Test Method Number 20

Determination of Basis Weight of Wipers
Determination of Absorbency and Rate of Absorbency of Wipers

Note:
This test method replaces and updates the following documents:
Texwipe Test Method No. 2: The determination of basis weight
Texwipe Test Method No. 3: Absorbency and rate of absorbency of wipers
Test Methods 2 and 3 are considered obsolete and are no longer available from ITW Texwipe.

1
Basis Weight

The basis weight of a fabric is its areal density, i.e. the weight of the fabric per unit area, typically expressed in g/m^2. Knowledge of wiper basis weight is important since it allows the expression of other measurements in units of either weight or area. As an example, if the absorbency value of a wiper, normally expressed in ml/m^2, is divided by its basis weight (expressed in g/m^2), the absorbency value in ml/g is obtained.

PURPOSE

To determine the basis weight of a wiper and to determine the capacity of a wiper for sorbing fluids and the rate with which those fluids are sorbed.

For wipers*, the most convenient approach to the measurement of basis weight is to measure the weight and area of a single wiper and simply ratio the two numbers. Standard test methods for basis weight (1,2) describe procedures that are virtually identical to that given here.

Measurement of Basis Weight:
a) Determine the weight, m_1, of a wiper on toploading balance with a resolution of 0.1 g.

b) Using a ruler, measure the length and width of the wiper to the nearest millimeter (mm). Calculate the wiper area, A, and express A in units of m^2 by dividing the area in mm^2 by 10^6.

c) Calculate basis weight as the ratio of m_1/A in g/m^2.

Sample calculation:
A wiper weighs 8.1 g (= m_1) and measures 225 mm x 224 mm.

Area A = [(225 mm x 224 mm) / (10^6) mm^2/ m^2] = 0.0504 m^2

Basis weight† = m_1/A = [8.1 g / 0.0504 m^2] = 160.7 g/m^2 = 161 g/m^2.

See footnote below for additional details.

* In this test method, wipers nominally measuring 9" x 9" (23 cm x 23 cm) are used as illustrative examples. Larger wipers can be used as long as the measurement equipment can accommodate them. If frequent measurements of basis weight are performed, the user may wish to utilize a die or punch to produce a wiper of constant area. Also humidity control may be necessary since fabrics can exhibit some degree of variance (up to 8% for cotton) in basis weight.

† We have overstated the accuracy of the reported value by one significant digit. Using the data shown, the best that one could hope for in the calculated result would be two significant digits or 1.6 x 10^2 g/m^2. For simplicity, we will retain the reported value as 161 g/m^2 and use that in the absorbency calculation that follows.

As a side note, the same wiper weighed 8.156 g on an analytical balance. This weight produced a slightly more accurate basis weight value of 161.8 g/m^2 or 162 g/m^2 after rounding, but it is not worth the inconvenience and expense of having to use an analytical balance with a resolution of say 0.1 mg for basis weight measurements, and a separate toploading balance for absorbency measurements. In our example, the toploading balance contributed a negligible negative error to the calculated basis weight of 1 part in 162 or 0.6%. To improve accuracy with the toploading balance, two wipers could have been weighed (and the area doubled); this would produce a basis weight result accurate to 3 significant digits.

We prefer the convenience and speed offered by a toploading balance for both basis weight and absorbency measurements. The absorbency measurement necessitates the measurement of wet wipers and the surface of a top loading balance can be easily dried off.

2
Absorbency

The ability of a wiper to absorb liquid is important for a number of reasons (3,4). Wipers are most frequently used either dampened or fully wetted for cleaning tasks. If a low surface tension liquid is used to wet the wiper, then surface contaminants can be removed easily. As a side benefit, dampened wipers carry less risk than dry wipers of creating an electrostatic discharge (ESD) event during cleaning. To be effective in any of these applications, wipers need to absorb liquids readily.

Absorbency characteristics for wipers tend to be essential for pharmaceutical and biotechnology applications where large amounts of liquids are applied for the cleaning and disinfection of production surfaces and equipment and where highly absorbent wipers can speed up the process. By contrast, in the microelectronics area, wipers are used damp (to remove particles), not saturated (as applicators), and absorbency is generally less of an issue. In fact, highly absorbent wipers can be a disadvantage in microelectronics, since it will take correspondingly larger amounts of liquids to bring the wiper to a given degree of dampness. This can result in increased solvent costs, and if the wetting agents are organic and volatile, can result in increased costs for volatile organic carbon (VOC) emissions.

Wiper absorbency can be measured and reported either on a weight basis (known as intrinsic absorbency) or an area basis (known as extrinsic absorbency). Wiper absorbency is most frequently measured using water as the liquid to be absorbed, but in principle, any liquid can be used as long as it will wet the wiper. If liquids other than water are employed, it will be necessary to correct for density factors (i.e. the density of the liquid cannot be assumed to be 1, as used below for water).

Absorbency data shows the capacity of the wiper to hold liquid at full saturation. Pre-wetted (i.e. damp) wipers supplied by manufacturers, or prepared by users, typically have wetting levels that are between 40 to 60% of full saturation.

Polyester knit wipers are sometimes described as “not very absorbent”. This is totally incorrect, since these wipers will often hold at saturation far more liquid than their cellulose wiper counterparts. What is different between the two types of wipers is the wetting mechanism. Polyester knit wipers are rendered hydrophilic (water-loving) through surface treatment during manufacture; water is *adsorbed* by these wipers and is held on the surface of the fabric in the interstices between the fiber bundles. Cellulose-based wipers, by contrast, take up water by *absorption*, in which water enters the fibers and causes them to swell. The “not very absorbent” charge is based on the fact that cellulose-based wipers will pick up water from a surface and leave it totally dry, whereas polyester-knit wipers will pick up most of the water, but will leave a very small amount on the surface. This residual liquid is usually not a problem, since it evaporates quickly under the high air flow of a typical cleanroom. From a particle, fiber, extractable residue and ion contamination perspective, most cleanrooms will not tolerate the presence of cellulose-based wipers and accept the residual surface liquid as a small price to pay for the benefit of better contamination control with polyester knit wipers.

