MAS STANDARDS PUBLICATION

Material Testing Protocol for Reusable Female & Male Absorbent Undergarments

MAS
CHANGE IS COURAGE

HOHENSTEIN

Authors:
Janith Dushyantha, Stefanie Biermann, Florian Girmond

CONTENTS

1. SCOPE & BACKGROUND

This Standard specifies the One-Way Transfer Coefficient, Wicking Rate & Rewet & Saturated Capacity for materials used in male/ female reusable absorbent undergarments designed to be used for any type of body fluids including but not limited to menstruation and urinary incontinence applications.

Femography by MAS has designed this testing standard together with Hohenstein Laboratories GmbH & Co. KG. The method of testing is simplified to ensure valid and repeatable test data of materials that will be incorporated in the reusable absorbent undergarments.

The chosen test parameters will help determine whether the materials tested do qualify to be used as wicking & absorbent components in the reusable absorbent undergarments.

2. NORMATIVE REFERENCES

The following reference document are required for the application of this standard. Latest edition of the document with amendments should be used.

- ISO 139, Textiles — Standard atmospheres for conditioning and testing
- AATCC 150-2018 — Dimensional Changes of Garments after Home Laundering (As a wash method to test after wash performance)
- ISO 6330:2021-11 -Textiles — Domestic washing and drying procedures for textile testing (As a wash method to test after wash performance.) [Note: washing method shall be selected based on the care label instructions of the Undergarment] Synthetic Blood Simulant Recipe
- Test method No. 12/2015 MDS-Hi (German Healthcare Medical Service) (https://www.gkvspitzenverband.de/media/dokumente/krankenversicherung_1/hilfsmittel/fortschreibungen_aktuell/20160311/032016_Pruefmethode_Nr_12-2015_MDS-Hi.pdf)
- Reference blood simulant (5.1.1): European patent specification EP 1 355 607 B1 (https://data.epo.org/publicationserver/document?iDocId=3303810&iFormat=0)

3. TERMS & DEFINITION

For the purposes of this document, the following terms and definitions apply.

3.1. Test Specimen/ Sample
Sample used in testing purpose to determine the required parameters.

3.2. Functional Properties
The nature of having a certain function and/or performance features in products.

3.3. Menstruation
Menstruation is the regular vaginal bleeding that occurs as part of a woman's monthly cycle.

3.4. Urinary Incontinence
Urinary incontinence refers to involuntary urine leakage.

3.5. Waiting Time
Keep time to settle absorbed liquid in between fluid additions.

4. PRINCIPLE

4.1. One Way Transfer Coefficient
Determine the wicking capability of fabric. The experiment measures how well liquid is transported from one surface of the fabric to the other.

4.2. Wicking Rate & Rewet
Wicking rate is defined by applying a specific amount of fluid to a small area of the material composite and the elapsed time until the fluid is completely absorbed is recorded.

Rewet is the fluid retention performance of the material. The testing principle is based on determination of the rewet based on the fluid amount that resurfaces on to the top of the material. For the real user case, it's typically how much absorbed liquid gets resurfaced to the body touching side from the top wicking material. This measures user comfortability in terms of wet or dry feeling throughout product usage.

4.3. Saturated Capacity
Measures level of solution that can be held in the absorbent gusset of the female reusable absorbent underwear when the gusset composite is submerged in blood simulant or 0.9% saline solution bath, followed by draining of excess fluid.

5. MATERIALS & APPARATUS

5.1. Test Liquids

<u>Saline for urine simulant:</u>
0.9 % saline solution (9 g of NaCl per litre of distilled water)

<u>Synthetic blood simulant:</u>
Dissolve 3 g CMC (Carboxy Methyl Cellulose, 0.60-0.95 degree of substitution, CAS 9004- 32-4, Sigma-Aldrich resp. Merck) and 9 g NaCl per litre of distilled water under stirring and heating up to 35 °C. Liquid is used after cooling to room temperature.
[Reference: European patent specification EP 1 355 607 B1]

