Innovative Thermoregulating Fabrics and Testing Methodology for Differentiation

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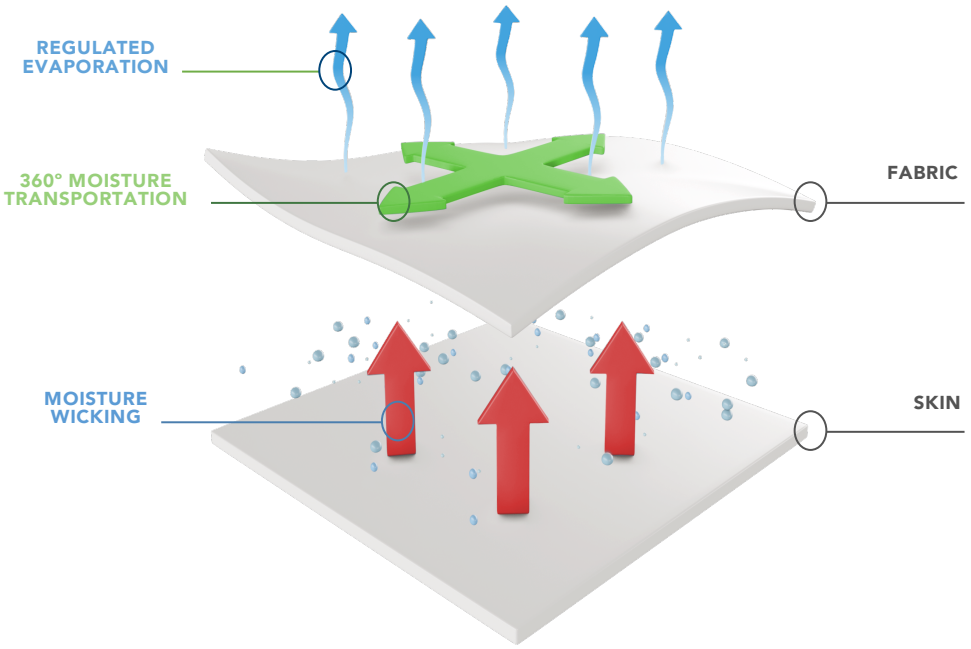
Overview

- Introduction to Coolcore and our technology
- Review of testing challenges to differentiate Coolcore technology
- Identifying appropriate test method to define “real-life” thermoregulating / cooling capabilities of materials
  - Details of how this method evaluates performance
- Comparison of new method to traditional tests
- New method comparison against competition
  - How do we stack up?
  - What can we improve?
- Conclusions
- What’s next?

Coolcore Technology

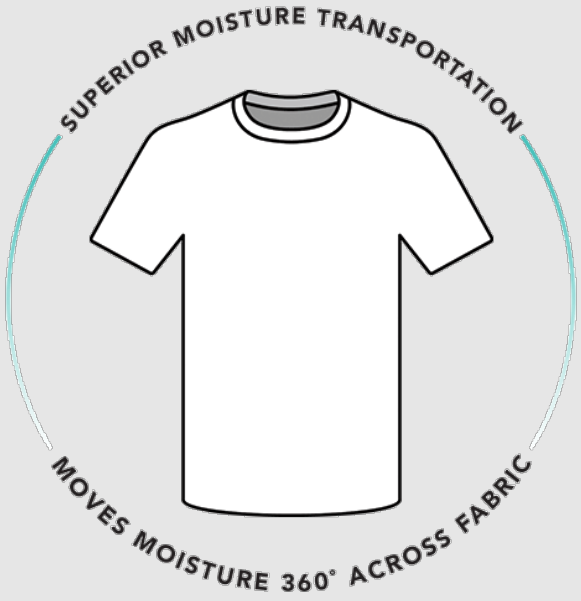
- Coolcore is a developer of innovative high-performance thermoregulating textiles
- Coolcore technology uses no chemicals to achieve cooling; rather a variety of fibers and unique material architecture to maximize moisture transport, distribution, and regulated evaporative cooling
- Mechanical Chemical-free technology
  - Never washes out
  - Superior durability
- The unique moisture transportation system allows for enhanced:
  - Moisture wicking
  - Moisture transportation
  - Regulated evaporative cooling
  - Superior drying times



Moisture Transportation

- Distribute moisture quickly throughout the garment
- Virtually eliminates sweat pooling spots
- Enhanced evaporative cooling
- Superior drying times
- Keeps you cool and comfortable

360º MOISTURE MOVEMENT



Testing Challenges?

