CHAPTER 7

STUDY OF MOISTURE MANAGEMENT PROPERTIES OF DOUBLE-FACE KNITTED FABRICS

7.1 INTRODUCTION

Comfort can be achieved in a fabric mainly due to the transfer of sweat from the skin to the fabric thus making the wearer to feel comfortable. This can be achieved by producing a double-face knitted fabric with layer next to skin made of hydrophobic material which transfers the sweat and the outer layer made of hydrophilic material which absorbs the sweat.

In order to study the moisture management properties,

i) Four different double-face knitted fabrics produced with cotton yarn as outer layer and polypropylene, polyester, acrylic and nylon yarns as inner layer are chosen for the study.

ii) Nine different double-face knitted fabrics produced with cotton as outer layer and polypropylene as inner layer by varying the yarn fineness are chosen for the study.
iii) Five different double-face knitted fabrics produced with cotton as outer layer and polypropylene as inner layer by varying the tuck position are chosen for the study.

7.2 METHODOLOGY

The influence of yarn type, yarn fineness and tuck density on moisture management properties of double-face knitted fabrics were studied.

In order to study this,

i) Five different yarns such as cotton, polypropylene, polyester, acrylic and nylon was selected. The polypropylene, polyester, acrylic and nylon selected was multifilament dope dyed yarn each of 120 denier (24 filaments) and cotton of 120 denier combed yarn. The selected yarns were knitted using high speed double circular knitting machine with speed of 25 rpm to produce four different double-face fabrics.

ii) Three different deniers of combed cotton yarn such as 120D, 180D and 240D and three different deniers of polypropylene multifilament dope dyed yarns such as 120D (24 filaments), 180D (36 filaments) and 240D (48 filaments) was selected for the study. The selected yarns were knitted using high speed double circular knitting machine with speed of 25 rpm to produce nine different double-face fabrics.
iii) Combed cotton yarn of 120D and polypropylene multifilament dope dyed yarn of 240D (48 filaments) was selected for the study. The selected yarns were knitted using high speed double circular knitting machine with speed of 25 rpm to produce five different double-face fabrics.

7.2.1 Processing

The double-face knitted fabrics were subjected to hot wash and bleached with hydrogen peroxide at 3% owm at 100°C and dyed with hot brand reactive dye at 5% owm at 90°C in winch dyeing machine. Then it was washed and dried in a stenter at 150-160°C and subjected to relaxation for 48 hours. Then the samples were tested for its moisture management properties.

7.2.2 Testing for Moisture Management Characteristics

For testing the moisture transfer capabilities of the double-face knitted fabrics, the Moisture Management Tester (MMT) was used. It sense, measure and record the moisture transfer behavior of the double layered knitted fabrics in multiple directions. The electrical resistance of the double-face fabric changes when moisture gets transferred in the fabric. During testing, a pre-defined weight of 0.15g of test solution was injected and introduced on the upper side of the fabric; the sensor plates which were interfaced with a computer continuously monitored and recorded the changes in electrical resistance value between each couple of metal rings located on the top and lower surfaces individually.
7.3 RESULTS AND DISCUSSION

To study the effect of yarn type on moisture management properties of double-face fabrics, four different double-face fabrics were used and denoted as C/PP fabric for 120D C/120D PP fabric, C/P fabric for 120D C/120D P fabric, C/A fabric for 120D C/120D A fabric and C/N fabric 120D C/120D N fabric.


To study the effect of tuck density on moisture management properties of double-face fabrics, five different double-face fabrics produced from 120D C/240D PP were used and denoted as 6×9 fabric for 6×9 double-face fabric, 6×6 fabric for 6×6 double-face fabric, 3×3 fabric for 3×3 double-face fabric, 9×9 fabric for 9×9 double-face fabric and 12×9 fabric for 12×9 double-face fabric.