5.2. Test Devices / Equipment

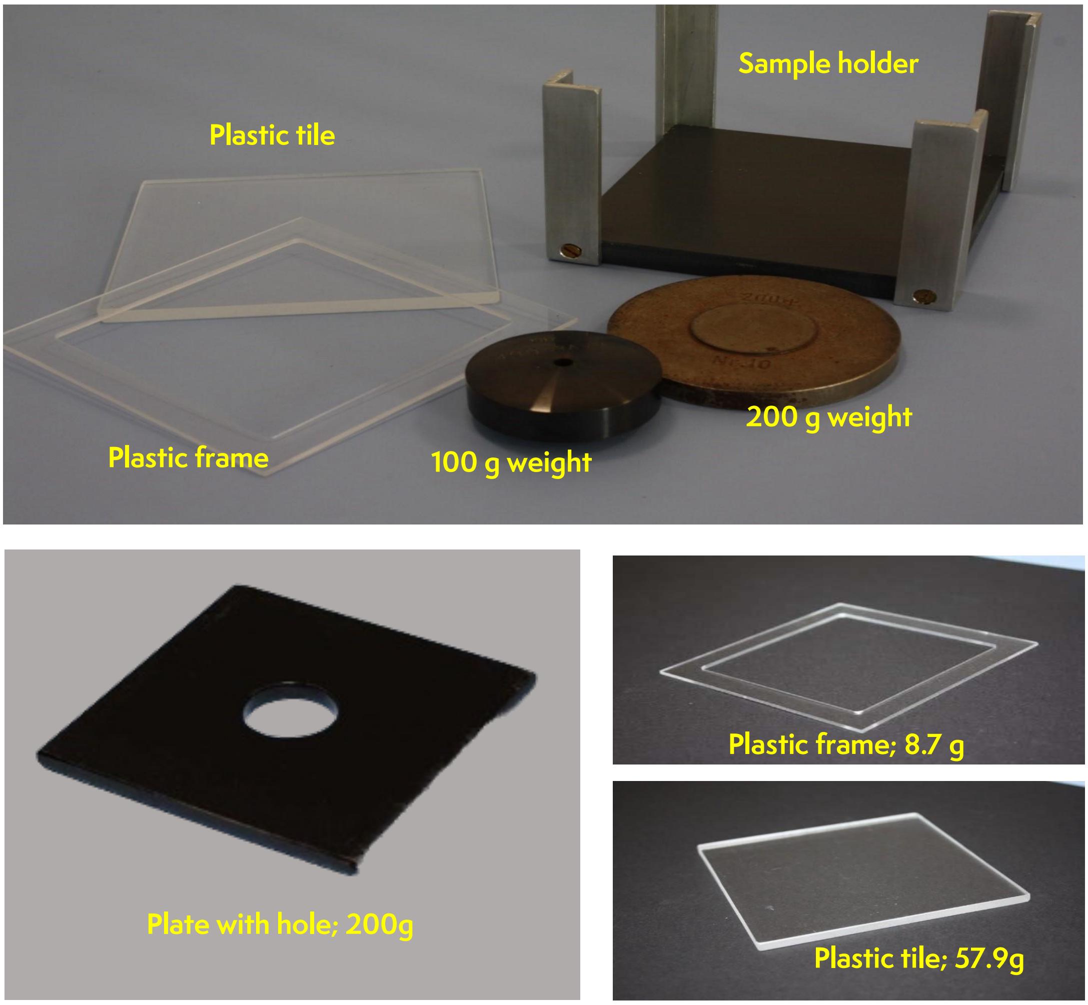
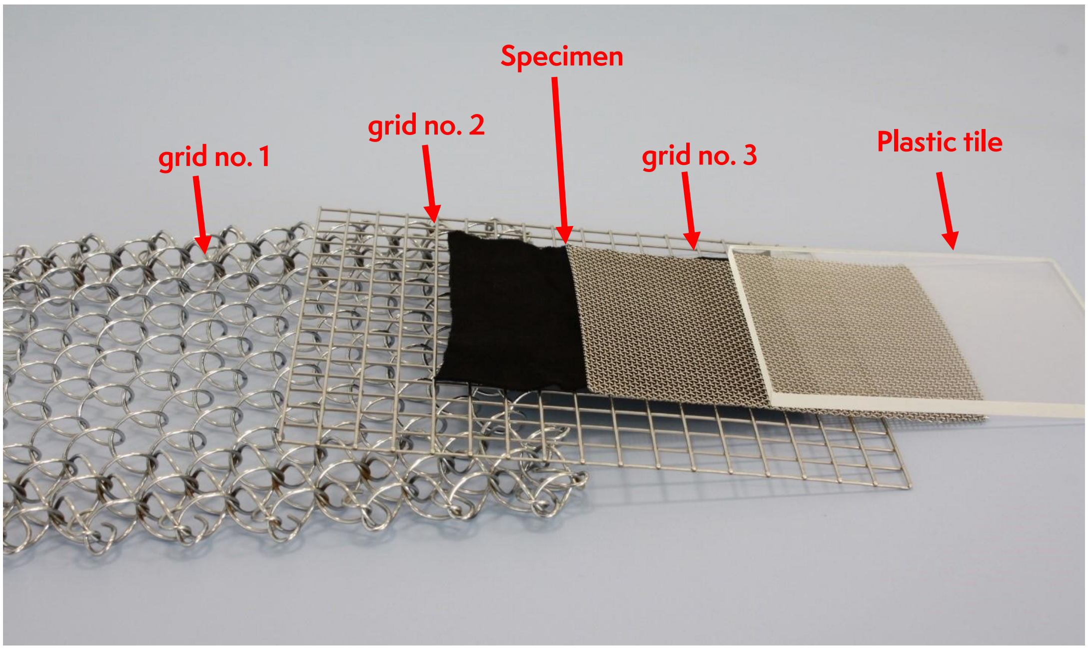


Figure 5.1: All equipment used for testing One Way Transfer Coefficient and Wicking Rate & Rewet.



