Designation: B970 – 09

Standard Test Method for Cleanliness of Powder Metallurgy (PM) Bearings and Structural Parts [1]

This standard is issued under the fixed designation B970; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a quantitative procedure to determine the cleanliness of PM bearings and structural parts.

1.2 This is a laboratory test consisting of cleaning sample parts under controlled conditions and calculating the amount or percent of residue from the mass of the removed contaminants.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B243 Terminology of Powder Metallurgy

3. Terminology

3.1 Definitions of PM terms can be found in Terminology B243. Additional descriptive material is available in the Related Materials section of Volume 02.05 of the Annual Book of ASTM Standards.

4. Summary of Test Method

4.1 The parts are washed with a solvent to remove surface residue.

4.2 The rinse solution is collected and filtered to capture the residue removed from the parts.

4.3 The filter is dried and the mass of residue measured.

5. Significance and Use

5.1 Residue on a bearing may be detrimental to its longevity due to abrasive wear.

5.2 Residue on structural parts may affect the fit of assemblies or disturb the performance of the entire piece of equipment via excess friction or wear.

5.3 Part producers can utilize this procedure to determine the cleanliness of their processes. High residue levels on sintered parts may indicate a lubricant removal problem. Residue levels may also indicate the condition of various fluids used in part processing.

5.4 This test method can be applied when required by the user or internally for process engineering or quality control/compliance purposes by the producer.

6. Apparatus

6.1 *Basket*—Perforated aluminum, wire or stainless steel basket with handle to submerge parts in the solvent when using cleaning Method A.

6.2 *Container*—Glass or metal container sized to hold test fluid and parts.

6.3 *Solvent*—Laboratory grade toluene, petroleum ether or others as specified, since these are extremely flammable materials, extra care should be used to avoid ignition sources.

6.4 *Filter apparatus and filters*—Unless otherwise specified, a 10 µm nylon filter shall be used.

6.5 *Analytical Balance*—With a sensitivity of 0.0001 g.

6.6 *Balance*—Capable of weighing the parts tested to four significant figures if reporting a mass %.

6.7 *Container*— Weighing bottle or petri dishes.

6.8 *Squirt Bottle*—50 mL suggested.

6.9 *Drying Oven*—Capable of 120 °C, should be explosion proof if solvent is highly flammable.

6.10 *Vacuum Pump*—Capable of sustaining a pressure lower than 70 kPa.

6.11 *Ultrasonic Bath*—If used to replace manual agitation (see section 8.2).

[1] This test method is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and are the direct responsibility of Subcommittee B09.04 on Bearings.

Current edition approved Nov. 1, 2009. Published March 2010. DOI: 10.1520/B0970-09.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

7. Interferences

7.1 The larger the sample size the greater the precision that would be expected.

7.2 2 The type of solvent can produce different results depending on the aggressiveness of the solution.

7.3 The cleanliness requirements of the application will dictate the aperture size of the filter.

7.4 The size of the parts being tested will have a direct effect on the number that need to be tested.

7.5 The samples shall be protected from external contamination until ready to test.

8. Procedure

8.1 *Cleaning and Rinsing the Parts – Method A:*

8.1.1 The parties involved shall agree to the sample size and sampling method. In no case shall the sample size be less than 100 g.

8.1.2 Select the filter diameter to match the filter apparatus being used for this test.

8.1.3 Weigh the petri dish/bottle to the nearest 0.0001 g and record its mass so it can be tared from the mass of container plus filter. This container will be used to store the dried filter from paragraph 8.1.4 and 8.3.4.

8.1.4 Dry the filter paper in the laboratory oven at approximately 120 °C for at least 15 min. Place the dried filter in a covered petri dish or weighing bottle and cool to room temperature.

8.1.5 Determine and record the mass of the filter paper (petri dish or weighing bottle tared) to the nearest 0.0001 g; identify this mass as P_1.

8.1.6 Clean a perforated stainless steel or aluminum basket and place the parts in the basket.

8.1.7 Place the basket in a clean container large enough to contain the sample and solvent.

8.1.8 Fill the container with sufficient solvent to cover the parts. Agitate the basket for 4-6 min. with a twisting, up and down motion. If the part size doesn't allow for dipping a low-pressure sprayer may be used with agreement of producer and user.

8.1.9 Rinse the parts and basket in the container with an additional 50-100 mL of solvent using a squirt bottle, collecting the solution in the container with the wash solution by allowing the parts to drain for at least 2 min..

