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AEROSPACE INFORMATION REPORT

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LIQUID FILTER RATINGS

1. SCOPE

This AIR explains the meaning of "ABSOLUTE" and "NOMINAL" ratings which are used to describe liquid filter element physical characteristics. A set of standard filter ratings and methods of determination to further describe an element performance are also included. These data are only applicable to a system in which the system liquid wets the filter element.

2. FILTER RATINGS

Filter ratings are arbitrary yardsticks which have been selected to differentiate between filter elements. Many factors are considered in establishing a filter rating procedure, such as sensitivity, reproducibility from test to test and between laboratories and speed of performance. While each filter rating measures a parameter which attempts to correlate with system performance, the rating procedures can only simulate rather than reproduce system conditions.

2.1 Absolute Filter Rating

The absolute filter rating is defined as the largest size hard spherical particle which will pass through the filter element. This determines the maximum pore (inscribed circle) opening in a filter media.

Two methods are used to measure absolute filter rating. The direct method is the maximum spherical particle test. The indirect method is the bubble point (pressure) test. Bubble point test may be correlated to maximum spherical particle test for a specific filter media and thus can be employed as a simple production test.

The maximum spherical particle test measures the diameter of the largest spherical particle passed through the filter media as measured under the microscope. Tests are based on the filtration of an artificial contaminant under specified test conditions. In order to obtain consistent results, spherical glass beads are used. Effluent fluid containing the artificial contaminants which have passed through the test filter is collected. This fluid is filtered through a membrane filter and the particles retained on a membrane surface are scanned microscopically and examined. The largest particle is measured and this defines the absolute size rating of the filter. The microscopic measurement is a two-dimensional one.

It must be recognized that some non-spherical particles larger than the absolute rating of the filter will be able to pass through the filter. This is because the pores in a typical filter element are not circular but have some irregular shape (e. g. a warped triangle). Thus the largest spherical particle that can pass through a pore is the diameter of a circle inscribed in the pore.

The bubble point test is defined by ARP 901. This test measures an air pressure at which the first bubble emits at the top surface of the wetted filter element. This pressure is theoretically a measure of the diameter of the bubble sphere inscribed in the pore structure. However, in the actual case, there is always discrepancy in the measurement between the actual bubble pressure and the theoretical one. Therefor it is recommended that for a given filter a correlation should be established between the bubble pressure test and the maximum spherical particle test. Both the maximum spherical particle test and the bubble pressure test can only indicate the diameter of the largest sphere inscribed in the pore structure.

2.2 Nominal Filter Ratings

The nominal filter ratings are a measure of the removal of a given percentage by size, of a given artificial contaminant above a certain size with element heavily loaded at rated flow. For example, a nominal 10 micron filter (as defined by MIL-F-5504A) removes 98% of all 10 micron and larger particles present when, at rated flow, the differential pressure across the filter is 40 psi. (The 10 micron value relates to the second largest dimension of the particles.)

Nominal ratings therefore attempt to assess the overall performance of the filter by assigning an "average" or nominal pore size which is smaller than the absolute pore size and which is some statistical measure of the collective action of all the pore channels. Efficiency type tests (see para. 4.2) are generally used to develop an arbitrary nominal rating for a filter element.

There is no known technique for relating a nominal to an absolute rating for a similar filter media. Many tests and interpretations have been devised to measure the total cumulative efficiency of an element. These efficiency tests are not standard and are not specified in detail. "Nominal" ratings often become mere names or code identifications for filters, and since existing Military specifications do not specify "nominal" filter size, further use of this term to describe a filter performance should be discouraged.

3. FILTER RATING PROCEDURES

3.1 Absolute Filter Rating.

3.1.1 Maximum Spherical Particle Filter Rating:

The test procedure for maximum specific spherical particles (5, 15 and 25 micron) passed through the filter is described in the following documents:

MIL-F-8815A
MIL-F-25682A
MIL-F-27656A

It is emphasized that filter sizes other than those covered by mentioned Military specifications require special considerations and test procedures. Such functional parameters as flow rate, type of fluid, contaminant type and amount, filter size, temperature of fluid and type of media influence the test procedures and require a specific treatment and development of additional test procedures which specify flow, quantity and type of contaminant to be used. Figures 1 and 2 are provided for additional information.

An ARP will be written to provide detail procedures for conducting tests on filter element not covered by above Military specifications.

3.1.2 Initial Bubble Pressure Test

The test method for initial bubble pressure test is described in ARP 901.

3.2 Nominal Rating

There are no test procedures for determination of a nominal rating.

4. SIGNIFICANT FILTER PARAMETERS

Various characteristics that are used to further describe filtration capabilities of an element are:

(a) Dirt Capacity
(b) Efficiency
(c) Mean Flow Pore Size

This is not to say that the mentioned parameters can be related to each other or to the absolute and nominal ratings discussed earlier, however, they are considered to be useful tools for describing filtration performance.

4.1 Dirt Capacity

Dirt capacity tests measure the amount of artificial contaminant which can be added before pressure-drop becomes unacceptably high. Thus, filtration tests and capacity tests measure different performance characteristics. Optimum filter design combines high filtration efficiency with high dirt capacity to achieve the best overall compromise between efficiency and economy.