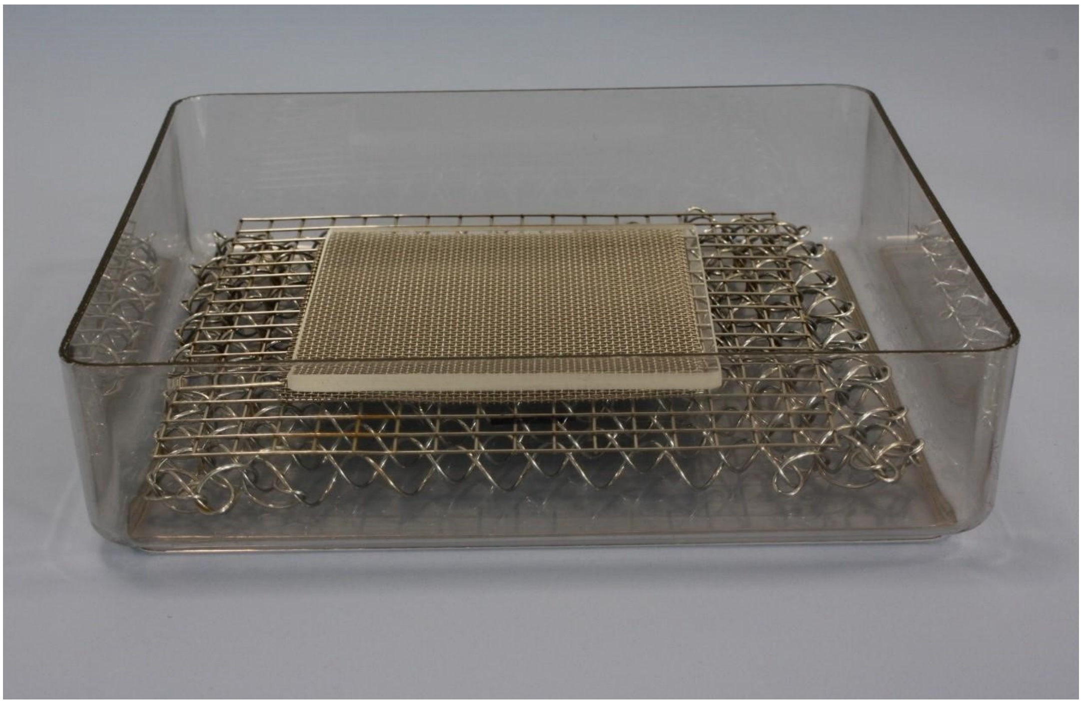


Figure 5.2: All equipment used for testing Saturated Capacity: Set-up, from left to right, grid no 1, grid no 2, specimen, grid no 3 and plastic tile.

5.3. Test Materials

<u>Absorbent and blot layer:</u>
Filter Paper: Whatman® qualitative filter paper, Grade 4
Article no#: Whatman Article No., 28414015 (US reference), Whatman 1004-150

NOTE: Please clean the fabric surface for any contaminant (e.g.: loose fibres, pilling from other materials) resulting in the wash using a wet tissue.

6. TEST PROCEDURE

6.1. One Way Transfer Coefficient

CODE: HOHENSTEIN001S, HOHENSTEIN001B

Determine the wicking capability of fabric. The experiment measures how well liquid is transported from one surface of the fabric to the other.

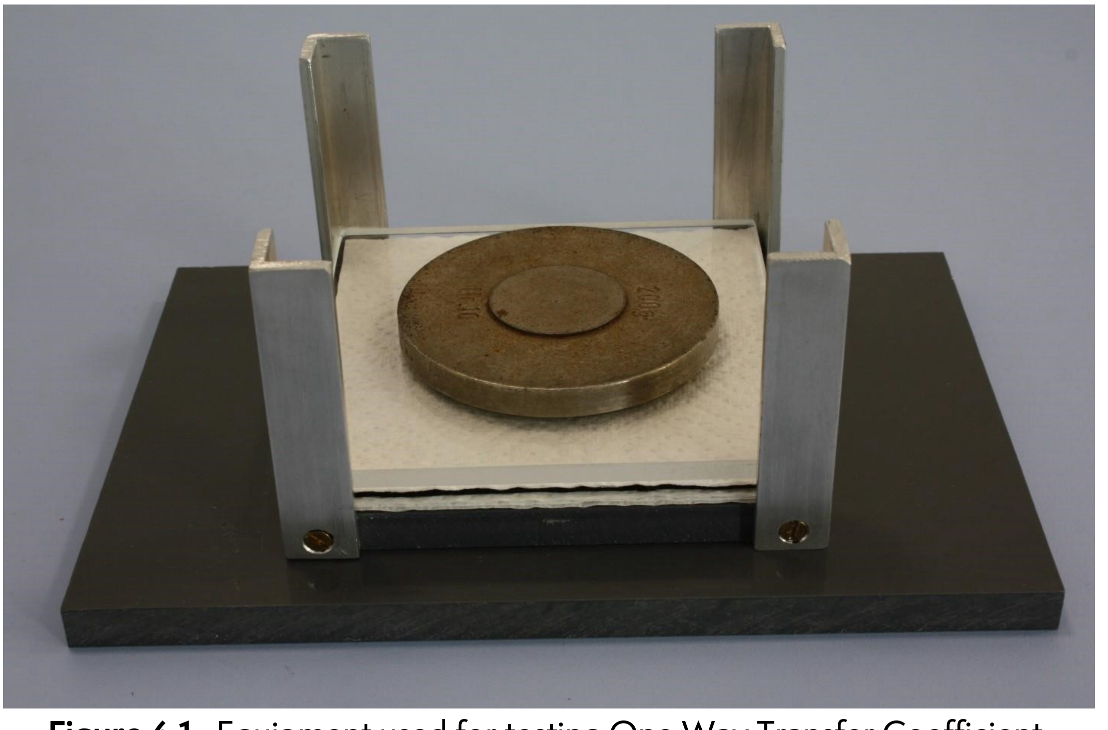


Figure 6.1: Equipment used for testing One Way Transfer Coefficient.