7.3.1 Effect of Yarn Type on Moisture Management Properties of Double-face Knitted Fabrics

The moisture management properties of double-face fabrics were studied and the wetting time, maximum wetted radius and spreading speed of water in both the top inner surface and bottom outer surface of the four different double-face fabrics was given in the Table 7.1.
Table 7.1 Double-face fabrics moisture management characteristics-I

<table>
<thead>
<tr>
<th>Double-Face Fabrics with Notation</th>
<th>Wetting Time (s)</th>
<th>Maximum Wetted Radius (mm)</th>
<th>Spreading Speed (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top inner Surface</td>
<td>Bottom outer surface</td>
<td>Top inner Surface</td>
</tr>
<tr>
<td>120D C/120D PP (C/PP)</td>
<td>5.531</td>
<td>13.406</td>
<td>10</td>
</tr>
<tr>
<td>120D C/120D P (C/P)</td>
<td>13.219</td>
<td>120</td>
<td>5</td>
</tr>
<tr>
<td>120D C/120D A (C/A)</td>
<td>13.031</td>
<td>120</td>
<td>5</td>
</tr>
<tr>
<td>120D C/120D N (C/N)</td>
<td>12.093</td>
<td>120</td>
<td>5</td>
</tr>
</tbody>
</table>

C-Cotton, PP-Polypropylene, P-Polyester A-Acrylic, N-Nylon

From the Table 7.1, it was found that in C/PP fabric, the wetting time taken by the polypropylene top surface to just start to get wetted was 5.531 seconds and the time taken by the cotton bottom surface to just start to get wetted was 13.406 seconds. But in case of C/P fabric, C/A fabric and C/N fabric, the time taken by the polypropylene top surface to just start to get wetted is around 13 seconds and the time taken for the cotton bottom surface to just start to get wetted was around 120 seconds. From this observation it was clear that the polypropylene with higher moisture transmission property starts transmitting the water in minimum time duration when compared to polyester, acrylic and nylon double-face fabrics. But in case of polyester, acrylic and nylon double layered knitted fabrics, the time taken to transfer the water to the top surface and observed by the bottom cotton surface was found higher since polyester, acrylic and nylon possesses lower water transmission property than polypropylene which results in no transfer of water from the top surface to the bottom surface even upto 120 seconds.
From the Table 7.1, it was found that in C/PP fabric, the maximum wetted radius on polypropylene top surface was found as 10 mm and the maximum wetted radius on cotton bottom surface was found as 25 mm. From this observation it was clear that polypropylene quickly clears the water to the bottom surface which absorbs with higher value for maximum wetted radius. But in case of C/P fabric, C/A fabric and C/N fabric the maximum wetted radius on polypropylene top surface is found as 5 mm and the maximum wetted radius on cotton bottom surface is found as 0 mm. From this observation it was found that polyester, acrylic and nylon lacks in transmitting the water from their inner surface to the cotton bottom surface resulting in minimum wetted radius values than polypropylene with zero absorption wetted radius on cotton bottom surface.

From the Table 7.1, regarding the spreading speed it was found that in C/PP fabric, the spreading speed on polypropylene top surface was found as 0.85 mm/sec and the spreading speed on cotton bottom surface was found as 2.17 mm/sec. From this observation it was clear that as polypropylene quickly transfers the water by capillary forces from its surface, it was having lower spreading speed when compared to the bottom cotton surface which absorbs the water and spread it at a faster rate than polypropylene. But in case of C/P fabric, C/A fabric and C/N fabric, the spreading speed on top surface of polyester, acrylic and nylon was found around 0.4mm/sec with zero spreading speed on the cotton bottom surface. From this observation it was found that polyester, acrylic and nylon lacks in transmitting the water from their inner surface to the cotton bottom surface resulting in minimum spreading speed values than polypropylene with zero spreading speed on cotton bottom surface.
Figure 7.1 Water content versus time of C/PP fabric

The water content versus time of C/PP fabric was shown in the Figure 7.1. As soon as the water was poured on the top surface of polypropylene layer it starts wetted at 5.5 seconds (a) and interacts with the polypropylene layer and it shows a maximum water content of 1570% (b) at 25 seconds. This interaction was an evidence of transverse wicking. In the mean time the cotton bottom layer gets wetted at 13.4 seconds (d) and spreads the water in the cotton layer and at 25 seconds it shows 500% water content which is due to increase in the gravitational force than the pouring force in the cotton layer. After 25 seconds polypropylene layer starts to transmit the water to the next bottom cotton layer so that the water content decreases.