Dirt capacity tests are conducted in a manner similar to efficiency tests. Artificial contaminant is added upstream from the filter under specified tests conditions. Pressure drop across the filter is measured per ARP 24B at a constant fluid flow rate and increments of contaminant are added periodically until a specified differential pressure has been reached. The total contaminant thus collected is called the dirt capacity of the filter element. Dirt capacity tests are sensitive to several test variables such as contaminant characteristics, rate and amount added, fluid, temperature, flow rate and system conditioning (volume, clean up filter, etc). Standardized Air Cleaner fine test dust, which simulates natural airborne dust, is commonly used for dirt capacity testing. Dirt capacity is essentially dependent on particle size distribution. Dirt capacity (and efficiency) is increased at lower flow rates and decreased at higher flow rates. There are two types of dirt capacity tests which are described in MIL-F-25682 and MIL-F-8815. The basic difference is the use of a clean up filter in MIL-F-25682. Experience has shown that dirt capacity tests with system clean up filters can increase dirt capacity values as much as 50%.

4.2 Efficiency

The efficiency test provides a comparison of filtration performance. In this test, a predetermined weight of a specified contaminant is introduced upstream of the filter under test and passed through the filter at rate flow. The effluent is collected and filtered through a membrane filter. The contaminant retained on the membrane filter is weighed and compared with the amount added to compute efficiency.

4.3 Mean Flow Pore Size

The mean flow pore size is defined as the diameter of the pore such that the pores in a filter larger than this diameter carry a volume of flow equal to the pores in the filter element smaller than this diameter. Mean flow pore tests are an extension of the bubble point test which can be used to measure filter pore size distribution as well as the largest single pore. Mean flow pore tests are begun like the bubble point test by wetting the filter element in the test liquid and increasing the measured air pressure applied to one side of the porous wall until the first bubble appears. This pressure is the bubble point. As the pressure is progressively increased, bubbles will appear at other sites which have smaller pores until finally the element appears to be "boiling" furiously. The air flow rate and the differential pressure across the porous wall is measured during this process. Comparison of the air flow through a submersed wetted element with the air flow through this same medium provides a basis for analysis of the pore size distribution.

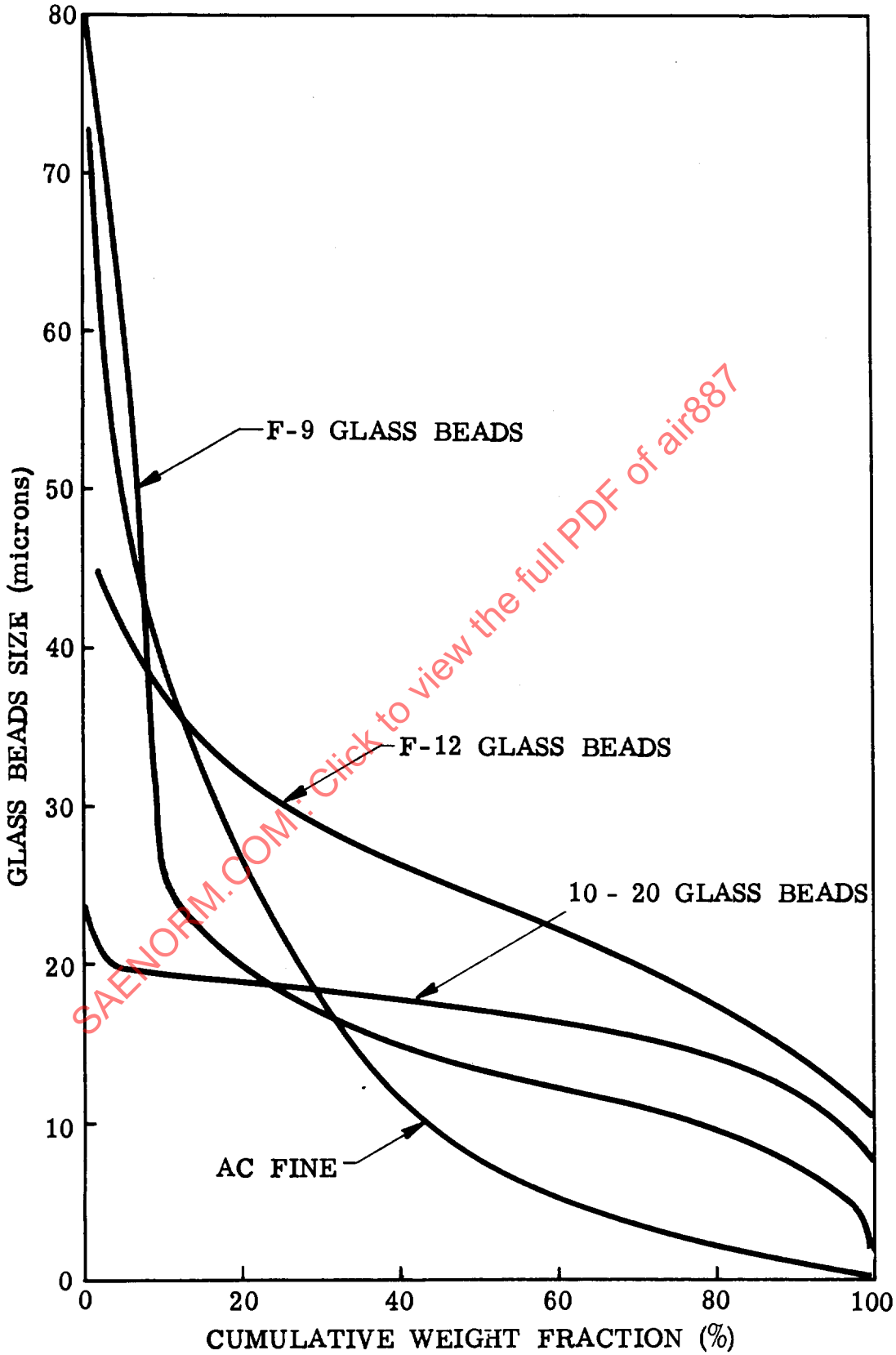

FIGURE 1 DISTRIBUTION OF GLASS BEADS FOR TESTING FILTER EFFICIENCY