6.1.1 Materials and Apparatus

The following materials and apparatus were used for the One-Way Transfer Coefficient experiment:

(a) Sample holder with plastic bottom tile (see picture below; measurements are given in mm)

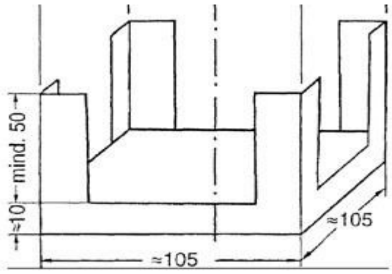


Figure 6.2: Sample holder (Image Source: MDS-HI 12/2015, dimensions in mm)

(b) Sample fabric (10 x 10 cm; 100 cm2 square cut).
(c) Filter paper (10 x 10 cm; 100 cm2 square cut; absorbent time of tissue paper should be on average < 10 s for saline solution and < 350 s for blood simulant).
(d) Weighing scale (accuracy 0,001 g).
(e) Stopwatch (precision between 0,05 -0,1 s).
(f) 200 g weight (dimensions do not matter as the weight/pressure is evenly distributed by the 10 x 10 cm plastic tile, see image 2).
(g) Plastic Tile (10 x 10 cm; weight approx. 60 g).
(h) Graduated pipette (volume: 10 mL; precision ± 0,05 mL)

(i) Liquids (ca. 100 mL):
- → Saline for urine simulant: 0.9 % saline solution (9 g of NaCl per litre of distilled water).
- → Synthetic blood simulant: Dissolve 3 g CMC (Carboxy Methyl Cellulose, 0.60-0.95 degree of substitution, CAS 9004- 32-4, Sigma-Aldrich resp. Merck) and 9 g NaCl per litre of distilled water under stirring and heating up to 35 °C. Liquid is used after cooling to room temperature.

In the case of testing for menstruation products, replace 0.9% saline solution with synthetic blood solution. A square area of 10 x 10 cm was cut from each sample using a punch.

6.1.2 General Experiment Protocol

Determine wicking surface.

(a) Storage of samples under conditions mentioned in ISO 139.

(b) Place 4 pieces of the filter paper on the sample holder (absorbent layer). Weigh the layer to determine the dry weight of absorbent layer. Maintain the dry weight within 5 g ± 0.1 g.

(c) Weigh the fabric sample for dry weight to be determined. Fabric sample acts as wicking layer. Place it on top of the absorbent layer with side 1 facing up.

(d) Weigh 2 pieces of the filter paper which will act as blot.

(e) Pour 10 ml of the respective liquid (saline solution or blood simulant) on to the surface of the centre of the fabric sample from the graduated pipette. The rate of liquid releasing should be 1 ml/s.

(f) For saline: wait 5 s, for synthetic blood: wait 30 s.
NOTE: In case the elapsed time to absorb the liquid is considered too long, a reduction from 10 to 5 ml of the respective liquid could be feasible or the liquid could be applied in 2 steps of 5 ml each with a 10-15 s pause in between.

(g) Place 2 pieces of the filter paper on top of the sample to act as a blot. Maintain the dry weight within 2 g ± 0.1 g.

(h) Place the plastic tile on top. Rationale for plastic tile is weight / pressure distribution.

(i) Place the 200 g weight on top of the tile.

(j) Start the stopwatch. Let the sample sit for 60 seconds.

(k) Take off the weight, tile, blot, and fabric sample.

(l) Weigh the absorbent, wicking and blot layer individually for wet weight.

(m) Repeat experiment 3 times.

(n) Repeat experiment for Side 2 of fabric sample.

Determine the weight gains for absorbent layer, fabric, and blot according to the following equation:

$$\text{Weight Gain (g)} = \text{wet weight (g)} - \text{dry weight (g)}$$

To determine wicking surface of fabric, the fabric side facing up with highest weight gain (g) for absorbent layer indicates wicking surface.

The One-Way Transfer coefficient of each sample was then calculated using the equation below:

$$\text{One way transfer coefficient} = \frac{\%\ \text{Weight gain on absorbent}}{\%\ \text{Weight gain on blot}}$$

The percentage weight gains used above were calculated based upon the following equation:

$$\%\ \text{Weight gain} = \frac{(\text{Wet Weight} - \text{Dry Weight})}{\text{Dry Weight}} \times 100$$

6.1.3 Results

Sample A		**Absorbent Layer**	**Wicking layer**	**Blot**
Reading 1	Wet weight (g)			
	Dry weight (g)			
	Weight Difference (g)			
Reading 2	Wet weight (g)			
	Dry weight (g)			
	Weight Difference (g)			
Reading 3	Wet weight (g)			
	Dry weight (g)			
	Weight Difference (g)			
Average Weight Gain %				
One way Transfer Coefficient				

Average of the Weight Difference for Blot (g):
Average of the Weight Difference for Absorbent (g):

6.2. Wicking rate & Rewet.

CODE: HOHENSTEIN002S, HOHENSTEIN002B (see also images 1, 3 & 4)