- During R&D phase; in addition to standard lab tests, several alternative evaluations were conducted including wear testing & an independent clinical study.
- Although results from extensive wear trials yielded positive results & confirmed superior performance of the technology; the challenge of how to demonstrate these advantages through laboratory testing remained.
- As exposure grew, many brands expressed interest. It was at this point where lack of test data to promote cooling performance & unsatisfactory performance on industry standard wicking tests presented a hurdle to market acceptance.

Why Do We Test?

- Quality Assurance?
- Predict performance?
- Discovery?
- All of these are good reasons to test, and there are many established tests available from ASTM, AATCC, EN, JIS etc.
- But what do we do when we want to evaluate a performance characteristic that is not really captured well on an exiting “standard” test method?

Try Something Else!

- Two separate intensive evaluations
  - 3rd party wear testing company
  - Independent clinical study conducted by select industry technology leaders
  - Showed very positive results
    - But very expensive, time consuming, and not easily used for ongoing comparison

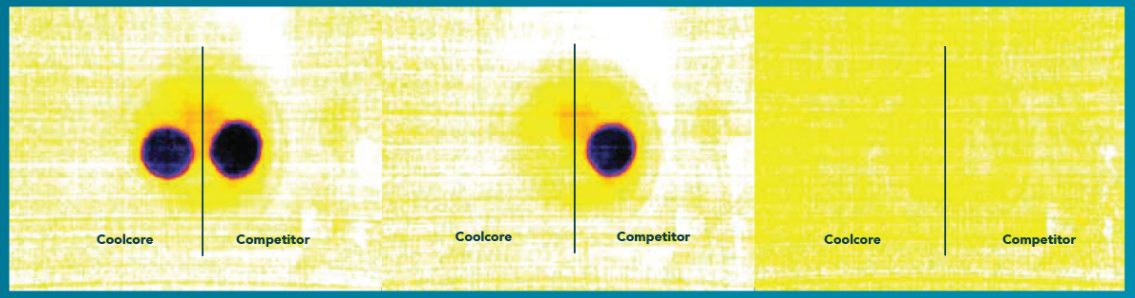
- Traditional standard lab tests
  - OK results but not remarkable to identify realistic physiological thermal regulation

Thermal Imagery

ABOVE IMAGES ARE OF THE SAME INDIVIDUAL AFTER 20 MINUTES OF ACTIVITY

Wind Tunnel Test (Dry Time)

Drying Time



START | 1 min 28 seconds | 2 min 09 seconds

Test Specs

Drops: 3
Fan Setting: 2 (3.9 m/s)
Ambient Air Temperature: 70°F / 21.11°C

Breakthrough

- Through continued efforts to identify better evaluation methods of quantifying cooling performance in textiles, Coolcore started working with a German testing facility, the Hohenstein Institute.
- The Hohenstein Institute developed the WATson testing device that measured the actual thermal effect of a textile under simulated wear conditions.
- At the time, the WATson testing device was an in-house apparatus with multiple configuration options.
- April 2019 the WATson testing device was officially established as Deutsche Institut fur Normung standard : DIN SPEC 60015

HOHENSTEIN INSTITUTE

DIN Geprüft

WATson

- The test procedure for the WATson machine is as follows:
- Fabric sample size: 25 x 25 cm (10 x 10 inches)
- Sample mounted on heated plate inside environmentally controlled chamber.
  - 30°C / 86°F and 70% RH
- Plate turned on (32°C / 89.6°F) and material allowed to reach equilibrium for 10 minutes.
- At 10-minute mark, moisture is introduced to simulate standard “sweat rate”.
- Moisture continues from T=10 to T=70
- At T=70 moisture is shut off to simulate end period of physical exertion

