"MICRON RATING" vs "BETA RATIO" FILTER RATINGS

Oil filter micron ratings are arbitrary values assigned to filters or media used in filters. A "micron" is a length (1 millionth of a meter), a "micron rating", however, is not actually a measured value. The micron rating for a filter specifies a particle size but does not establishing the filter's efficiency at removing that size of particle or indicate the capacity of the filter. A *nominal micron* rating reflects an average rating where pore size can vary from extremely small to very large in the same media. An *absolute micron* rating indicates the pore sizes range from the rated size and smaller.

Beta Ratio Tests are by far the most accurate and objective way to compare the performance of filters. A Beta Ratio Test measures a filter's ability to remove particles of given sizes. In other words, the test measures the filter's efficiencies at specific particle sizes. The beta ratio test equipment actually counts the particles in the fluid before the filter and after the filter.

$$\beta_X = \frac{n_{Upstream} \geq X\ \mu m}{n_{downstream} \geq X\ \mu m}$$

ISO 16889:1999 Multi-pass Test

The multi-pass test standard is intended to provide a test procedure that will provide reproducible test data and can be used to evaluate the dirt-holding capacity and the particulate removal efficiency (Beta Ratio) of a filter element. The test measures the particulate removal efficiency as it relates to the ingression of dirt particles creating increased differential pressure over element life (Beta Stability).

Test material of a known particle size distribution is added to the fluid in the injection reservoir until it reaches a specified concentration in grams of contaminant per liter of test fluid. The fluid in the injection reservoir is then pumped continuously into the clean fluid in the test reservoir, thereby creating a low concentration test solution. This test solution is circulated continuously to the test filter at a constant flow

rate. The test solution is filtered by the element under test and returns to the test reservoir (along with any unfiltered particles). This cleaned fluid is contaminated again by the injection fluid, and is once again pumped to the test filter.

During the test, the element differential pressure, the upstream and downstream particle counts and the amount of injected contaminant are continuously monitored. In most instances, the multi-pass test is completed when the element differential pressure reaches the specified limit or the Beta Ratios fall below a specified level.

Calculation of Average Beta Ratios

To calculate the average Beta Ratio, the total test time taken to arrive at the element differential pressure alarm setting (or customer-specified value) is divided into 10 equal time frames. In each time frame, the sum (total number) of upstream particles from each counting period is calculated then averaged. Accordingly, the downstream particles are summed and averaged. These values are then graphed against the differential pressure at the end of the time frame. This allows for the Beta Ratio to be determined at different filter differential pressures.

Calculation of a Single Beta Ratio for Length of Test

A single beta value for the duration of the test is derived by summing the average upstream particle counts from each of the 10 time frames, and dividing this total by the sum of the average downstream particle counts from each of the 10 time frames. These values are then used to determine the particle size that would yield the average beta ratio of 2, 10, 75, 100, 200 or 1,000.

Efficiency

Filter element efficiency for a particular micron rating is determined by the Beta Ratio for that micron rating. The calculation is Beta Ratio minus one divided by the Beta Ratio then multiplied by 100. For example, an element with a Beta Ratio of 200 for a particular micron rating has the following efficiency:

(200-1)/200 or
99.5 percent efficient

Table 1 shows the Beta Ratio, corresponding efficiency and the number of particles that will pass to the downstream side of the element for each 100,000 particles seen at the upstream side of the element.

Table 1. Beta Ratio and Efficiency

Beta Value	Efficiency	# Upstream	# Downstream
2	50.0000%	100,000	50,000
4	75.0000%	100,000	25,000
10	90.0000%	100,000	10,000
20	95.0000%	100,000	5,000
40	97.5000%	100,000	2,500
60	98.3333%	100,000	1,667
75	98.6667%	100,000	1,333
100	99.0000%	100,000	1,000
125	99.2000%	100,000	800
150	99.333%	100,000	667
200	99.5000%	100,000	500
300	99.6667%	100,000	333
500	99.8000%	100,000	200
1,000	99.9000%	100,000	100
2,000	99.9500%	100,000	50
4,000	99.9750%	100,000	25
5,000	99.9800%	100,000	20
10,000	99.9900%	100,000	10
20,000	99.9950%	100,000	5
50,000	99.9980%	100,000	2

Beta Stability

Beta stability is the measure of how well a filter element is able to maintain its measured Beta Ratio at pressure drops beyond the limits of the normal operating range. For example, beta 200 stability = 210 psid, means that the Beta Ratio for the rated micron size will not drop below beta 200 until it reaches 210 psid across the element.

A comprehensive filtration strategy designed to maintain the proper target cleanliness for the system can substantially reduce contamination-related failures. Filter elements must be compared based on the multi-pass test results. The Beta Ratio, or particle removal efficiency, is also important. Using elements with low Beta Ratios or poor efficiencies, even though the purchase price may be lower than an element with high Beta Ratio or good efficiency, will inevitably result in much more costly system failures.

Extracted in part from Eric Ringholm, HYDAC Technology Corporation, "Understanding Filter Beta Ratios". ***Practicing Oil Analysis*** **Magazine. January 2004**