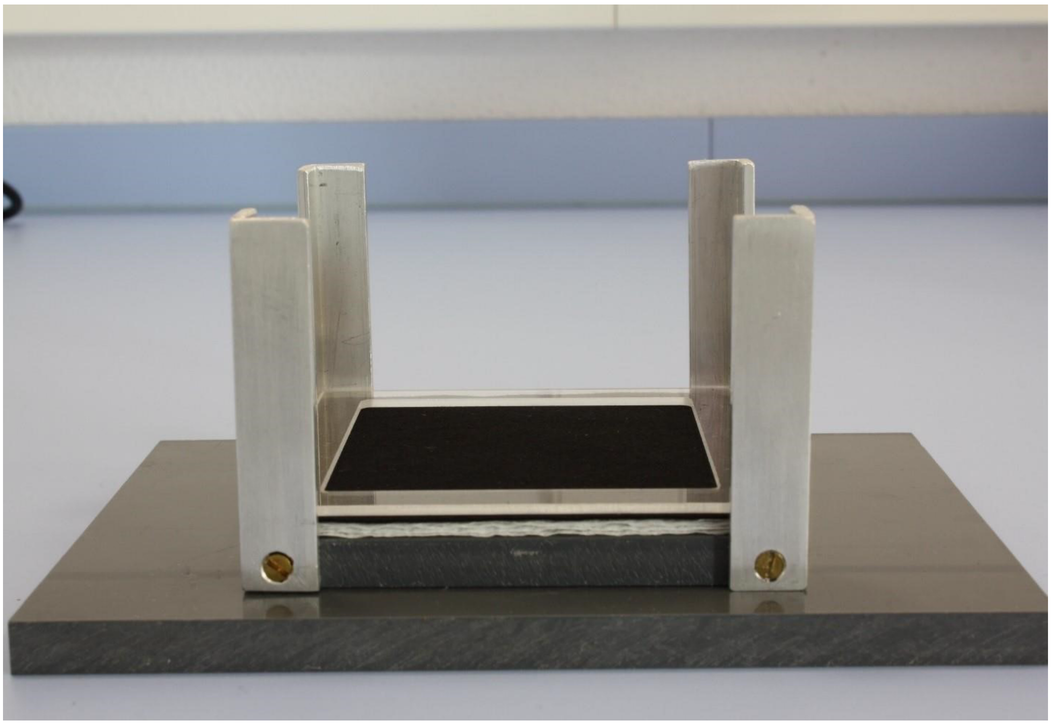


Figure 6.3: Equipment used for Wicking Rate & Rewet

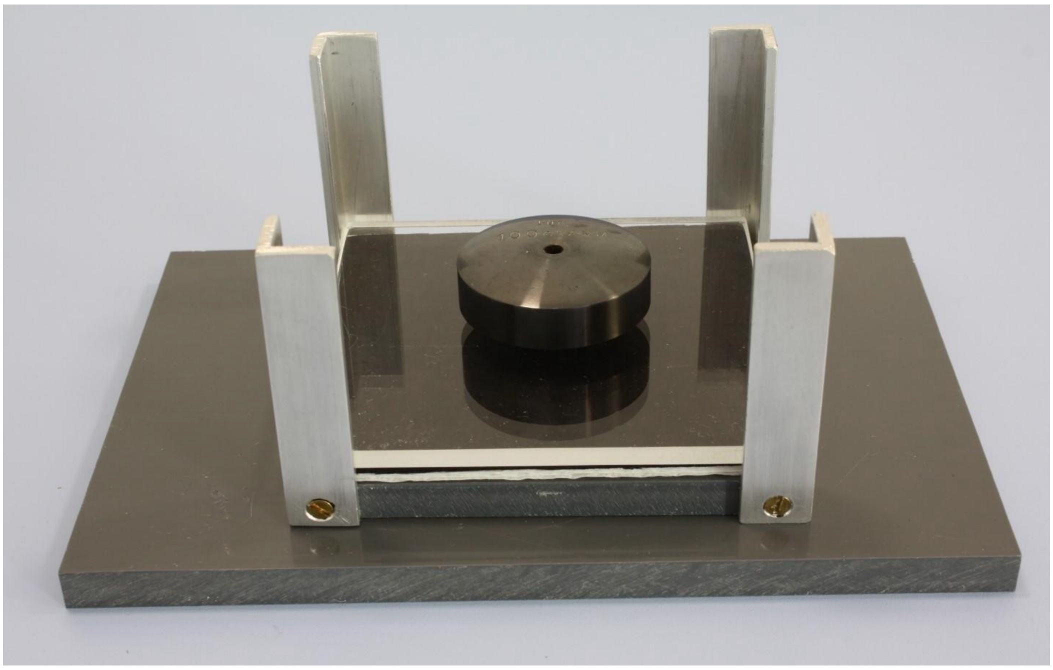


Figure 6.4: Equipment used for Wicking Rate & Rewet

6.2.1 Materials and Apparatus

The following materials and apparatus were used for the wicking rate experiment:

(a) Sample fabric (10 x 10 cm; 100 cm2 square cut)

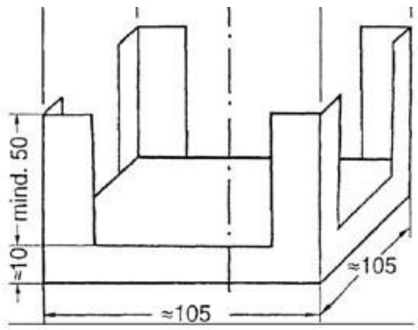


Figure 6.5: Sample holder (Image source: MDS-HI 12/2015, dimensions in mm).

