

Berkshire Corporation Test Methods 1&2 Absorbency and Rate of Absorbency of Wiping Materials

Introduction

Much of Berkshire Corporation's effort has been directed toward developing tests to evaluate the suitability of wiping materials to perform various functions. The following literature details the company's procedures for determining the absorbency and rate of absorbency. The first of these is designed to answer the questions: how much water (or other fluid) will a wiper hold when it is fully sorbed? The second is addressed to finding a measure of how rapidly a wiper can pick up some relevant amount of water or other fluid. Berkshire's goal was to devise tests that were sufficiently precise, interpretable for quantitative ranking of wipers, as relevant as possible to the intended use, and not biased for or against any particular type of manufacture.

From the wiper under consideration a trapezoidal-shaped piece is cut measuring 25mm by 88mm by 112mm. The area and mass the test specimens is determined.

2

A hook is attached to the right angle corner diagonally opposite the acute angle of the trapezoid strip. (With wipers of low basis weight it may be necessary to attach two hooks, or one bifurcated hook, to each right angle corner to prevent the strip from folding over on itself.)

3

The mass of the hook and the wiper assemblage is determined.

4

While the assemblage is held by the hook, it is immersed into a beaker of water (or other fluid), allowing the wiper specimen whatever length of time or degree of persuasion (not detrimental to the wiper) necessary for it to become fully wetted. It is then removed from the fluid, allowing to hang vertically above the beaker for sixty seconds, and reweighed.

5

The above operation is repeated 4 more times on the same specimen.

6

For the specimen, the derived data are calculated as follows:

Where,

Absorbency is the volume of water (or other fluid) in cubic centimeters per square meter of wiper.

$$\text{Absorbency (cc/m}^2\text{)} = \frac{\{(M_{w1} + M_{w2} + \dots M_{w5})/5\} - M_0}{(P_s)(A)}$$

M_0 is the mass, in grams, of the test specimen and hook before wetting.

$M_1, M_2 \dots M_5$ are the masses, in grams, of the test specimen and hook after complete sorption and sixty seconds of draining.

P_s is the density of the fluid in grams per cubic centimeter.

A is the area of the trapezoidal section of wiper in square meters. $A = 1/2$ (height)(sum of bases)

Specific Absorbency (cc/g) = absorbency / basis weight

General Discussion

The trapezoidal cut facilitates the removal of water from the point of the specimen during the sixty second dripping period. Obviously, longer or shorter times could have been chosen this is certainly the most arbitrary part of the method. We found, however, that shorter times resulted in wet balance pans and longer times changed the numbers only slightly.

The reason for the immersion and generous allowance of time for full sorption is that many wipers pick up water very slowly. To be fair to those wipers which sorb well but slowly, we thought that "absorbency" should be made to embrace the pickup of fluids at, if you will, their "thermodynamic" limits. The place for classification along "kinetic" lines is in the rate of absorbency test described below, but we felt that the slower wipers should not be punished twice.

Expressing absorbency in volume per unit areas is useful since wipers are used and sold by area and spills are thought of as volume not mass. Mass of fluid per unit mass of wiper is to be eschewed since it leads to the tendency of reporting in such terms as "five times its weight in water" we are frequently unsure as to what numerator is in such an expression.

Specific absorbency, in volume of fluid per unit mass, is a very useful expression. It can be thought of as a normalization for basis weight, permitting a comparison between wipers which are offered at different weights. It also answers the question: how good are the raw materials, and their physical arrangement in this wiper, for sorbing fluids?

Incidentally, we like the euphemism term "sorption" since it gets around the haggling of whether the pickup is ad- or ab-, a point which does not matter so long as the pickup takes place.

Repeated immersions and removals of the same test specimen gave us very reproducible numbers. Precision can be improved by using larger specimen sizes and/or increasing the number of immersions, but certainly two significant figures are sufficient for data dealing with this feature of a wiper.