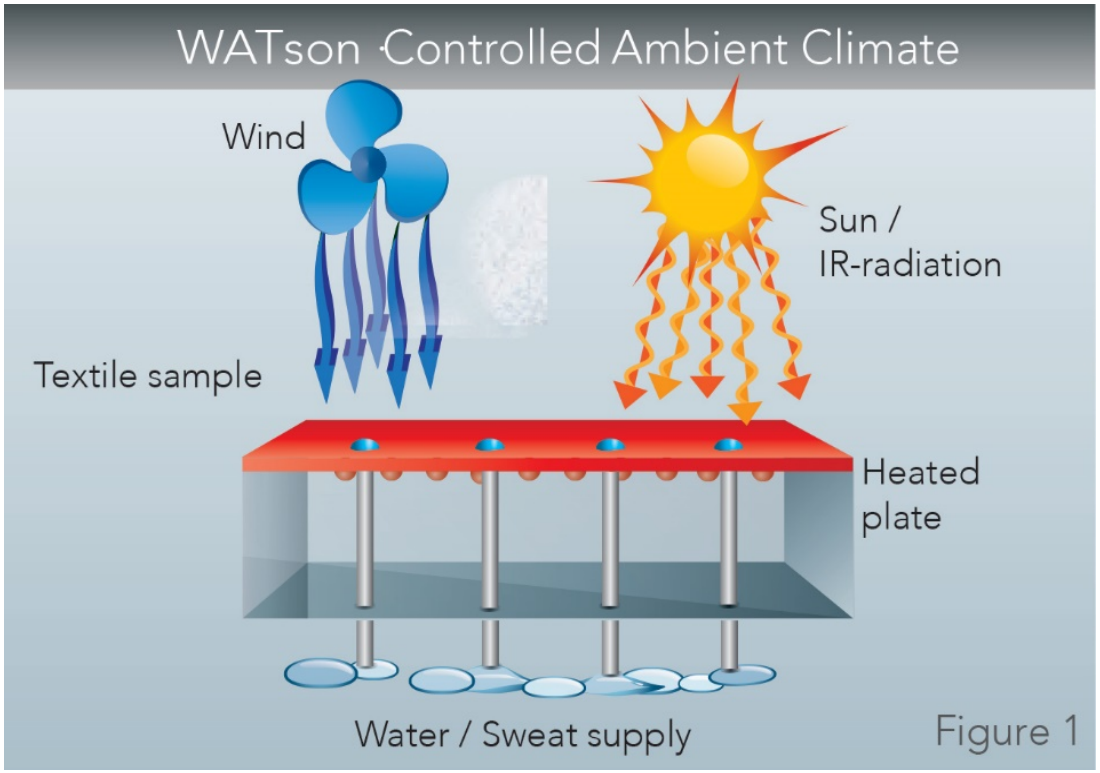


Figure 1. Configuration of WATson test apparatus. Note. From Hohenstein Institute trade literature (p.2),Https://www.hohenstein.de/media/downloads/FC_Flyer_WATson%20Cooling%20Power__EN_2015.pdf.

WATson

- The WATson device measures evaporative heat loss by recording power in WATTs required to maintain heated plate at constant temperature of 32°C / 89.6°F
- This measurement effectively inversely measures the cooling ability of the textile being tested