Measurement of Absorbency

Wiper absorbency — intrinsic or extrinsic — is based on measuring the weight gained by a wiper when it is saturated with water at normal room temperatures (20 – 22 C). Under these conditions, the gram weight of water absorbed by the wiper is assumed to be equivalent in magnitude to the milliliter (ml) volume of water (i.e. assume that the density of water is 1 g/ml). Determine the weight, m_1 and area, A of the dry wiper as described above. Immerse the wiper in a photographic tray partially filled with deionized water, sufficient to provide thorough wetting of the wiper. Allow the wiper to become saturated for 60 sec. Using a tongs, remove the wiper by one corner and allow it to drain above the water surface for 60 seconds. Without further delay (to avoid evaporative losses), measure the weight, m_2, of the saturated wiper on the toploading balance. Determine the weight and corresponding volume of the water absorbed and calculate the absorbency either on a per weight basis (intrinsic), or a per area basis (extrinsic).

Sample calculation:

Using the dry wiper weight and area values from the basis weight calculations above,

Dry Wiper weight = m_1 = 8.1 g

Wet Wiper weight = m_2 = 33.8 g

Weight of water absorbed = m_2 - m1 = (33.8 – 8.1) g = 25.7 g

Volume of water absorbed = 25.7 ml (assuming density of water = 1 g/ml)

Dividing the volume of water absorbed by the area yields the extrinsic absorbency;

i.e. extrinsic absorbency = 25.7 ml / 0.0504 m^2 = 510 ml / m^2

The intrinsic absorbency value is obtained by dividing the volume of water absorbed by the weight of the dry wiper;

i.e. intrinsic absorbency = 25.7 ml / 8.1 g = 3.17 ml/g.

At times, this information is expressed as an efficiency of absorption. In this example the wiper absorbs 3.17 times its weight in water.

The same result for intrinsic absorbency can be obtained by dividing the extrinsic absorbency value by the basis weight;

i.e. intrinsic absorbency = [510 ml / m^2] / [160.7 g/ m^2] = 3.17 ml/g

3

Absorbency Rate

The rate at which wipers absorb liquids is important for rapid cleanup of spills with dry wipers or rapid wipedown of surfaces with dampened wipers. Having to wait long periods of time for wipers to absorb liquids is not only frustrating, but the inconvenience may lead to skipping the wipedown of critical surfaces or in some cases the use of sub-standard wipers which may be more quickly absorbent, but that will contribute other contaminants to the wiped surface. Absorbency rate can be measured in any number of ways (5) including:

- *drop disappearance* in which one times the disappearance of specular reflection when a droplet of water is dispensed onto a wiper,
- *co-planar wicking*, in which the rate of water uptake is measured by the weight change of a wiper when it is put into contact with a liquid reservoir at one end, and,
- *trans-planar wicking*, in which a stack of wipers is put in contact with a liquid reservoir and the rate of water uptake through the stack is measured.

Measurement of Absorbency Rate

For ease of measurement, we will focus on the *drop disappearance* method, since it requires only a wiper holder, a liquid dispenser, a light source and a stopwatch.

When conducting the test the wiper should be held under mild, even tension for best results. This can be achieved in a number of ways. The wiper can be draped across across the end of a 1.5" (38 mm) diameter glass tube and held in place with a rubber o-ring. Alternately, an embroidery hoop or a frame (1) can be used to hold the wiper.

Position the wiper between the operator and the light source so that the surface of the wiper is illuminated. Hold a glass dropper‡ filled with water at a 45 degree angle about 1 cm above the wiper. Dispense one drop and start the stopwatch when the drop contacts the wiper. Time the disappearance of the specular reflectance, i.e. when the illuminated area no longer reflects the incident light (i.e. no longer glistens). Repeat the measurement at least 3 times on different portions of the wiper and average the results.

Hydrophilic polyester knit wipers should exhibit absorbency rates of less than 1 second.

Alternate Method for Absorbency Rate

It is worth nothing that another test method (6) is available for measuring absorbency rate. This method, originally published by the Association of the Nonwoven Fabrics Industry (INDA) and now included in the IEST RP-CC004.3 document, provides the ability to simultaneously measure basis weight, absorbent capacity and absorbency rate, all based on the time required to wet out a stack of wipers. This method does not measure the rate at which a wiper can absorb across its surface — it provides a measurement of *trans-planar wicking*. This method is not used by ITW Texwipe and is only cited here for completeness.

The test assumes that the absorption rate and sorption capacity are independent of the number of wiper plies, that the aspect ratio of the wipers is not greater than 2:1 and that the absorption rate is independent of the area of the wipers. Further, the test works best for perfectly level and flat stacks, with uniform wiper-to-wiper contact within the stack. This method may be inappropriate for wipers with low absorption rates (<200 ml/m2/s), requires the use of at least 30 wipers (for replicate measurements) and is somewhat more complicated than the reflection loss method. None of these restrictions apply to the reflection loss method.

‡If desired, a buret can be substituted for the dropper for dispensing droplets of water. In that case, it is easiest to establish a drop rate of about one drop every 5 seconds, then position the wiper under the buret when the timing is to begin.

4

References

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5. D. W. Cooper, "Understanding Wiper Absorption Capacity and Rate", A2C2 (now Controlled Environments), September, 1999.

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