RATE OF ABSORBENCY OF WIPING MATERIALS - TIME TO 1/2 SORPTION

Outline of Test Method

1

Modify a Millipore Clean Room Monitoring Filter Holder (No. XX5004740) as follows:

- a. Remove the prefilter support screen and prefilter retaining O-ring.
- b. Remove the test filter support screen.
- c. Reassemble the housing.

2

The sample of wiper to be tested is clamped in the modified Millipore unit using the garment monitoring adapter. This will result in the segregation of a circle of wiper with an area of $1075 \times 10^{-6} \text{m}^2$. The assembly may be clamped in a ring stand or other suitable support. While we suggest using the Millipore apparatus, any mechanism which will suspend and isolate a comparable circular area of wiper is appropriate.

3

The volume of water (or other fluid) which that area of wiper can sorb is calculated as follows:

volume (μl) = $(1/2)(\text{absorbency in cc/m}^2)(1000\mu\text{l/cc})$
($1075 \times 10^{-6} \text{m}^2$), having previously calculated the absorbency by the foregoing test.

4

Using a microliter syringe (50 μl and 500 μl capacity will cover the volumes of most, if not all, wipers), the volume of fluid calculated in step 3 above is delivered to the center of the clamped specimen. The fluid should be delivered at a rate fast enough so that there is never a disappearance of specular reflection during the delivery but not so fast that the jet forces the fluid through the sheet, permitting drops to fall off the bottom surface. The delivery is made in a single pool approximately in the center of the clamped sample.

5

The surface of the sample is illuminated with the suitable light source and the time in seconds for the disappearance of the specular reflection is determined.

6

The procedure is repeated on several different sections of the wiper (the same number of times on each side) and the results are averaged.

General Discussion

Most existing rate tests submit to the wiper a portion of water which is fixed and therefore, in general, inappropriate in quantity. The volume of fluid presented should bear some relationship to the quantity of fluid that the sheet could possibly sorb. Neither an infinite supply of fluid (setting a section of the wiper into a pan of fluid) nor a very small supply (a standard-sized microdrop) can be right for all wipers. Rather, we suggest that each wiper be presented with some fixed fraction --say, one-half--of its own particular "thermodynamic" capacity for the fluid in question and the time to sorb that quantity be measured. The result can be thought of as "time to half-complete sorption."

We considered capillary rise but rejected it because using a visible indication of wetness as an index to the degree of complete sorption can understate the actual amount of water that a sheet can hold. There is also the problem of the competing effect of evaporation, plus surface energies with which to contend.

Berkshire Corporation Test Method 5

Extractable Matter from Wiping Materials

Introduction

This document is divided into two sections, the first treating the quantity of matter (without specifying the composition of that matter) removable from a wiper, while the second is concerned with the analysis for specific compounds or species.

In Section A, procedures are given for determining the total (as defined) unspecified mass which might be accessible when a wiper is used with a given solvent. If conditions of roughly one to one hundred (mass of sample/volume of solvent) are employed and one assumes that the matter being extracted is present in the wiper on the order of one percent (m/m), then certainly no thermodynamic solubilities will be compromised by the resultant one to one thousand (m/v) ratio which represents what the extractable material "sees." In terms of "total" burden, the spirit, if not the letter, of the concept has been adhered to.

Also discussed are the less severe conditions employed for determining what amount of unspecified mass might be removable during use. A different question is asked and a different one is answered.

In Section B conditions and procedures are given for the analysis of specific compounds or species. Obviously, only incomplete guidelines can be provided here because of the enormous number of different items for which one can analyze. Guidelines are offered for the analysis of organic components. Metallic species (positive ions, metals in their zero oxidation state, soluble and insoluble salts), perhaps the items of greatest interest, are treated both for the total burden and the amount available under less than complete conditions of extraction. Finally, procedures are briefly outlined for analysis for non-metallic ions.

Throughout this document, we have avoided the use of Soxhlet extractions because that procedure frequently represents the hard way to answer a simple question; furthermore, it is frequently impossible to duplicate or specify the actual conditions that are obtained.