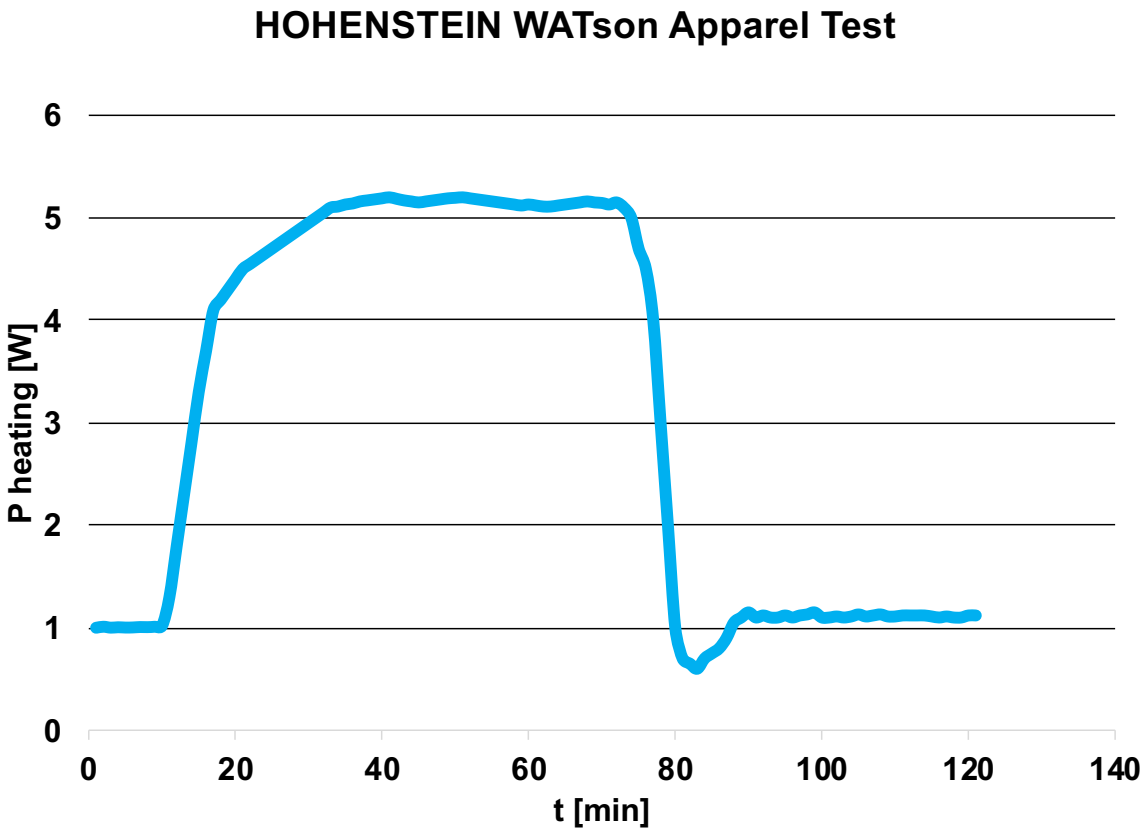


Figure 2. Graphical example of WATson test results.

WATson Key Measurements

- Three key measurements from the WATson test:

1. Wicking Power or the WATT power value at T=20. This represents how quickly the material can adsorb & distribute the moisture making it available for evaporative cooling.
2. Cooling Power which is the average power between the T=60 & T=70. This represents the evaporative cooling capacity of the fabric sample at the end of maximum moisture exposure.
3. Drying performance which is measured in time from T=70 to time the power drops to original level of 10-minute mark in beginning of test.

- Using these data points, the test shown in Figure 2 can be reviewed in bar graph format (Figure 3) for easier comparison between selected materials.

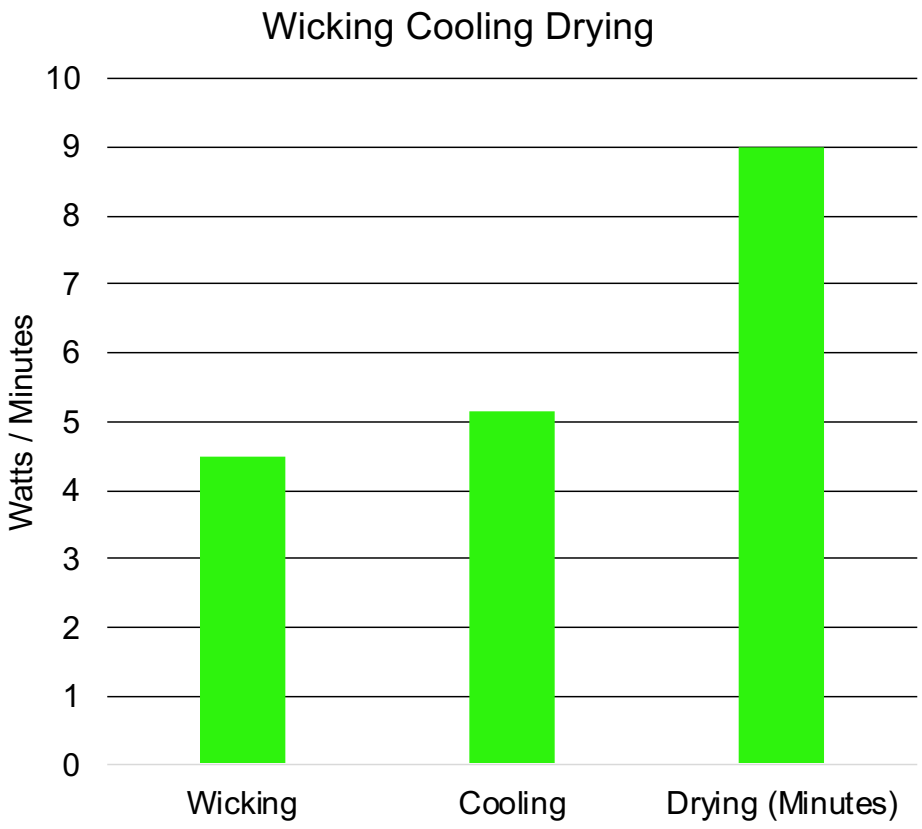


Figure 3. Bar graph of key data from WATson test.