The cotton layer absorbs the water from the polypropylene layer due to inter layer space transfer and the water content increases from 500% to 1300% in cotton layer. At 65 seconds (h) both the polypropylene and cotton layer has equal amount of water content of 1310% (g) as shown in (f). After 65 seconds, the water content in the polypropylene layer tends to decrease as it transfers the water and the water content in cotton layer tends to increase as it absorbs it. At 120 seconds, the polypropylene layer reveals lesser water content of 1100% (c) as it transfers the water and the cotton layer indicates
larger water content of 1300% (e) as it absorbs it. This indicates clearly that the water present in the polypropylene layer gets transferred to the cotton layer which absorbs and spreads the water in making the polypropylene layer dry than the cotton layer.

The water location versus time of C/PP fabric was shown in the Figure 7.2. The wetted area on the bottom cotton layer of C/PP fabric was found higher than the top polypropylene layer but the outer surface shows lesser water content.

Figure 7.2 Water location versus time of C/PP fabric
The finger print of C/PP fabric was shown in the Figure 7.3. It was found that C/PP fabric shows fast in medium wetting, fast in medium absorption rate, shows a very large bottom wetted radius. But the C/PP fabric was slow to medium spreading speed, excellent in one way transport and very good at OMMC value. The C/PP fabric was found as fast absorbing and quick drying fabric.

Figure 7.4 Water content versus time of C/P fabric
The water content versus time of C/P fabric was shown in the Figure 7.4. As soon as the water was poured on the top surface of polyester layer it starts wetting at 13 seconds (a) and has water content of 1342% (b) at 25 seconds and starts decreasing and at 120 seconds it has water content of 1200% (c). But the cotton bottom layer doesn’t absorb the water even at 120 seconds and the water remains in the polyester top layer.

Figure 7.5 Water location versus time of C/P fabric

The water location versus time of C/P fabric was shown in the Figure 7.5. The wetted area on the top polyester layer of C/P fabric was found smaller and there was no wetted area seen on the bottom cotton layer of C/P fabric.

The finger print of C/P fabric was shown in the Figure 7.6. It was found that C/P fabric has medium wetting, very fast absorption rate, with no wetted radius. The fabric indicates very slow spreading speed with respect to top surface of polyester and found with no wetting, no absorption rate , no wetted radius, no spreading speed on bottom cotton surface. It has poor one way transport and poor OMMC value. The C/PP fabric was found as water proof fabric.
Figure 7.6 Finger print of C/P fabric

Figure 7.7 Water content versus time of C/A fabric

The water content versus time of C/A fabric was shown in the Figure 7.7. As soon as the water was poured on the top surface of acrylic layer it starts wetting at 13 seconds (a) and reveals water content of 1364% (b) at 25 seconds however it starts decreasing and at 120 seconds it has water
content of 1300% (c). But the cotton bottom layer doesn’t absorb the water even at 120 seconds and the water remains in the acrylic top layer.

Figure 7.8 Water location versus time of C/A fabric

The water location versus time of C/A fabric was shown in the Figure 7.8. The wetted area on the top acrylic layer of C/A fabric was found smaller and there was no wetted area seen on the bottom cotton layer of C/A fabric.

Figure 7.9 Finger print of C/A fabric
The finger print of C/A fabric was shown in the Figure 7.9. It was found that C/A fabric has medium wetting, very fast absorption rate, with no wetted radius. The fabric shows very slow spreading speed with respect to top surface of acrylic and found with no wetting, no absorption rate, no wetted radius, no spreading speed on bottom cotton surface. It has poor one way transport and poor OMMC value. The C/A fabric was found as water proof fabric.

