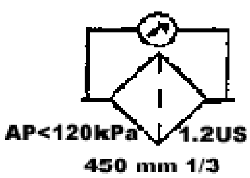
TECHNICAL SERVICE BULLETIN 97-1

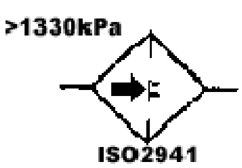
Hydraulic Filter Performance Criteria

Hydraulic or Fluid Power systems come in many sizes and shapes. They can be simple or complicated in their design, however all hydraulic systems need protection from harmful abrasive particles. Early fluid power systems were simple and filters were nonexistent. Today we see fluid power systems as fast growing and ever changing. This is due to the fact that fluid power systems are being used in place of various power transmitting devices such as belts, chains, cables, shafts, etc. Fluid power systems are becoming more sophisticated through tighter tolerances, faster cycle times and higher pressures. This puts more demand on the filtration system. The filter is a very important component in the fluid power system. System filters are becoming more efficient and more numerous. Placement of the filters in the hydraulic system is becoming more critical; strategic locations are necessary due to the sensitive, close tolerance components within the system.

To ensure that you are receiving the correct replacement filter for each of your applications, you need to review the performance criteria recommended by the original equipment manufacturer. This service bulletin can be used as a review of the requirements you may encounter and what those requirements mean to you. The major criteria for performance are: resistance to flow, collapse strength, fabrication integrity, capacity/efficiency, flow fatigue, hydrostatic burst, vibration durability and impulse fatigue tests.



Resistance to flow or differential pressure shows how pressure drop occurs across the filter or how much resistance to flow the filter imparts to the system. This resistance, sometimes referred to as pressure drop or delta P (ΔP), has a direct bearing on the filter life. Be sure you note the viscosity and flow of the fluid used in determining these criteria.



Collapse strength is determined by the ISO 2941 test procedure. Collapse strength is the minimum acceptable differential pressure at which a structural failure of the filter element and/or center tube will occur. When a filter reaches a level of plugging or a cold start occurs or a combination of both, an increase in pressure is seen between the inlet (dirty side) and the outlet (clean side). If this differential pressure is great enough, the filter element and/or center tube can rupture or collapse. This is serious because unfiltered fluid and damaged filter

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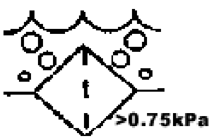
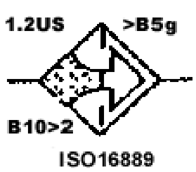
components can then be routed back into the system (see TSB 96-2 for diagnosing collapsed center tube failures).



Fabrication integrity (or bubble point) is determined by the ISO 2942 test procedure. This test ensures that the filter media does not leak due to holes or improper assembly. In this test, the filter element is submerged in test fluid and slowly pressurized until bubbles appear.



Capacity/efficiency can be determined from ISO 16889 Multi-pass test procedure. This test will tell you how much contaminant the filter will retain and the efficiency of the filter in removing the contaminant. This is a laboratory test that is very difficult to compare to the real world, but it will give a relative comparison of different filters, if the test conditions are the same. The capacity is usually given in grams of standardized test contaminant. The efficiency is given as a Beta ratio.

Beta Ratio is a formula used to calculate the filtration efficiency of a particular filter using the data from multi-pass testing. Part of the ISO 16889 standard says the maximum reliable filtration ratio is Beta(x) = 75. This is commonly known as the "absolute" rating for the filter. The Beta(x) = 2 is commonly known as the "nominal" rating.

To covert a Beta ration to efficiency, use the following formula: (Beta Ratio-1)/Beta Ratio = Filter Efficiency. The Beta(x) =2 efficiency is (2-1)/2 = 1/2, the efficiency is 50%. The Beta(x) = 75 efficiency is (75-1)/75 = 74/75 = .98666 or 98.67%. The (x) after the word Beta denotes the size particle that is being considered. Therefore, Beta (10) = 4 means that the filter in question is 75% efficient at removing 10 micron size contaminants and larger from the hydraulic system (see TSB 89-5 and TSB 04-2 for further information on micron ratings and Beta ratios).

The International Rating System for fluid contamination levels is called the ISO rating code (ISO stands for The International Organization for Standardization, along with ANSI - American National Standards Institute, NFPA - National Fluid Power Association and SAE - Society of Automotive Engineers - these organizations establish standards for testing fluid power components). Most equipment manufacturers publish filtration level requirements using the ISO code. There is no direct relationship between filter manufacturers published Beta ratings that describe the media efficiency performance levels and the ISO code which describes the system cleanliness level. The ISO code for a system will be determined by oil sampling

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analysis.

ISO 4406: 1999 establishes a three factor code (X/Y/Z) to express fluid cleanliness in terms of a range of particles per milliliter. The "X" factor represents the count of particles equal to and greater than 4 microns in size contained within one milliliter of sample fluid. The "Y" factor represents the count of particles equal to and greater than 6 microns in size contained within one milliliter of sample fluid. The "Z" factor represents the count of particles equal to and greater than 14 microns in size contained within one milliliter of sample fluid. Based on the count for each of these size ranges and the chart below, the three factor code can be developed. An example code would be 18/16/13. This means that within the fluid sample, per milliliter, there are more than 1,300 but less than or exactly 2,500 particles equal to and greater than 4 microns in size (Code #18), more than 320 but less than or exactly 640 particles equal to and greater than 6 microns in size, and more than 40 but less than or exactly 80 particles equal to and greater than 14 microns in size. Consult equipment and component manufacturers for specific codes required in particular applications.

	Particle Count / Milliliter	
Code #	Greater Than	Less than or Equal To
24	80,000	160,000
23	40,000	80,000
22	20,000	40,000
21	10,000	20,000
20	5,000	10,000
19	2,500	5,000
18	1,300	2,500
17	640	1,300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	0.64	1.3
6	0.32	0.64

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