(b) Filter paper (10 x 10 cm; 100 cm2 square cut;)
(c) Weighing scale (accuracy 0,001 g)
(d) Stopwatch (precision between 0,05 -0,1 s)
(e) 100 g weight (dimensions do not matter as the weight/pressure is evenly distributed by the 10 x 10 cm plastic tile, see image 4)
(f) Plastic Tile (10 x 10 cm; weight approx. 60 g).
(g) Steel or Plastic Tile with hole (see specifications below, measurements given in mm)
(h) Plastic frame (10 x 10 cm; 0,5 cm frame width)

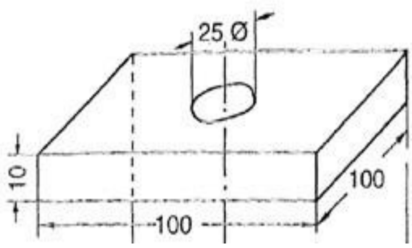


Figure 6.6: Sample holder (Image Source: MDS-HI 12/2015, dimensions in mm).

(i) Graduated pipette (Volume: 10 mL; precision ± 0,05 mL)
(j) Micro-Pipette, capable of dispensing the required volume of water to an accuracy of 0,01 ml.
(k) Liquids (ca. 100 mL):
  → Saline for urine simulant: 0.9 % saline solution (9 g of NaCl per litre of distilled water)
  → Synthetic blood simulant: Dissolve 3 g CMC (Carboxy Methyl Cellulose, 0.60-0.95 degree of substitution, CAS 9004- 32-4, Sigma-Aldrich resp. Merck) and 9 g NaCl per litre of distilled water under stirring and heating up to 35 °C. Liquid is used after cooling to room temperature.

In the case of testing for menstruation products, replace 0.9% saline solution with synthetic blood solution. A square area of 10 x 10 cm was cut from each sample using a punch.

6.2.2 General Experiment Protocol

(a) Storage of samples under conditions mentioned in ISO 139.

(b) Place 4 pieces of the filter paper on the sample holder (absorbent layer).

(c) Weigh the dry weight of Absorbent Layer Maintain the dry weight within 4 g ± 0.1 g.

(d) Weight the dry weight of sample fabric. Place the sample fabric, acting as wicking layer, on top with wicking surface facing upwards. (Wicking surface determined in One Way Transfer coefficient test).

(e) Drop a single drop (size 0.1 ml) of the respective liquid on the center of the fabric sample surface.

(f) Record the time for the droplet to completely disappear from the surface.

(g) Put the plastic frame respectively steel/plastic tile with hole on top. Use the plastic frame in case of synthetic blood or if the droplet with saline solution does not disappear within the 5 min or in general for hydrophobic absorbent layers / materials.

(h) Pour 10 ml with a flow rate of 1 ml/s of the respective liquid on to the fabric surface.

Wait for 10 minutes.
NOTE: In case the elapsed time to absorb the liquid is considered too long, a reduction from 10 to 5 ml of the respective liquid could be feasible or the liquid could be applied in 2 steps of 5 ml each with a 10-15 s pause in between.

(i) Weigh a blot of 2 pieces of the filter paper. Maintain the dry weight within 2 g ± 0.1 g. Place them on the wet surface of sample fabric.

(j) Remove the top plastic frame resp. steel/plastic tile, see also image 3.

(k) Place the plastic tile on top and a weight of 100 g upon (image 4). Restart timer for 1 minute. (Rationale for plastic tile is weight / pressure distribution)

(l) Remove weight.

(m) Weigh the blot layer (absorbent and wicking layer are optional) for wet weight. And mention the average of the calculated rewet % of the blot reading.

(n) Repeat the experiment 3 times.

(o) Repeat experiment for Side 2 of fabric sample.

The rate of wicking was then calculated using the following

$$\textit{Rate of Wicking} = \frac{1}{\textit{Droplet disappearance time}}$$

$$\textit{\% Rewet} = \frac{\textit{W2 (Wet Weight)} - \textit{W1 (Dry Weight)}}{\textit{W1 (Dry Weight)}} \times 100$$

6.2.3 Results

Sample A	Reading 1	Reading 2	Reading 3	Average	Rate of Wicking
Time (s)					

Sample A		Absorbent Layer	Wicking layer	Blot
Reading 1	Wet weight (g)			
	Dry weight (g)			
	% Rewet			
	Weight Difference			
Reading 2	Wet weight (g)			
	Dry weight (g)			
	% Rewet			
	Weight Difference			
Reading 3	Wet weight (g)			
	Dry weight (g)			
	% Rewet			
	Weight Difference			

Average of the Blot Reading (% Rewet):
Average of the Weight Difference:

6.3. Saturated capacity

CODE: HOHENSTEIN003S, HOHENSTEIN003B (see also images 5, 6, 7 & 8)