![Figure 7.10 Water content versus time of C/N fabric](image)

**Figure 7.10 Water content versus time of C/N fabric**

The water content versus time of C/N fabric was shown in the Figure 7.10. As soon as the water was poured on the top surface of nylon layer it starts wetting at 12 seconds (a) and has water content of 1369% (b) at 25 seconds and starts decreasing and at 120 seconds it has water content of 1369% (c). But the cotton bottom layer absorbs only 5% of the water even at 120 seconds and the water remains in the nylon top layer.
The water location versus time of C/N fabric was shown in Figure 7.11. The wetted area on the top nylon layer of C/N fabric was found smaller and there was no wetted area seen on the bottom cotton layer of C/N fabric.

![Figure 7.11 Water location versus time of C/N fabric](image1)

**Figure 7.12 Finger print of C/N fabric**
The fingerprint of C/N fabric was shown in the Figure 7.9. It was found that C/N fabric has medium wetting, very fast absorption rate, with no wetted radius. It also shows very slow spreading speed with respect to top surface of nylon and found with no wetting, no absorption rate, no wetted radius, no spreading speed on bottom cotton surface. It has poor one way transport and poor OMMC value. The C/N fabric was found as water proof fabric.

7.3.2 Effect of Yarn Fineness on Moisture Management Properties of Double-Face Fabrics


Among the selected nine double-face fabrics no significant difference was found for the moisture management characteristics.

7.3.3 Effect of Tuck Density on Moisture Management Properties of Double-Face Fabrics

The moisture management properties of double-face fabrics were studied and the wetting time, maximum wetted radius and spreading speed of water both in the top inner surface and bottom outer surface of the five different double-face fabrics was given in the Table 7.2.
Table 7.2 Double-face fabrics moisture management characteristics-II

<table>
<thead>
<tr>
<th>Double-Face Fabrics of 120D C/240D PP with Notation</th>
<th>Wetting Time (s)</th>
<th>Maximum Wetted Radius (mm)</th>
<th>Spreading Speed (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top inner Surface</td>
<td>Bottom outer surface</td>
<td>Top inner Surface</td>
</tr>
<tr>
<td>6×9 double-face fabric (6×9)</td>
<td>7.969</td>
<td>19.687</td>
<td>10</td>
</tr>
<tr>
<td>6×6 double-face fabric (6×6)</td>
<td>10.876</td>
<td>34.688</td>
<td>10</td>
</tr>
<tr>
<td>3×3 double-face fabric (3×3)</td>
<td>11.625</td>
<td>24.750</td>
<td>5</td>
</tr>
<tr>
<td>9×9 double-face fabric (9×9)</td>
<td>11.90</td>
<td>52.0</td>
<td>5</td>
</tr>
<tr>
<td>12×9 double-face fabric (12×9)</td>
<td>11.719</td>
<td>48.656</td>
<td>5</td>
</tr>
</tbody>
</table>

The wetting time from the Table 7.2, shows that the polypropylene top surface of 6X9 fabric start wetting at 7.9 seconds and the time taken by the cotton bottom surface to start wetting was 19.6 seconds which was found better than the other four fabrics.

The maximum wetted radius in the Table 7.2 indicates that, in 6×9 fabric, the maximum wetted radius on polypropylene top surface was found as 5 mm and the maximum wetted radius on cotton bottom surface was found as 25 mm. From this observation it was clear that polypropylene quickly clears the water to the bottom surface with minimum wetted radius and the cotton layer absorbs and spreads to have maximum wetted radius which was found better than the other four fabrics.

The spreading speed of fabrics in the Table 7.2 shows that, in 6X9 fabric, the spreading speed on polypropylene top surface was found as 0.89 mm/sec and the spreading speed on cotton bottom surface was found as 3.12
mm/sec. From this observation it was clear that in 6×9 fabric, the polypropylene layer quickly transfers the water by capillary forces from its surface and the bottom cotton surface absorbs the water and spread it at a faster rate than other four fabrics.