Wicking vs WATson

- Having identified the WATson testing protocol capable of more accurately measures fabric performance attributes of moisture transport, evaporative cooling, and drying; previous testing was reexamined.
- Two test methods identified by many customers as “standard” were; Vertical Wicking of Textiles AATCC 197, and Absorbency of Textiles AATCC 79.
- However, these tests do not take all factors into consideration such as: fabric construction, weight, density, fiber content, and fabric finish.
- Realistically they are only measures of water absorption and not moisture distribution as it would relate to most aspects of wearer comfort.

Vertical Wicking

- On vertical wicking many brands had “internal” standard targets of 150mm or more.
- As shown in Figure 4 only one of Coolcore’s fabrics hit this mark.

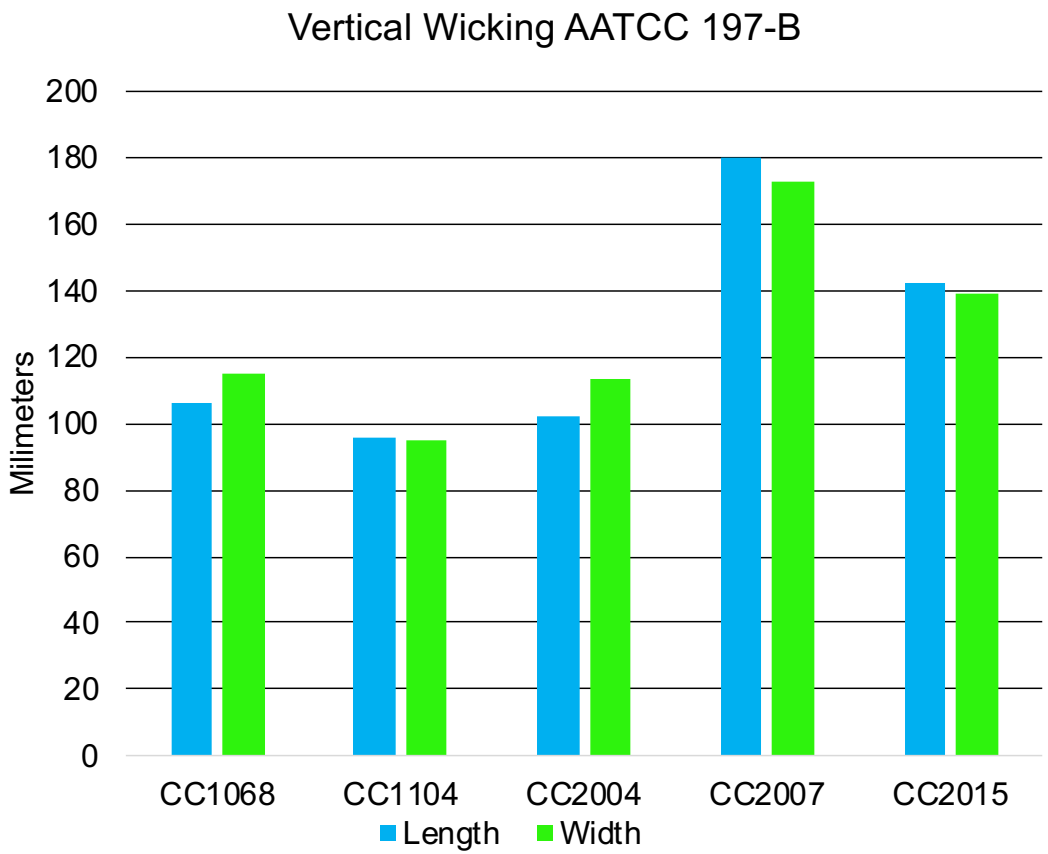


Figure 4. Graph of Vertical Wicking AATCC 197 of select Coolcore styles.

Absorbency of Textiles

- On Absorbency of Textiles, many brands expected results of less than 3 seconds for water drop absorption.
- Figure 5 shows that only two of five Coolcore materials exhibited a “pass” on this test.
- Test results from Vertical Wicking & Absorbency of Textiles would indicate that only CC2007 would be acceptable.

