he frequently shares his expertise in contamination issues, oil analysis and new filtration technology. He is an active member in several organizations that support performance improvement and industry issues, including the National Fluid Power Association, the Technical Association of Pulp and Paper Industries, and standard development committees for the International Organization for Standardization (ISO).