![Water Content vs Time Graph](image)

**Figure 7.13 Water content versus time of 6×9 fabric**

The water content versus time of 6×9 fabric was shown in the Figure 7.13. As soon as the water was poured on the top surface of polypropylene layer it starts wetted at 7.9 seconds (a) and interacts with polypropylene layer and at 22 seconds it shows a maximum water content of 1380% (b). After 22 seconds it starts to transmit the water to the next bottom cotton layer so that the water content gets decrease. In the mean time the cotton bottom layer gets wetted with 390% water content from 1 second to 19.6 seconds (d) and spreads the water in the cotton layer. At 23 seconds as the polypropylene layer transfers the water to the cotton layer it absorbs and it shows a maximum water content of 1843% as shown in (j). At 21 seconds (h) both the polypropylene and cotton layers have equal amount of water content.
of 1000% (g) as shown in (f). It was interesting to note that after 22 seconds the polypropylene layer tends to transfer the water to the cotton layer which absorbs and spreads the water. After 21 seconds the water content in the polypropylene layer tends to decrease as it transfers the water and the water content in cotton layer tends to increase as it absorbs it. At 120 seconds the polypropylene layer has water content of 20% (c). But the cotton layer has water content of 1050% (e) at 120 seconds as it absorbs the water. This indicates clearly that the water present in the polypropylene layer gets transferred to the cotton layer and the cotton layer absorbs it thus making the polypropylene layer dry than the cotton layer.

![Water Location vs Time](image)

**Figure 7.14 Water location versus time of 6×9 fabric**

The water location versus time of 6×9 fabrics was shown in the Figure 7.14. The wetted area on the top polypropylene layer of 6×9 fabrics was found smaller and the wetted area on the bottom cotton layer was found larger.

The finger print of 6×9 fabric was shown in the Figure 7.15. It was found that 6×9 fabric has fast to medium wetting, very fast absorption rate,
small top wetted radius and very large bottom wetted radius, very slow to medium spreading speed, very good one way transport and very good OMMC value. The 6×9 fabric was found as moisture management fabric.

**Figure 7.15 Finger print of 6×9 fabric**

The water content versus time of 6×6 fabric was shown in the Figure 7.16. As soon as the water was poured on the top surface of polypropylene layer it starts wetting at 10.8 seconds (a) and at 20 seconds it shows a maximum water content of 1400% (b). After 20 seconds it starts to transmit the water to the next bottom cotton layer so that the water content gets decreases. In the mean time the cotton bottom layer gets wetted with 400% water content from 1 second to 34.6 seconds (d) and spreads the water in the cotton layer. At 95 seconds it indicates a maximum water content of 1907% (e).
Figure 7.16 Water content versus time of 6x6 fabric

At 90 seconds (h) both the polypropylene and cotton layers have equal amount of water content of 1350% (i) as shown in (g). It was interesting to note that after 20 seconds, the polypropylene layer tends to transfer the water to the cotton layer which absorbs and spreads the water. After 90 seconds the water content in the polypropylene layer tends to decrease as it transfers the water and the water content in cotton layer tends to increase as it absorbs it. At 120 seconds the polypropylene layer shows water content of 50% (c) as it transfers the water and the cotton layer contains water content of 1480% (f) as it absorbs it. This indicates clearly that the water present in the polypropylene layer gets transferred to the cotton layer and the cotton layer absorbs and there exist water in between the two layers making the polypropylene layer dry than the cotton layer.
Figure 7.17 Water location versus time of 6x6 fabric

The water location versus time of 6x6 fabrics was shown in the Figure 7.17. The wetted area on the top polypropylene layer of 6x6 fabric was found smaller and the wetted area on the bottom cotton layer was found larger.

Figure 7.18 Finger print of 6x6 fabric
The finger print of 6×6 fabric was shown in the Figure 7.18. It was found that 6×6 fabric has medium to slow wetting, fast absorption rate, small top wetted radius and large bottom wetted radius, slow spreading speed, excellent one way transport and excellent OMMC value. The 6×6 fabric was found as moisture management fabric.