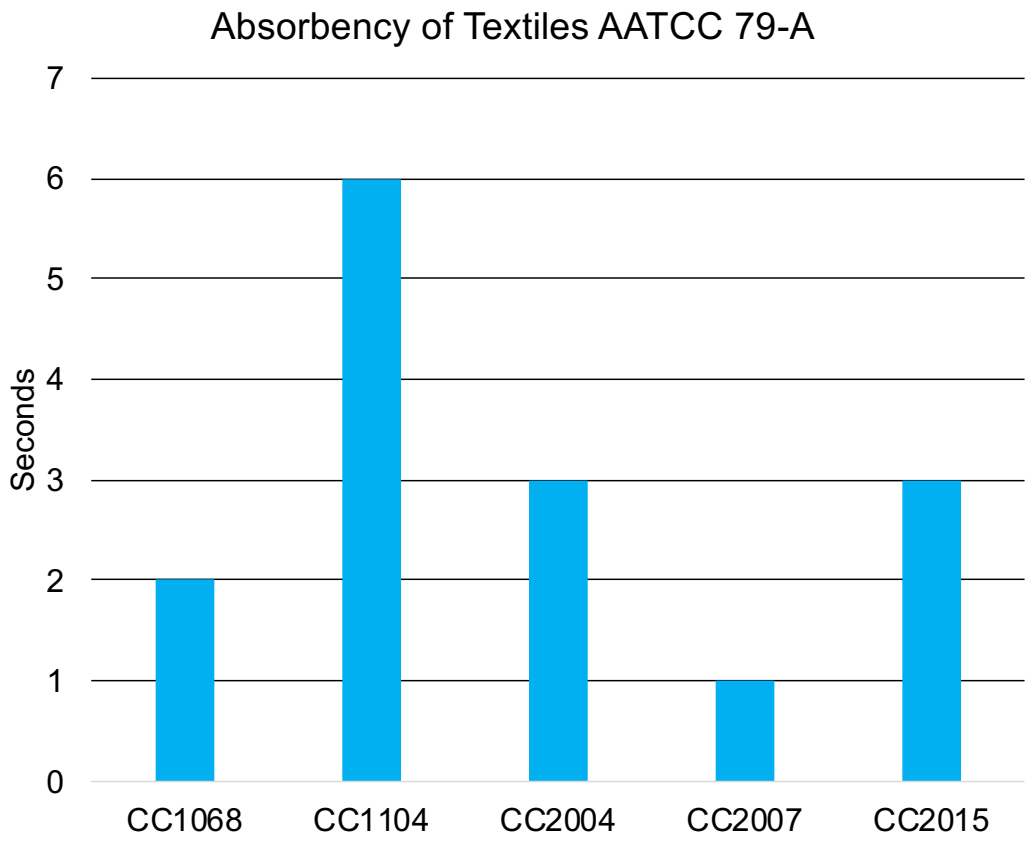


Figure 5. Graph of Absorbency of Textiles AATCC 79 of select Coolcore styles.

Coolcore WATson

- Coolcore fabrics tested on WATson told a more detailed story of material performance apparel. Specifically, in regard to cooling.
- Referencing Figures 4 & 5:
- CC1104 demonstrated low score on two industry standard wicking tests.
  - However, when evaluated under the WATson test, CC1104 confirmed the best performance in all areas of wicking, cooling, and drying.
  - CC1104 is the lightest of the five materials tested and is a fine gauge woven.
- CC2007 appeared to pass the typical wicking tests and performed well for wicking cooling and drying under the Hohenstein WATson testing. This exemplifies why the standard industry accepted tests of wicking are not necessarily an accurate measure of a material's thermoregulation capability.
- CC1068 scored second best on absorbency of textiles and third best on vertical wicking of the five Coolcore materials evaluated. This was another Coolcore woven material, but also contained 15% Cotton. Therefore, slightly lower numbers on WATson Wicking Cooling & Drying is logical as the cotton portion of the construction would retain liquid water and bind it from evaporation.