A. ANALYSIS FOR UNSPECIFIED EXTRACTABLE MATTER

Total Burden with a Particular Solvent

A section of wiper (of known mass and area) is placed in a beaker with 200 milliliters of the appropriate solvent and the contents are brought to a boil on a hotplate. After five minutes of boiling (more solvent can be added if appreciable volatilization has occurred), the contents of the beaker are filtered through filter paper which has been washed previously with the solvent being used. The once-extracted sample is returned to the beaker and a second portion of solvent is added, brought to a boil for five minutes, filtered and the filtrates combined. The solvent is evaporated to a small volume, transferred to a small, tared weighing dish and brought to dryness in an oven. The mass of extractable material is determined and the results are expressed per unit mass and per unit area of wiper.

The only restriction on the size of sample and volume of solvent is that there be a thermodynamic excess of the latter over the type of constituent being pursued, a condition easily met--if there is to be any solubility at all--by using a few grams of wiper in 100 and 200 milliliters of solvent.

If volatility, flammability or noxiousness of the solvent is a problem or concern (e.g., with dichloromethane or acetone or pyridine, respectively), the sample may be placed instead in a boiling flask and the latter fitted with a condenser, carrying out the boiling and extraction under conditions of reflux for the specified time.

Less than Total Burden with a Particular Solvent

A section of wiper (of known mass and area) is soaked in 200 milliliters of the appropriate solvent for ten minutes after which time the solvent is filtered through filter paper which has been washed previously with the solvent being used. The filtrate is evaporated to a small volume, transferred to a small, tared weighing dish and brought to dryness in an oven. The mass of extractable material is determined and the results are expressed per unit mass and per unit area of wiper.

B. ANALYSIS FOR SPECIFIC EXTRACTABLE COMPONENTS

Organic Components

Generally, the components sought will be soluble in liquids of some known polarity. Following extraction according to procedures given above, the solution containing the component of interest should be concentrated, appropriate separation techniques employed if applicable, and subsequent analysis done by conventional methods: spectroscopy (infrared, nuclear magnetic resonance, mass, ultraviolet, etc.) and/or gas chromatography and/or classical methods.

Inorganic Species: Metals and Metallic Ions

Total Burden

The particular pathway chosen here depends upon the species of interest and upon its oxidation state. Even if the cations normally associated with water soluble salts are of interest (e.g., sodium, potassium, lithium, etc.), it is not normally possible to effect complete extraction using water, owing to the ion exchange capacity of the carboxyl moieties which are present on the cellulose polymer, a major component in most wiping materials. In order to be assured that these species--to say nothing of those ions which form water insoluble carbonates, bicarbonates, oxides, etc.--are rendered soluble, it is necessary to use acid in the extraction procedure. The protons from the acid replace metal ions held at the carboxyl groups (present in cellulose at approximately ninety microequivalents per gram) as well as dissolving most salts of common metal ions. A reasonable choice for the acid is 0.5M nitric. A few grams of wiping material in twenty-five milliliters of acid is a reasonable way to do the extraction.

5

Berkshire Corporation Test Method 5 Extractable Matter from Wiping Materials

Subsequent analysis of the solution using atomic absorption spectrophotometry is reasonable, either with or with dilution, depending on the species of interest and its sensitivity.

For less accessible and/or more exotic species, the choice of sample work-up must be chosen accordingly. For example, if analysis for total aluminum were desired, the sample must be ashed, the ash fluxed with sodium carbonate at 900°C and the flux dissolved and analyzed for the metal ion.

For iron, manganese, vanadium or other ions which exhibit multiple oxidation state, it is necessary to decide if the analysis must include differentiation according to the various oxidation states. Obviously, matters become much more complicated in that situation.

In summary, analysis for metal ions which form acid soluble salts is most readily accomplished using diluted nitric acid followed by atomic absorption spectrophotometry. For the less accessible species, ashing or perchloric acid digestion may be necessary steps prior to analysis.

Less than Total Burden

The wiper should be soaked in the appropriate solvent for ten minutes and the resultant solution analyzed for the ions of interest.

Inorganic Species: Non-metallic Ion

This category includes a large number of ions, the most important of which are chloride, sulfate and nitrate. Dissolution of compounds of the first is usually not a problem; most sulfates are soluble in strong acid; virtually all nitrates are water soluble.