Figure 7.19 Water content versus time of 3×3 double-face fabric

The water content versus time of 3×3 fabric was shown in the Figure 7.19. As soon as the water was poured on the top surface of polypropylene layer it starts wetting at 11.6 seconds (a) and at 25 seconds it shows a maximum water content of 1100% (b). After 25 seconds it starts transmitting the water to the next bottom cotton layer so that the water content gets decrease. In the mean time, the cotton bottom layer starts wetting at 24.7 seconds (d) and spreads the water in the cotton layer. At 35 seconds it indicates a maximum water content of 1605% (e). At 27 seconds (h) both the polypropylene and cotton layers have equal amount of water content of 800% (i) as shown in (g). It was interesting to note that after 25
seconds the polypropylene layer tends to transfer the water to the cotton layer which absorbs and spreads the water. After 27 seconds, the water content in the polypropylene layer tends to decrease as it transfers the water and the water content in cotton layer tends to increase as it absorbs it. At 120 seconds, the polypropylene layer has water content of 90% (e) as it transfers the water and the cotton layer shows water content of 1570% (f) as it absorbs it. This indicates clearly that the water present in the polypropylene layer gets transferred to the cotton layer and the cotton layer absorbs it thus making the polypropylene layer dry than the cotton layer.

Figure 7.20 Water location versus time of 3×3 fabric

The water location versus time of 3×3 fabric was shown in the Figure 7.20. The wetted area on the top polypropylene layer of 3×3 fabrics was found smaller and the wetted area on the bottom cotton layer was found larger but the outer surface was found with lesser water content.
Figure 7.21 Finger print of 3×3 fabric

The finger print of 3×3 fabric was shown in the Figure 7.3. It was found that 3×3 fabric has medium to slow wetting, medium to slow absorption rate, small top wetted radius and large bottom wetted radius, very slow spreading speed, excellent one way transport and excellent OMMC value. The 3×3 fabric was found as moisture management fabric.

Figure 7.22 Water content versus time of 9×9 fabric
The water content versus time of 9×9 fabric was shown in the Figure 7.22. As soon as the water was poured on the top surface of polypropylene layer it starts wetting at 11.9 seconds (a) and at 14 seconds it reaches a maximum water content of 1180% (b). After 14 seconds it starts to transmit the water to the next bottom cotton layer so that the water content gets decreases. In the mean time the cotton bottom layer gets wetted with 150% water content from 1 second to 52 seconds (d) and spreads the water in the cotton layer. At 70 seconds it indicates a maximum water content of 1675% (e). At 55 seconds (h) both the polypropylene and cotton layers have equal amount of water content of 1000% (i) as shown in (g). It was interesting to note that after 14 seconds the polypropylene layer tends to transfer the water to the cotton layer which absorbs and spreads the water.

![Water Location vs Time](image)

**Figure 7.23 Water location versus time of 9×9 fabric**

After 55 seconds the water content in the polypropylene layer tends to decrease as it transfers the water and the water content in cotton layer tends to increase as it absorbs it. At 120 seconds, the polypropylene layer has water content of 20% (e) as it transfers the water and the cotton layer shows water content of 1560% (f) as it absorbs it. This indicates clearly that the water
present in the polypropylene layer gets transferred to the cotton layer and the
cotton layer absorbs thus making the polypropylene layer dry than the cotton
layer.

The water location versus time of 9×9 fabric was shown in the Figure 7.23. The wetted area on the top polypropylene layer of 9×9 fabric
was found smaller and the wetted area on the bottom cotton layer was found
larger but the outer surface was found with lesser water content.

Figure 7.24 Finger print of 9×9 fabric

The finger print of 9×9 fabric was shown in the Figure 7.24. It was
found that 9×9 fabric has medium to slow wetting, fast to medium absorption
rate, small top wetted radius and large bottom wetted radius, very slow
spreading speed, excellent one way transport and excellent OMMC value. The
9×9 fabric was found as moisture management fabric.
Figure 7.25 Water content versus time of 12×9 fabric

The water content versus time of 12×9 fabric was shown in the Figure 7.25. As soon as the water was poured on the top surface of polypropylene layer it starts wetting at 11.7 seconds (a) and at 25 seconds it reaches a maximum water content of 1190% (b). After 25 seconds it starts to transmit the water to the next bottom cotton layer so that the water content gets decrease. In the mean time the cotton bottom layer gets wetted with 150% water content from 1 second to 48.6 seconds (d) and spreads the water in the cotton layer. At 58 seconds, it shows a maximum water content of 1567% (e). At 55 seconds (h) both the polypropylene and cotton layers have equal amount of water content of 1180% (i) as shown in (g). It was interesting to note that after 25 seconds the polypropylene layer tends to transfer the water to the cotton layer which absorbs and spreads the water.