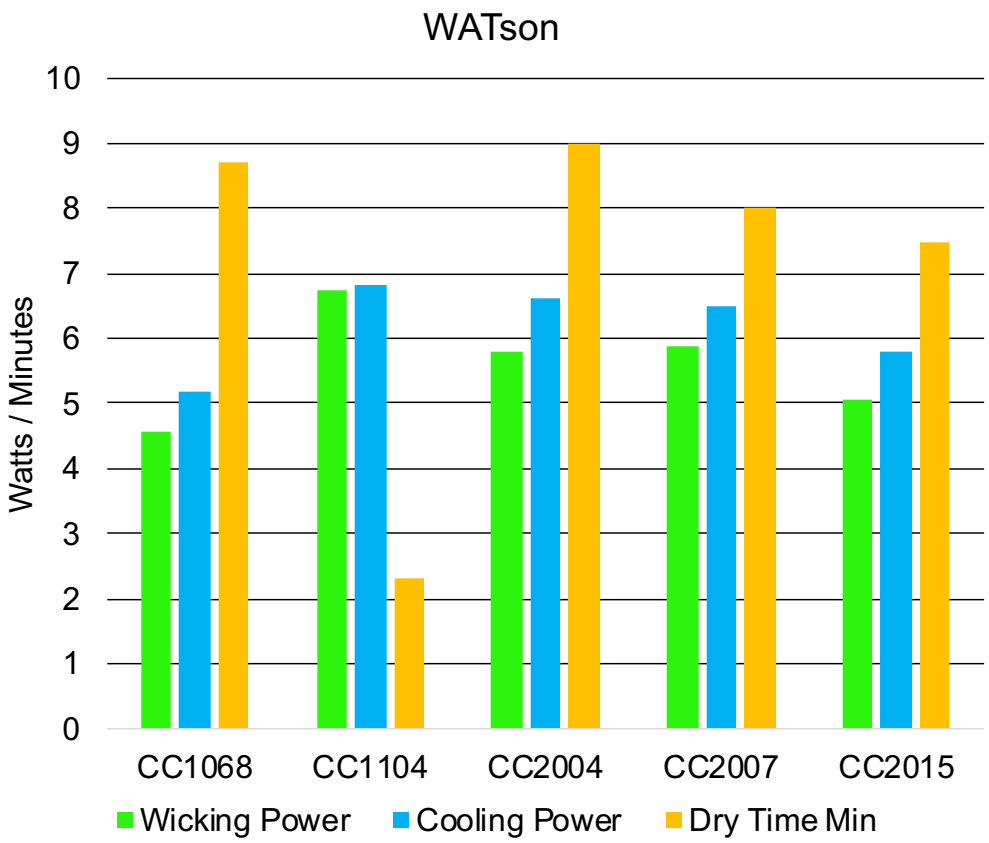


Figure 6. Graph of WATson Wicking & Cooling power and Dry time of select Coolcore styles.

Wicking Power

- Figure 7 shows the Wicking Power values for the two Coolcore Styles and seven competitive technologies tested.
- The Wicking Power number is the WATT value at T=20 minutes. After 10 minutes of moisture introduction this power value is a key indicator of how quickly the material is able to distribute the moisture and make it available for evaporation.
- It can be seen from the graph that two materials exhibit superior performance values during this period of measurement under the WATson test.

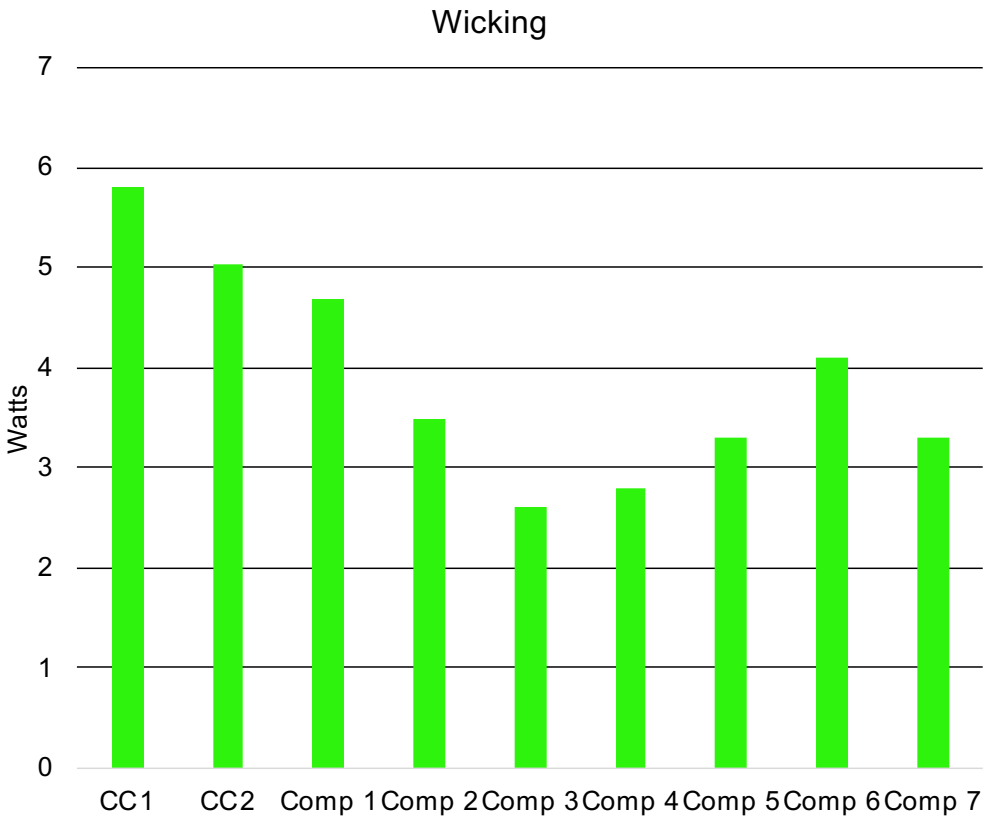


Figure 7. WATson Wicking Power of select Coolcore fabrics against market competition