Analysis for nitrates is best done using a specific ion electrode, chlorides by argentometric titration and sulfates by precipitation as the barium salt.

Berkshire Corporation Test Method 6

Particles Generated from Dry Wiping Materials

Introduction

Since most wipers enter the cleanroom in the dry state, the increased demand for a dry particle test may be warranted. Certainly, wipers get handled dry before they ever become wetted.

It has been our experience that dry testing significantly understates the number of particles that might actually be released when the wiper is used in a wet condition. The existence of cohesive forces and static charge, present in all wipers but to different extents, holds particles in place and allows only a portion of them to be removed through the administration of air. It has been estimated that as a result of the presence of these forces, approximately one million times more energy would have to be imparted to the wiper using air than that which is sufficient, administered with water, to remove the same burden of particles. It is only when testing is performed on a wetted sample that these forces are dissipated and the release of particles from the wiper more closely approximates what will occur during actual use.

Thus, while a dry test might yield results consistent with the particle generation produced from a dry wiper under normal usage, it must be kept in mind that these data represent only a small fraction of that particle burden present in the wiper.

The procedure described herein details the application of a non-uniform stress to a wiper by a flexing apparatus. The subsequent sampling and counting of the particles generated are also outlined.

FLEX TEST

Outline of Test Method

1

In this procedure the stress is imparted to the wiper by a flexing device, the design of which is based on the Gelbo Flex Tester. The unit consists of metal and plexiglass enclosure, housing two opposed, cylindrical heads, one stationary and the other attached to a rotating and reciprocating, motor-driven arm. When activated the movable head approaches the stationary one and rotates approximately 180 degrees in the course of its full stroke. A return of the head to its resting position completes one cycle. The rate of flexing is one Hertz.

2

A sample is mounted in the flexor by wrapping and clamping the ends of the wiper around the heads which are in their extreme open position. Optimally, the width of the wiper will correspond to the circumference of the flexor heads, yielding a cylinder of wiper (the edges of which just abut) between the heads. The distance between the heads may be altered by sliding the stationary one on its supporting shaft in the axial direction and locking it in place by means of a set screw. This enables the flexor to accommodate various sizes of wipers. Care should be taken that the stationary head does not collide with the reciprocating head when the heads are in the extreme closed position.

3

The particles generated by the flexed wiper are collected by sampling probe located beneath the wiper. The probe is attached via tubing to an air-borne particle counter. The counter samples air at the rate of one cubic foot per minute (cfm) from the chamber in which the wiper is stressed. Thus, if the sample is stressed for one minute (60 cycles), one cubic foot of air will have been drawn from the chamber and the particles it contains counted. The duration of flexing to the sample may be adjusted depending upon the physical characteristics of the wiper, its intended use and the magnitude of the stress associated with that use. In addition, the number of samples tested is arbitrary but should be adequate to yield statistically significant results.

4

During testing, low background counts may be achieved by situating the flexing apparatus under a cleanroom laminar flow bench. Ports located in the rear and front panels of the flexing chamber allow this air flow to reduce the particle burden present to a level acceptable for testing a sample. During flexing, the front ports may be closed to prevent the flow of air through the chamber.

5

A blank may or may not be necessary, depending upon the cleanliness of the work area, and the cleanliness of the wiper specimen. The value of the blank is the particle count achieved when air is sampled under identical conditions to those for testing a sample, but when no sample is present. Blanks may be performed before and, at the discretion of the tester, after the testing of a sample. The value for the sample is then corrected for the blank(s).

Conclusion

It must be kept in mind when employing any dry particle test the number of particles generated by the sample will be considerably lower than that which can be released by a wetted sample. It has been our experience that the dry test as described above consistently yields values for particle generation which are orders of magnitude lower than those we acquire from the same type of sample on a wet test.