After 55 seconds the water content in the polypropylene layer tends to decrease as it transfers the water and the water content in cotton layer tends to increase as it absorbs it. At 120 seconds, the polypropylene layer has water content of 100% (c) as it transfers the water and the cotton layer shows water content of 1450% (f) as it absorbs it. This indicates clearly that the water...
present in the polypropylene layer gets transferred to the cotton layer and the cotton layer absorbs, making the polypropylene layer dry than the cotton layer.

![Water Location vs Time](image)

**Figure 7.26  Water location versus time of 12×9 fabric**

The water location versus time of 12×9 fabric was shown in the Figure 7.26. The wetted area on the top polypropylene layer of 12×9 fabric was found smaller and the wetted area on the bottom cotton layer was found larger.

![Finger print of 12×9 fabric](image)

**Figure 7.27  Finger print of 12×9 fabric**
The finger print of 12×9 fabric was shown in the Figure 7.27. It was found that 12×9 fabric has medium to slow wetting, medium to slow absorption rate, large bottom wetted radius, slow to medium spreading speed, excellent one way transport and excellent OMMC value. The 12×9 fabric was found as moisture management fabric.

7.4 CONCLUSION

This chapter mainly focuses on the study of moisture management properties of double-face fabrics suitable for making sportswear.

7.4.1 Effect of Yarn Type on Moisture Management Properties of Double-Face Fabrics

With regard to wetting of fabrics, it is found that in C/PP fabric, the time taken for the polypropylene top surface to just start to get wetted is 5.531 seconds and the time taken for the cotton bottom surface is just 13.406 seconds. But in case of C/P fabric, C/A fabric and C/N fabric, the time taken for the polypropylene top surface to get wetted is around 13 seconds and the time taken for the cotton bottom surface for getting wetted is around 120 seconds. From this observation, it is clear that the polypropylene with higher moisture transmission property starts transmitting the water in minimum time duration when compared to polyester, acrylic and nylon double-face fabrics.

When the maximum wetted radius of fabrics are considered, it is found that in C/PP fabric, the maximum wetted radius on polypropylene top surface is found as 10 mm and the maximum wetted radius on cotton bottom surface is found as 25 mm. From this observation, it is clear that polypropylene quickly clears the water to the bottom surface which absorbs with higher value for maximum wetted radius. But in case of C/P fabric, C/A fabric and C/N fabric, the maximum wetted radius on polypropylene top
surface is found as 5 mm and the maximum wetted radius on cotton bottom surface is found as 0 mm.

When spreading speed is considered, it is found that in C/PP fabric, the spreading speed on polypropylene top surface is found as 0.85 mm/sec and the spreading speed on cotton bottom surface is found as 2.17 mm/sec. From this observation, it is clear that as polypropylene quickly transfers the water by capillary forces from its surface, it has lower spreading speed when compared to the bottom cotton surface which absorbs the water and spread it at a faster rate than polypropylene. But in case of C/P fabric, C/A fabric and C/N fabric, the spreading speed on top surface of polyester, acrylic and nylon are found around 0.4mm/sec with zero spreading speed on the cotton bottom surface.

