



Pall Corporation

Scientific & Technical Report

The Essential Guide to Oil Filter Performance Testing Standards

Evaluating Filter Performance? Always Use a Recognized Protocol

Filter users depend on national and international standards for the testing of fluid filters for a certain level of quality and performance and for comparison of performance claims from different filter manufacturers. Without a standard test method each manufacturer would be left to their own methodology and convenience to evaluate and rate filters

The role of standards organizations is to provide the industry with a level playing field where product performance can be assessed, replicated and communicated in a reliable and consistent manner. Following is a comparison between a few filter testing procedures, some internationally recognized, some not:

ISO 16889:2008 Hydraulic fluid power — Filters — Multi-pass method for evaluating filtration performance of a filter element:

This is the most widely recognized test for evaluating the performance of hydraulic and lubrication filters since 1999. It improved and replaced ISO 4572 that was in use since 1981. Often referred to as the “Multi-pass Test”, this test standardizes measurement of efficiency (the Beta Ratio) as well as flow resistance, contamination loading characteristics, etc. The test is performed under steady state flow condition with injection of a standardized contaminant. Particle counts are monitored on-line as the filter is loaded with test contaminant (ISO Medium Test Dust). This test procedure was a major step in the standardization, clarity, and communication of filter performance

evaluation, and has served as the primary filter test standard since 1999 but things could be improved....

SAE ARP4205 — Aerospace Fluid Power — Hydraulic Filter Elements — Method for Evaluating Dynamic Efficiency with Cyclic Flow:

Some real life filter applications are tougher than others. Most hydraulic systems exhibit cyclic flow conditions that can have an impact on filter performance that a lab test under the ISO 16889 procedure could not reproduce, nor predict. Faced with the need to better simulate these tough dynamic operating conditions, the A-6C1 committee of SAE on Contamination & Filtration reviewed numerous proposals by industry experts.

After a long process of discussion, testing, evaluation, and verification, the committee approved a test method in December 2005, the SAE ARP4205 procedure.

This test cycles flow for 5 seconds at the full flow and 5 seconds at 25% of the full flow rate – thus cycling at the rate of 0.1 Hz. The SAE ARP4205 procedure includes a specific detailed method for validation of the test stand and the ability of the stand to accurately measure the contamination levels. The method uses ISO Fine Test Dust as the test contaminant.

Under the SAE ARP4205 test conditions, similarly rated filters as per the testing under ISO16889, showed

very different performance, illustrating the need for cyclic tests to better predict real life behavior of filter elements under cyclic flow conditions.

Table I below shows the SAE ARP4205 test results for similarly rated (5µm_(C) per ISO 16889) from eight different manufacturers. The results are shown as fluid cleanliness levels, per ISO 4406, downstream of the test filters, giving the users a recognizable performance criterion. The oil cleanliness based on the actual stabilized particle counts downstream of the filters at 80% net pressure drop, which is near the end of the filter service life, clearly illustrate that filter from manufacturer 1 maintained the best fluid cleanliness, and therefore will provide the greatest protection to the system. This represents a clear differentiation among filters with similar micron rating per the Multi-pass test.

| Filter Mfg | Stabilized Particle Count, particles/mL | | | ISO Code | Clean Δp (psid) |
|------------|---|-----------|------------|----------|-----------------|
| | > 4 µm(c) | > 6 µm(c) | > 14 µm(c) | | |
| 1 | 17 | 1.3 | 0.0 | 11/07/01 | 1.5 |
| 2 | 41 | 1.8 | 0.0 | 14/11/01 | 4.9 |
| 3 | 71 | 5.0 | 0.5 | 13/09/06 | 2.4 |
| 4 | 84 | 14.8 | 0.0 | 15/10/01 | 3.1 |
| 5 | 161 | 5.8 | 0.0 | 13/08/01 | 5.4 |
| 6 | 210 | 6.8 | 0.0 | 15/10/01 | 2.2 |
| 7 | 401 | 22.0 | 0.0 | 16/12/01 | 3.9 |
| 8 | 542 | 20.8 | 0.0 | 16/12/01 | 2.7 |

Table 1 – Test results per SAE ARP4205 for similarly rated filters from eight manufacturers.

