FRAM® Technical Information

# Now A Fluid Filter Rating That Makes Sense

There is no question that fleet management needs a valid standard for making apples to apples price/performance comparisons of the lube oil and hydraulic fluid filters offered by various manufacturers. Until recently, such a standard has not been available.

In the absence of a valid basis of comparison, the industry has made use of a non-standardized measure which has been called by many names, including nominal rating, nominal micron rating, and micron rating. For filter manufacturers, original equipment manufacturers and, especially, end-users, attempts to use micron ratings as a means of comparison have resulted in far more harm than good. To be perfectly blunt, comparisons based on today's micron are almost meaningless.

Fortunately, a meaningful, universally valid filter rating standard – the B (beta) ratio – will be in effect in the near future. The purpose of this article is to explain the new standard and its advantages. But first it will be helpful to briefly discuss the old micron rating and what is wrong with it.

### Micron Ratings Are Not Repeatable

Micron is another name for micro-meter (one millionth of a meter or 39 millionths of an inch). Micron ratings were used initially by various filter manufacturers to evaluate the relating porosity of flat sheets of media used in making the filter elements.

The intended purpose of indicating the relative freeness or tightness of a sheet of filter media has been served well by the micron rating. However, the micron rating has also found its way into widespread use as a measure of filtration efficiency, something for which it was not originally intended. Here are some of the reasons why micron rating is totally inappropriate for this use:

1. *The test is not repeatable at different labs.* Each manufacturer has its own test procedures. Although the test is a valid comparison of one paper to another within a given company, the micron rating does not lend comparison of filters made by different manufacturers. While one manufacturer may give a paper a nominal micron rating of 10, another may rate it 2 and a third may rate it 15. There simply is no basis for comparison.
2. *There is no consistent relationship between micron rating and actual filtration efficiency.* The relative porosity of a sheet of filter media is only one of the factors which determines the efficiency of a filter. The physical construction of the media, the filter and the element, as well as the types of contaminants to be encountered, are also very important. The entire filter needs to be tested, not just the paper.
3. *The micron rating does not show what happens to a filter over time.* The performance of a liquid filter may deteriorate with use. The micron rating is a one-pass test done on a new sample of filter paper which provides no information about how a filter will stand up under continued use.

The inadequacies of micron ratings have been readily apparent to the vast majority of OEMs. Many have established their own rigid, repeatable, performance criteria which a filter must meet to qualify as acceptable for a particular vehicle. Others are calling for the standardized multi-pass test and its resultant unit of measure, the B ratio.

To further simplify the specification of filters, SAE is currently moving toward adopting the multi-pass test as a standard procedure.

Unfortunately, reliance on micron ratings is still wide-spread at the user level. Filter manufacturers reluctantly provide micron ratings to fleets who are still insistent on having this information, even though it serves more to confuse than to clarify. This situation will improve as end-users develop an appreciation for the tremendous usefulness of multi-pass test data.

### A True Measure of Filter Performance

The multi-pass test has developed from the on-going work of Dr. Ernest Fitch and his staff at the fluid power research center of Oklahoma State University's Engineering Department. Working under a grant from the U.S. Army's MERDC (Mobile Equipment Research and Development Command) in the early 1960s, Dr. Fitch was commissioned to study the ways in which contamination affects fluid system performance.

The multi-pass test was developed initially as a means of assessing hydraulic fluid filters. This information was made available to the industry through Dr. Fitch's close affiliation with the National Fluid Power Association which adopted the multi-pass test as a test procedure, as did the American National Standards Institute (ANSI) and finally the International Standards Organization (ISO). The multi-pass test has also been adapted to other types of liquid filters, most notably, those for lube oil.

As a means of evaluating filter efficiency, the multi-pass test answers the major deficiencies found with micron ratings:

1. *The multi-pass test is repeatable.* In order to perform this test, strict procedures must be followed using only validated test equipment. Therefore, multi-pass test data is generally comparable from one filter manufacturer to another.
2. *The multi-pass test provides a true indication of filter efficiency* because an entire filter is tested, not just a sheet of filter media.
3. *The test does account for what happens to a filter over time* because measurements are taken at multiple intervals during the filter's effective test life. The drop in a filter's efficiency during multi-pass testing is analogous to what will happen to a filter under field conditions.