8.2 *Cleaning and Rinsing the Parts – Method B:*

8.2.1 This method may be used with agreement between the parties involved if in its application the part is subjected to a pressure that is lower than 100 kPa.

8.2.2 Caution must be used to avoid using Method B with materials that may be susceptible to damage when subjected to ultrasound.

8.2.3 The ultrasonic device, the duration of the cleaning and the frequency require agreement between the parties involved.

8.2.4 The parties involved shall also agree to the sample size and sampling method. In no case shall the sample size be less than 100 g.

8.2.5 Select the filter diameter to match the filter apparatus being used for this test.

8.2.6 Weigh the petri dish/bottle to the nearest 0.0001 g and record its mass so it can be tared from the mass of container plus filter. This container will be used to store the dried filter from paragraph 8.2.7 and 8.3.4.

8.2.7 Dry the filter paper in the laboratory oven at approximately 120 °C for at least 15 min. Place the dried filter in a covered petri dish or weighing bottle and cool to room temperature.

8.2.8 Determine and record the mass of the filter paper (petri dish or weighing bottle tared) to the nearest 0.0001 g; identify this mass as P_1.

8.2.9 Clean a glass or stainless steel container and place the parts in the container.

8.2.10 Fill the container with sufficient solvent to cover the parts.

8.2.11 Place the container with the solvent into the ultrasonic device. Operate the sonic cleaner for the agreed time and frequency.

8.2.12 Remove the parts from the solvent and rinse the parts with an additional 50-100 mL solvent using a squirt bottle, collecting the solution in the container with the wash solution. Drain the parts into the container for at least 2 min.

8.3 Filtering and Determining the Mass of Residue:

8.3.1 Assemble the filter paper into the filter apparatus and place on top of a flask sufficiently large enough to hold the entire volume of solution. Attach the flask to a vacuum pump. Turn on the vacuum pump and pour the solution into the top of the filter apparatus.

8.3.2 After the solvent from the container has been filtered, rinse the container and the funnel of the filter apparatus with additional solvent from the squirt bottle allowing this solution to also pass through the filter apparatus.

8.3.3 Remove the filter paper from the filter apparatus and dry in a laboratory oven at approximately 120 °C for at least 15 min.

8.3.4 Place the dried filter paper back into the petri dish and cool to room temperature. Weigh and record the mass of the filter paper and residue (petri dish or weighing bottle tared) to the nearest 0.0001 g. Identify this mass as P_2.

8.3.5 The residue collected on the filter may be further examined visually or chemically analyzed to determine the types of residues and possibly help determine the source of contamination.

9. Calculation

9.1 The amount of residue associated with the structural parts or bearings may be calculated and subsequently reported in two different ways. Either way is equally acceptable.

9.1.1 Residue per 100 parts, (R_{100})

$$R_{100}\,(g/100\,parts) = \frac{P_2 - P_1}{N} \times 100 \qquad (1)$$

where:

P_2 = mass of dried filter paper with residue, g,
P_1 = original mass of dry filter paper, g, and
N = number of parts being tested.

9.1.2 Mass percent residue, (%R)

$$0\% = \frac{P_2 - P_1}{M} \times 100 \quad (2)$$

where:

P_2 = mass of dried filter paper with residue, g
P_1 = original mass of dry filter paper, g, and
M = total mass of parts being tested, g.

10. Report

10.1 The solvent used.

10.2 Number of parts tested.

10.3 Whether hand agitation or ultrasonic cleaning was used.

10.4 Grams of residue as calculated in section 9.1.1 to the nearest 0.0001 g (R_{100}) or percent residue as calculated in section 9.1.2 to the nearest 0.001% (%R).

10.5 Identification of the parts tested.

10.6 Sampling method.

10.7 Identification of location in process from which parts were sampled.

11. Precision and Bias

11.1 *Precision:*

11.1.1 The repeatability (r) for three test specimens, from one lot tested in one laboratory, averaging 0.003% residue, was 0.0002%. Reproducibility and more complete repeatability are being determined and will be available on or before December 2014.

11.2 *Bias:*

11.2.1 No information can be presented on the bias of this procedure for measuring residue of PM parts because no material having an accepted reference value is available.

12. Keywords

12.1 bearings ; cleanliness; contamination; filtration; Residue