While considering the water content versus time, the water poured on the top surface of polypropylene layer of C/PP fabric starts wetting at 5.5 seconds (a) and interacts with the polypropylene layer and it shows a maximum water content of 1570% (b) at 25 seconds. This interaction is an evidence of transverse wicking. In the mean time the cotton bottom layer starts wetting at 13.4 seconds (d) and spreads the water in the cotton layer and at 25 seconds it contains 500% water content which was due to increase in the gravitational force than the pouring force in the cotton layer. After 25 seconds, polypropylene layer starts transmitting the water to the next bottom cotton layer so that the water content gets decrease. The cotton layer absorbs the water from the polypropylene layer due to inter layer space transfer and the water content increases from 500% to 1300% in cotton layer. At 65 seconds (h) both the polypropylene and cotton layers have equal amount of water content of 1310% (g) as shown in (f). After 65 seconds, the water content in the polypropylene layer tends to decrease as it transfers the water and the water content in cotton layer tends to increase as it absorbs it. At 120
seconds the polypropylene layer shows lesser water content of 1100% (c) as it transfers the water and the cotton layer reaches larger water content of 1300% (e) as it absorbs it. This indicates clearly that the water present in the polypropylene layer gets transferred to the cotton layer which absorbs and spreads the water in making the polypropylene layer dry than the cotton layer.

But in the case of C/P fabric, C/A fabric and C/N fabric, as soon as the water is poured on the top layer it starts wetting at 13 seconds and shows water content of around 1300% at 25 seconds and starts decreasing. At 120 seconds it shows water content around 1200%. But the cotton bottom layer doesn’t absorb the water even at 120 seconds and the water remains only on top layer with respect to polyester, acrylic and nylon. Also the wetted area on the top layer of C/P fabric, C/A fabric and C/N fabric, is found smaller and no wetted area is found on the bottom cotton layer.

Comparing all the selected double-face knitted fabrics of C/PP fabric, C/P fabric, C/A fabric and C/N fabric, it is found that C/PP fabric (120D C/120D PP fabric) has shows better moisture management characteristics and suits in making sportswear. It is concluded that the selection of yarn plays a major role in determining the moisture management characteristics of double-face fabrics to achieve suitability for making sportswear.

7.4.2 Effect of Yarn Fineness on Moisture Management Properties of Double-Face Fabrics

significant difference is found in the above fabrics for the moisture management properties in relation to the different deniers of yarns.

7.4.3 Effect of Tuck Density on Moisture Management Properties of Double-Face Fabrics

When wetting is considered, it is found that in 6×9 fabric, the polypropylene top surface just start to get wetted at 7.9 seconds and the time taken for the cotton bottom surface to start wetted was 19.6 seconds which is found better than the other four fabrics.

Regarding maximum wetted radius, it is found that in 6×9 fabric, the maximum wetted radius on polypropylene top surface is found as 5 mm and the maximum wetted radius on cotton bottom surface is found as 25 mm. From this observation it is clear that polypropylene quickly clears the water to the bottom surface has minimum wetted radius and the cotton layer absorbs and spreads to have maximum wetted radius which is found better than the other four fabrics.

It is found that in 6×9 fabric, the spreading speed on polypropylene top surface is found as 0.89 mm/sec and the spreading speed on cotton bottom surface is found as 3.12 mm/sec. From this observation, it is clear that in 6×9 fabric, the polypropylene layer quickly transfers the water from its surface and the bottom cotton surface absorbs the water and spread it at a faster rate than other four fabrics.

When the water content versus time is considered, it is found that in 6×9 fabric the time taken to have equal water content both in polypropylene layer and cotton layer is found as only 21 seconds and afterwards it transfers the water from polypropylene layer and the cotton layer absorbs. But for 6×6 fabric, 3×3 fabric, 9×9 fabric and 12×9 fabric it is found as 90 seconds, 27
seconds, 55 seconds and 55 seconds respectively. This clearly indicates that 6×9 fabric has the tendency to quickly transfer the water from the polypropylene layer to cotton layer thus making the polypropylene layer dry than cotton layer and it is found better than the other four fabrics. The wetted area on the bottom cotton layer is also found larger than the top polypropylene layer when compared to the other four fabrics.

Comparing all the selected double-face fabrics made of 120D C/240D PP of 6×9 fabric, 6×6 fabric, 3×3 fabric, 9×9 fabric and 12×9 fabric, it is found that 120D C/240D PP of 6×9 fabric having optimum tucks per unit area has given better moisture management characteristics and suits in making sportswear. It is concluded that the number of tucks per unit area plays a major role in determining the moisture management characteristics of double-face fabrics to achieve suitability for making sportswear.