Since the magnitude of the cohesive forces cited herein will vary with the composition of the wiper, and since these forces are mitigated by the presence of water in a wet test, we might expect that a different rank ordering to the particle generation of wipers would result on wet and dry tests. This, in fact, has been our finding. In general, wipers with high percentages of synthetic constituents have yielded relatively low dry particle counts. On our wet test these sample wipers produce comparatively high counts. On the other hand, those wipers containing mostly cellulosic components rank relatively high in particle generation the dry test and low on the wet test. This is only an empirical rule of thumb, as the particle generation on any wiper will be contingent upon other factors as well, including quality, handling, and the presence of additives such as binders, surfactants, etc.

6

Berkshire Corporation Test Method 6 Particles Generated from Dry Wiping Materials

HELMKE DRUM TEST

References: IES-RP-CC-003-87-T, Section 5.3.

Outline of Test Method

This procedure is used as an alternate test to the Dry Flex Test when the sample is not large enough to mount in the flexor or cannot otherwise be flexed (ie: 4x4" wipers, masks, glove liners). The samples to be tested are placed in a rotating drum and are tumbled to release particles. The air in the drum is drawn through a sampling probe and the particles released from the samples are counted by an automatic particle counter.

1

A Helmke Drum apparatus or equivalent (as specified in IES-RP-003) is placed in laminar flow conditions. The speed of the drum rotation is adjusted to $10 \text{ rpm} \pm 0.1 \text{ rpm}$. Sample air is drawn through a sampling probe located in the test chamber to a air-borne particle sensor at a rate of one cubic foot per minute. Particles $\geq 0.5 \mu\text{m}$ are counted by an automatic particle counter.

2

The concentration of air-borne particles inside the test chamber is determined by taking a count for one minute while the drum is rotating. This number will be considered the blank and is to be subtracted from the sample count. [The blank should not impinge upon the sample concentration by more than ten percent.] After the blank count is determined the drum is stopped; ten samples (or number of samples suitable to obtain significant counts) are placed in the drum. The particle counter and drum are started simultaneously. Counts for ten, one-minute runs are obtained.

3

Record the total number of particles released by the samples; subtract the blank from these counts and divide by the number of samples tumbled. The results are expressed as the number of particles ($\geq 0.5 \mu\text{m}$) per sample per cubic foot of air.

7

Berkshire Corporation Test Method 7 Chemical Reactivity of Cleanroom Wiping Materials

Outline of Test Method

A 4" x 4" sample (approximately 1 gram) of the product in question is weighed and the mass recorded. The sample is then immersed in a 50 - 100cc solution (depending on the absorbency of the material) (at $21^{\circ}\text{C} \pm 3^{\circ}\text{C}$) of the desired chemical and concentration for three minutes with constant stirring. At the end of this time the sample is removed, rinsed in deionized water, blotted, and dried in an oven at 100°C . Once dry, the sample is allowed to equilibrate to room temperature and humidity and is then reweighed. The difference in these two masses is divided by the original mass and the quotient is expressed as the percent loss in mass.

A control sample is run by immersing it in 100 cc of deionized water, with all other variables being held constant. The percent loss in mass produced by the control sample is then subtracted from that of the experimental sample to yield a corrected percent loss in mass.

8

Berkshire Corporation Test Method 8 Particles Generated From Wetted Wiping Materials

Test Method BIAXIAL SHAKE TEST

REFERENCE: IES RP-CC-004

EQUIPMENT

Wide mouth 4 Liter (gallon) jar
500 or 1000 milliliter graduated cylinder
Biaxial shaker (W.S. Tyler Model RX-86)
Automatic particle counter (APC)($\geq 0.5\mu\text{m}$)
Laminar flow clean bench
12" Tweezers
Filtered deionized water
Metric ruler
Aluminum Foil

GLOVES AND APPROPRIATE CLEANROOM APPAREL MUST
BE WORN THROUGHOUT PROCEDURE

1

Blank

A blank is performed before each sample is tested to determine the background count of particles contributed from the water and apparatus. This impingement should not exceed ten percent of the number of particles expected to be obtained on the wiper sample.