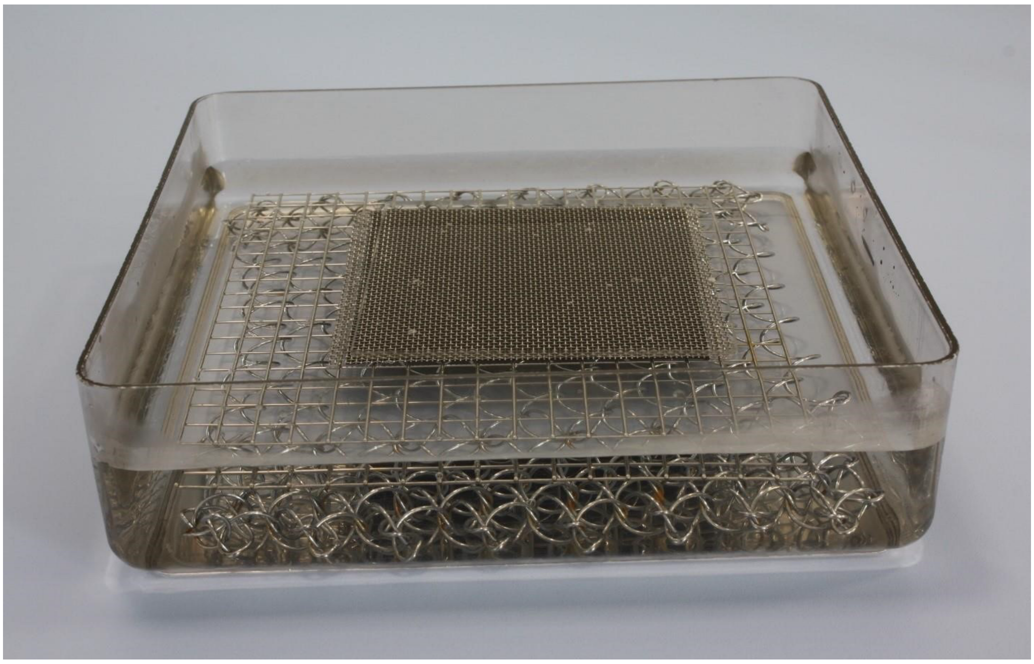


Figure 6.7: Saturated Capacity test: Set-up in container with test liquid.

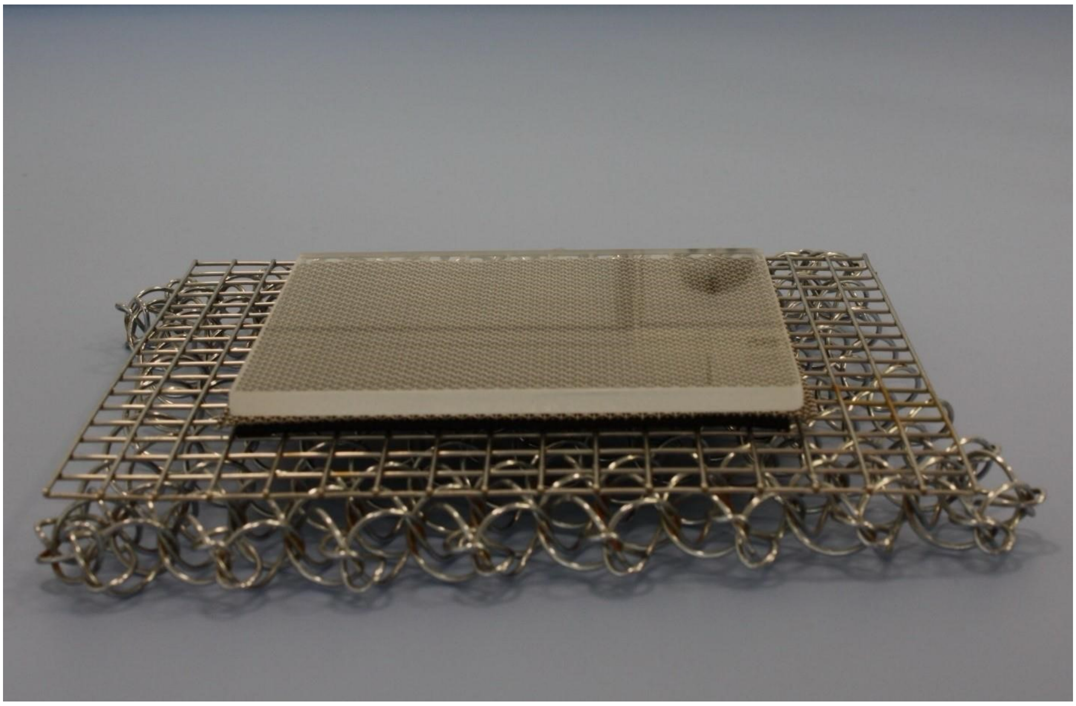


Figure 6.8: Saturated Capacity test: Set-up outside of container

6.3.1 Materials and Apparatus

The following materials and apparatus were used for the saturated capacity experiment:

(a) Sample holder with plastic bottom tile (see picture; measurements are given in mm)

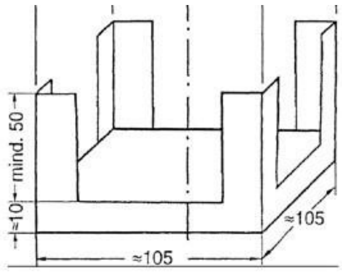


Figure 6.6: Sample holder with plastic tile (Image Source: MDS-HI 12/2015, dimensions in mm)