Pall Cyclic Stabilization Test (CST):

Over 15 years ago, Pall developed a test procedure to qualify a new line of filters designed specifically to sustain very tough operating conditions. Pall’s “Stress resistant Technology – (SRT)” filters were developed using the Pall Cyclic Stabilization Test (CST) at the time. Within a few years, thousands of

installations around the world were equipped with CST rated filters.

Pall SRT filters demonstrated superior performance both in lab and real life measurements of fluid cleanliness, validating the CST test as a consistent and reliable predictor of actual filter performance in tough conditions. In fact, it was actually the CST procedure that was proposed to the SAE A-6C1 committee by Pall and was later adopted with a few minor modifications as the SAE ARP4205 procedure in 2005.

Despite claims to the contrary, today there are a number of independent laboratories all over the world that can run filter performance tests under cyclic flow conditions per the SAE ARP4205 to provide a true, unbiased, and reproducible assessment of a filter.

Dynamic Filter Efficiency (DFE) test – Hy-Pro’s internal testing procedure:

The DFE test used by Hy-Pro was originally a contender in the selection process of the SAE AC6-1 Committee on Contamination and Filtration. Because it was rejected by the committee in favor of the Pall CST proposal, the DFE test is not a SAE standard procedure, and cannot be replicated under the strict guidelines of SAE, nor any other standards body. There are a number of fundamental differences between the CST and the DFE procedures - most prominently the DFE cycles the flow at full rate for 3 minutes and at 50% of the full flow for 3 minutes, thus cycling at the rate of 0.0028 Hz compared to 0.1 Hz for the Pall CST test – which makes the DFE cycle rate 36 times slower. The rate of change of the flow rate (the speed at

which flow rate changes from one value to the other) is not published for the DFE test. It is impossible to know if the filter is subjected to rapid change in flow rate, or a slow rise. In the CST procedure, flow changes happen within 0.1 to 0.2 seconds. In addition, the Hy-Pro DFE literature does not discuss important test parameters such as initial contamination level for filter test or the injection system and the base upstream gravimetric level. The SAE ARP4205 procedure includes a specific detailed method for validation of the test stand and the ability of the stand to accurately measure the contamination levels. There was no such validation procedure for the DFE test when proposed to SAE. The “DFE Rating” Hy-Pro uses for its filters is somewhat analogous to the “nominal” filter rating in the sense that only the filter manufacturer assigning the nominal rating knows what it means and it is different from one manufacturer to the other.

ISO 23369 — Hydraulic fluid power — Multi-pass method of evaluating filtration performance of a filter element under cyclic flow conditions:

It should be noted that there is another cyclic flow test procedure under development by ISO under the designation ISO 23369. This procedure recognizes the need for rapid flow cycling and specifies a cycle rate of 0.1 Hz with the flow change taking place within 0.1 to 0.2 seconds, the same as SAE ARP4205. This shows the wider recognition and applicability of the SAE ARP4205 procedure as the standard to adequately measure, and compare, filter performance under cyclic flow conditions.

Conclusion:

The ability of a filter to sustain tough operating conditions and still provide excellent fluid cleanliness is paramount to protect modern machinery.

International standards bodies like SAE and ISO have worked hard and diligently to develop testing procedures that would simulate real life conditions. Today SAE ARP4205, and – in the future, the ISO 23369, are designed to provide an unbiased, repeatable and equitable evaluation of filter performance.

Filter users should therefore seek out test data based on these industry-proven, peer reviewed and committee sanctioned test methods. Relying on non-standard procedures invalidates any meaningful comparison between filters. It can ultimately place critical machines at risk if the filters designed to protect them have not been evaluated and shown to perform in accordance with the tough conditions of an industry recognized test standard.

References:

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Power Generation


25 Harbor Park Drive
Port Washington, New York 11050
+1 516 484 3600 telephone
+1 888 873 7255 toll free US



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