Wash jar and graduated cylinder with DI water. Measure 800 milliliters (or amount necessary to obtain 600ml after blank samples have been drawn by APC) of DI water into graduated cylinder and pour into jar. Secure a piece of aluminum foil over jar mouth and clamp jar into biaxial shaker. Shake for one minute. Remove jar from shaker. Under laminar flow remove aluminum foil and place sampling tube from APC in jar. Let liquid sit for five minutes to dissipate air bubbles. Draw liquid through APC. (If pressurized sampling vessel is used, samples may be drawn immediately.) Calculate the average of three runs.

2

Sample

With tweezers carefully place wiper sample into the 600 ml of water remaining in jar. Secure aluminum foil on jar and clamp into biaxial shaker. Shake for five minutes. Remove jar from shaker. Under laminar flow remove aluminum foil. With long tweezers remove wiper sample from jar allowing it to drip into jar for approximately 10 seconds. Follow procedure for counting as in Step 1. Measure dimensions of wet wiper in centimeters and calculate area of wiper.

3

Calculations

$$\# \text{ Particles } (\geq 0.5\mu\text{m}) / \text{cm}^2 = \frac{(C-B) (V_s)}{(V_a) (A_w)}$$

C = average of sample counts

B = average of blank counts

V_s = volume of liquid sample was shook in

V_a = volume of one aliquot of APC

A_w = area of wiper in square centimeters

9

Berkshire Corporation Test Method 9 Basis Weight

Outline of Test Method

Materials:

Analytical Balance (reading 4 decimal places)

Ruler (able to measure in millimeters)

Triangle

Scissors

Samples

1

Sample should be of a size that will be representative of the lot of material (suggested size = 9" x 9"). Square sample so that opposite sides are of equal length using triangle.

2

Measure and record length and width of sample to the nearest millimeter.

3

Weigh on analytical balance and record weight (in grams) to four decimal places.

4

Calculate Basis Weight as follows:

$$\text{Basis Weight} = \frac{\text{Weight of Sample (gm)}}{\text{Length(mm)} \times \text{Width(mm)}} \times \frac{10^6 \text{mm}^2}{\text{m}^2} = \frac{\text{g}}{\text{m}^2}$$

10

Berkshire Corporation Test Method 10 Caliper

Outline of Test Method

Reference: TAPPI Method T411 OM-84

Materials:

TMI Digital Micrometer Model 49-70 (conforms to TAPPI T411 and ASTM D624-5.2)

This method describes the procedure for measuring single sheet thicknesses of paper, wovens and knits.

1

Turn on micrometer and allow to warm up. Check zero setting and adjust if necessary. Set micrometer to read in microns.

2

Place sample between pressure foot and anvil when micrometer is in the open position. Record digital readout near the end of each dwell time.

3

Measure the thickness of each sample at ten nonoverlapping areas. Report the average in microns.

Berkshire Corporation Test Method 11

Particles Generated From Dry Wiping Materials

Test Method HELMKE DRUM TEST

REFERENCE: IES Recommended Practice :
IES-RP-CC-003-87-T, October 1987

EQUIPMENT

Helmke Drum tumbling chamber as described in
IES-RP-CC-003-87-T, Section 5.3.
Laminar flow bench in Class 100 Cleanroom
Air sampling tube
Automatic Airborne Particle Counter ($\geq 0.5\mu\text{m}$)

GLOVES AND APPROPRIATE CLEANROOM APPAREL MUST
BE WORN THROUGHOUT PROCEDURE

PROCEDURE

Wipers or other cleanroom product samples are placed in a tumbling chamber. As the samples are tumbled, the released particles are drawn from the tumbling chamber into an automatic particle counter (APC) via a sampling tube. The standard sample size for this test consists of ten product units per sample. The sample size may vary depending on the sample type and/or the expected particle generation (i.e. in the testing of cleanroom garments the normal sample size is one garment per tumble test). Berkshire Corporation uses this test to evaluate dry particle generation on products that cannot be evaluated by the Dry Flex Test Method (Berkshire Test Mtd No. 6). Some of these products include 4"x4" wipes, 6"x6" wipes, swabs, glove liners and masks.