(b) Sample fabric (10 x 10 cm; 100 cm2 square cut)
(c) Filter paper (10 x 10 cm; 100 cm2 square cut;)
(d) Weighing scale (accuracy 0,001 g)
(e) Stopwatch (precision between 0,05 -0,1 s)
(f) Tweezers
(g) 200g weight
(h) Plastic Tile (10 x 10 cm; weight approx. 60 g)
(i) Container (plastic): dimensions approx. 20 cm x 20 cm x 6 cm
(j) 3 grids, (no.1 for distance from container bottom (approx. 18 cm x 18 cm; x 1,7 cm; mesh size approx. 1,3 cm), no 2 placed on top of no. 1 for flat specimen positioning (approx. 16 cm x 16 cm, mesh size 1 cm), no. 3 for distance between sample and plastic tile (approx. 10 x 10 cm, mesh size 1 mm).
(k) Liquids (approx. 1500 mL, depending on the container volume. Specified container is filled up to approx. 4 cm height):
   - → Saline for urine simulant: 0.9 % saline solution (9 g of NaCl per litre of distilled water).
   - → Synthetic blood simulant: Dissolve 3 g CMC (Carboxy Methyl Cellulose, 0.60-0.95 degree of substitution, CAS 9004- 32-4, Sigma-Aldrich resp. Merck) and 9 g NaCl per litre of distilled water under stirring and heating up to 35 °C. Liquid is used after cooling to room temperature.

In the case of testing for menstruation products, replace 0.9% saline solution with synthetic blood solution. A square area of 10 x 10 cm was cut from each sample using a punch.

6.3.2 General Experiment Protocol

(a) Storage of samples under conditions mentioned in ISO 139.

(b) Dry weights of the fabric sample is recorded, W2.

(c) Fill container with enough liquid (depending on size of container as well as height of grids/ plastic tile). Place grid no 1 in the container. Place specimen on grid no 2. Grid no 3 as well as the plastic tile on top. (see picture no. 5) Completely submerge the setup in the container for 180 seconds (see picture 6-8).

(d) Using tweezers, gently lift the sample from the liquid and hold it above the beaker to drain excess liquid for 10 seconds.

(e) Sample placed on the sample holder.

(f) 2 pieces of the filter paper placed on top of the wet sample.

(g) Plastic Tile (for weight / pressure distribution) and weight of 200 g placed on top of the standard absorbent and kept there for 1min.

(h) Final weight (W1) of the sample measured.

(i) Repeat the experiment 3 times.

(j) Tabulate the findings.

The % saturated gain for each of the samples is calculated using the following equation:

$$\%\ Saturated\ Gain = \frac{W1\ (Wet\ Weight) - W2\ (Dry\ Weight)}{W1\ (Dry\ Weight)} \times 100$$

The volume absorbed for each of the samples is calculated using the following equation:

Weight Gain (g) = wet weight (g) – dry weight (g)

Volume Absorbed (ml) = Weight Gain (g) / Density of the Fluid (gcm^{-3})

Density of the Fluids

→ 0.9 % saline simulant – 1.005 gcm^{-3}

→ Synthetic blood simulant - 1.012 gcm^{-3}

6.3.3 Results

Sample A		**Value**
Reading 1	Wet weight (g)	
	Dry weight (g)	
	% Saturated Gain	
	Absorbed Volume	
Reading 2	Wet weight (g)	
	Dry weight (g)	
	% Saturated Gain	
	Absorbed Volume	
Reading 3	Wet weight (g)	
	Dry weight (g)	
	% Saturated Gain	
	Absorbed Volume	
Average % Saturated Gain		
Average Absorbed Volume		

6.4. Testing codes

Use following codes in the Test Request Form.

Code	Test	Fluid
HOHENSTEIN001S	One Way Transfer Coefficient Studies	Saline
HOHENSTEIN001B	One Way Transfer Coefficient Studies	Blood Simulant
HOHENSTEIN002S	Wicking Rate & Rewet Studies	Saline
HOHENSTEIN002B	Wicking Rate & Rewet Studies	Blood Simulant
HOHENSTEIN003S	Saturated Capacity	Saline
HOHENSTEIN003B	Saturate Capacity	Blood Simulant

7. BIBLIOGRAPHY

- ISO 139, Textiles — Standard atmospheres for conditioning and testing
- AATCC 150-2018 — Dimensional Changes of Garments after Home Laundering
- ISO 6330:2021-11 -Textiles — Domestic washing and drying procedures for textile testing. Test method No. 12/2015 MDS-Hi (German Healthcare Medical Service)

ABOUT US

MAS is a pioneer in innovation in apparel solutions in the hygiene space.

Femography by MAS is a pioneer in innovative apparel solutions addressing female health. Our purpose is to bring normalcy to women's lives from menarche to menopause, and everything in between, supporting them through the ups & downs of womanhood. The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our processes.

COPYRIGHTS

USEFUL CONTACTS

Janith Dushyantha
Email: janithd@masholdings.com
Address: 50, Foster Lane, Colombo 10, Sri Lanka

FEMOGRAPHY by MAS
50, Foster Lane, Colombo 10, Sri Lanka

MAS
CHANGE IS COURAGE

femography