### How the Multi-pass Test Works

The multi-pass test requires the continuous injection of contaminant into the test system. The separation capability of the test filter is monitored by analyzing upstream and downstream fluid samples at regular intervals until the filter produces a specified pressure drop in the system due to its plugging.

In addition to answering the major deficiencies of micron ratings, multi-pass testing produces a far more precise measure of filter efficiency, the B ratio. B ratio is defined as the number of particles greater than a given size in the fluid upstream of the filter, divided by the number of particles of the same size found downstream of the filter. Particle numbers are determined by count, not weight.

A $B_{10}$ value of 2 would mean that for every 1,000 particles greater than 10 microns found upstream, 500 particles greater than 10 microns passed though the filter. Since only half of the particles are removed, a $B_{10}$ value of 2 indicates that the filter is 50% efficient for taking out particles larger than 10-microns. (Figure 1 shows efficiencies indicated by various B values.)

A given filter may have several meaningful B values. This is important because particles of different sizes produce different wear characteristics. In specifying a filter for a given vehicle, the engine manufacturer may want to look carefully at not only $B_{10}$ values but $B_5$, $B_{15}$, $B_{20}$, or $B_{30}$ as well.

### A Few Cautions are in Order

The fleets should be enthusiastic about the transition to multi-pass testing because it provides filter performance data far more useful than has been available in the past. Unfortunately, once the standard is adopted, it will take many years before a majority of filters will have multi-pass data available.

Multi-pass test equipment is very expensive, and it is not likely that manufacturers will have more than one or two test set-ups available for testing the thousands of filter models currently in use.

Furthermore, the test itself is a lengthy procedure. Even though particles are counted by automatic counters, it still take roughly 12 hours to perform a test on a single filter with conventional test equipment.

FRAM, working closely with a specialized equipment supplier, recently acquired a computerized multi-pass test system which will perform this test in approximately four hours. Even so, it would be many years before all the filters in the company's product line could be tested.

A few other cautions are in order. Although B ratio is a far superior measure of filter performance than micron rating, it should not be regarded as the only important measure. For example, hydrostatic (leak) resistance, which is not addressed by multi-pass testing, is an important consideration for spin-on filters.

End-users should also be wary of numbers games – they can also be played with B ratios. B ratios higher than 75 indicate little additional improvement in filtering efficiency. Furthermore, the test procedure to develop the B ratio is valid only for B value up to 75. For B ratios of 75 and higher, there are not enough particles in downstream liquid samples to make counting them statistically significant.

Another numbers game has to do with illegitimate comparisons. Even though multi-pass data does lend itself to comparison of filters from different manufacturers, it is still necessary for the end-user to be very alert to various ways in which information can be presented. The end-user should be certain that valid comparisons are made, and that these are supported by recognized and accepted test methods.

Fortunately, multi-pass test data is not difficult to understand. Anyone who is comfortable with the few examples given earlier in this article should have no trouble using the data. As this data becomes available, heavy duty fleets will have a far more useful tool for making cost/performance evaluations of various filter products.

In summary, multi-pass testing is an excellent laboratory research tool for evaluating what happens when different filter sizes, filter media, flow rates, and contaminant size categories are used. The B ratios provide a composite picture of how a given filter will perform throughout its entire useful life. They provide engine manufacturers with a great deal of useful information for specification purposes. And they give the end-user a meaningful basis of comparison (apples-to-apples) of one brand of filter to another.

**Figure 1:**
**B Values And Corresponding Efficiency Levels**

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|---|---|---|---|---|---|---|---|---|---|
| $Beta_x$ | = | 1.0 | = | 0.0% Efficient | $Beta_x$ | = | 4.0 | = | 75.00% Efficient |
| $Beta_x$ | = | 1.2 | = | 16.67% Efficient | $Beta_x$ | = | 16.0 | = | 93.75% Efficient |
| $Beta_x$ | = | 1.5 | = | 33.33% Efficient | $Beta_x$ | = | 20.0 | = | 95.00% Efficient |
| $Beta_x$ | = | 2.0 | = | 50.00% Efficient | $Beta_x$ | = | 50.0 | = | 98.00% Efficient |
| $Beta_x$ | = | 3.0 | = | 66.67% Efficient | $Beta_x$ | = | 75.0 | = | 98.67% Efficient |

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