1

Setup

The Helmke Drum is set up in front of a laminar flow bench with the open end of the tumbling chamber perpendicular to the flow of air. The velocity of the air past the drum should be 90 ft/min \pm 20 ft/min. The drum rotation speed is adjusted to 10 rpm \pm 1 rpm.

2

Blank

A blank is performed to determine the background count of particles in the tumbling chamber. Before samples are introduced a one minute count is taken while the drum is rotating. This number will be deducted from the sample count. This impingement should not exceed ten percent of the number of particles obtained on the samples.

3

Sample

Insert the samples into the test chamber. Simultaneously start the drum rotation and the APC. The samples are tumbled for ten minutes with the APC taking particle counts at the end of each one-minute interval.

4

Calculations

The blank is subtracted from the average of the ten - one minute counts and divided by the number of units per test. The results are expressed as :

#particles $\geq 0.5\mu\text{m}$ /unit/cubic foot of air sampled

Berkshire Corporation Test Method 12

Fiber Test

OUTLINE OF TEST METHOD

1

Purpose:

The purpose of this procedure is to determine the number of fibers that can be released from a wiper subjected to a mechanical stress. For the purposes of this test a fiber is defined as a particle with length to width ratio exceeding 10 to 1 and a length greater than or equal to 100µm.

2

Introduction:

A wiper is agitated in 600ml of filtered, deionized water in a biaxial shaker, releasing particles and fibers into the water. An aliquot of the liquid is filtered onto a gridded membrane and the fibers are microscopically counted.

3

Equipment:

Vacuum Filtration Apparatus consisting of :

1000 ml side-arm vacuum flask

300 ml funnel top

Fritted glass or stainless screen filter support with # 8 stopper

(Millipore XX1004700 with XX1004705 or Millipore XX1004730 with XX1004705 or equivalent)

100 ml graduated cylinder

Gridded Filter Membrane- 0.45µm, 47mm, black (Millipore - HABG04700)

PetriSlide- (Millipore PD1504700)

Hot Plate- capable of being set at low temperatures

Filter Forceps-flat tipped, non-serrated (Millipore XX6200006)

StereoZoom Microscope - with mechanical stage-set up to view fibers $\geq 100\mu\text{m}$, or equivalent

Variable intensity light source

Laboratory Hand Counter (Baxter B4120-2A- 2)

Vacuum pump

Laminar Flow Bench or Class M3.5 (Class 100) cleanroom

4

Procedure:

GLOVES AND APPROPRIATE CLEANROOM APPAREL MUST BE WORN THROUGHOUT PROCEDURE

Clean and rinse all apparatus with filtered, deionized water and place under laminar flow bench. Attach filtration apparatus to suitable vacuum source.

With non-serrated forceps grasp a membrane by the edge; wet and rinse the surface under a stream of deionized water. Center the membrane on the filter support; place the filtering funnel top in place over the membrane and clamp into place.

Refer to Biaxial Shake Test, IES-RP-CC004.2 - Evaluating Wiping Materials Used in Cleanrooms and Other Controlled Environments (or Berkshire Test Method No. 8) for sample preparation procedures. After the wiper sample has been shaken and removed from the sample jar, swirl the liquid contents of the jar.

Pour a 100 ml aliquot of the liquid into the funnel top of the filtering apparatus; apply vacuum until all liquid has been filtered through the membrane. Remove vacuum and rinse funnel with approximately 10 ml of deionized water. Reapply vacuum until all liquid has been filtered through. In order to prevent disruption of the fiber distribution on the surface of the membrane do not direct the stream of liquid on to the filter surface; direct the stream down the side of the funnel top. A 100 ml graduated cylinder may be used to facilitate pouring the 100 ml aliquot. Carefully remove clamp and funnel top taking care not to disturb the membrane. With forceps remove membrane from support screen and place on warm hot plate (approximately 170°F) to dry. Adjustments to the hotplate may be needed to obtain proper temperatures for slow drying. If hotplate is too warm the membrane may buckle and the surface will not be flat. This may cause difficulty in viewing the surface under the microscope.

Place the dry membrane in a PetriSlide with the grid lines aligned vertically and horizontally. Identify the sample properly.