Cooling Power

- Figure 8 displays the Cooling Power values of the nine materials tested.
- These power numbers represent the average values during simulated period of physical exertion.
- Higher average scores during this evaluation period of the test represent a material's ability to provide increased cooling function to the wearer. Ultimately, increased cooling would lead to increased comfort and efficiency of wearers physical performance.
- It can clearly be observed that again two fabrics demonstrated superior cooling power function during this portion of the test.

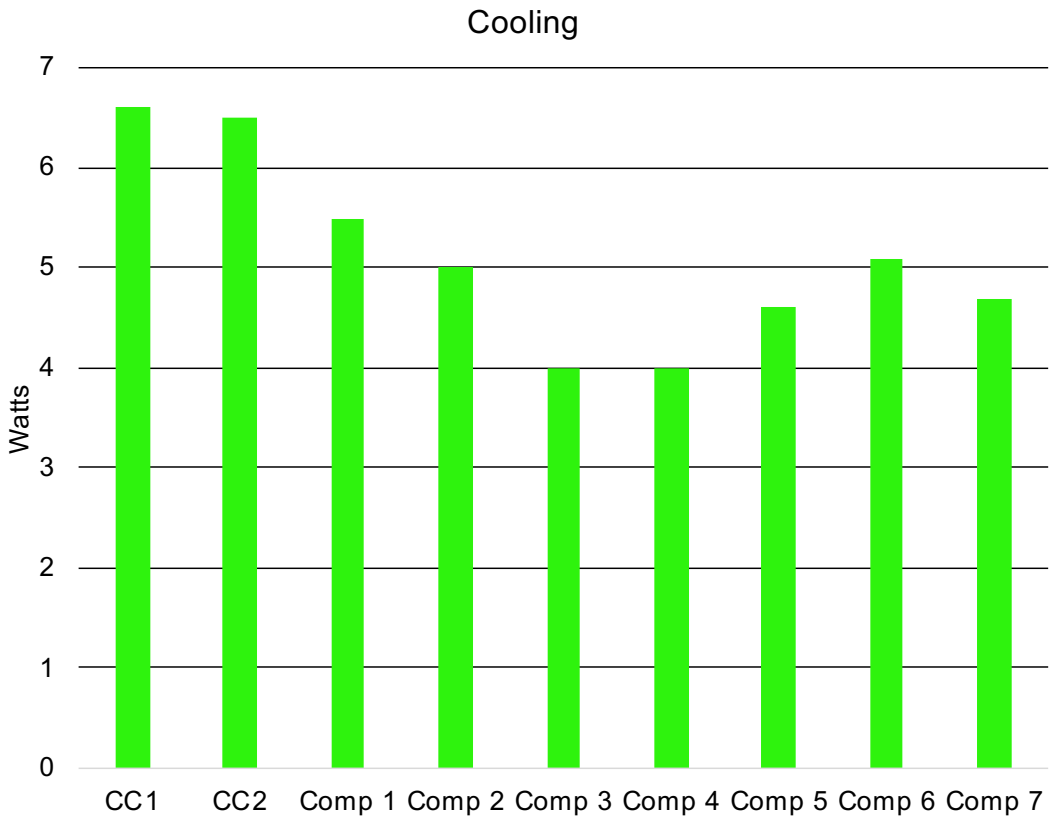


Figure 8. WATson Cooling Power of select Coolcore fabrics against market competition.

Dry Time

- Figure 9 reports the Dry Time of the selected materials evaluated.
- These values are reported in minutes from T=70 until such time that that the Power returns to value as observed T=10 minutes (equilibrium point).
- This dry time value is of significant importance as it relates to the time a garment would return to dry state and quench cooling as the wearer ceased physical activity.
- Also, worthy of note that this value can show a materials propensity for, or lack there of, saturation.
- The shorter the time, the more effectively the material has distributed the same volume/amount of moisture over the entirety of the test.
- Referencing Figure 9, two materials positively illustrate exceptional dry times over the other materials tested.

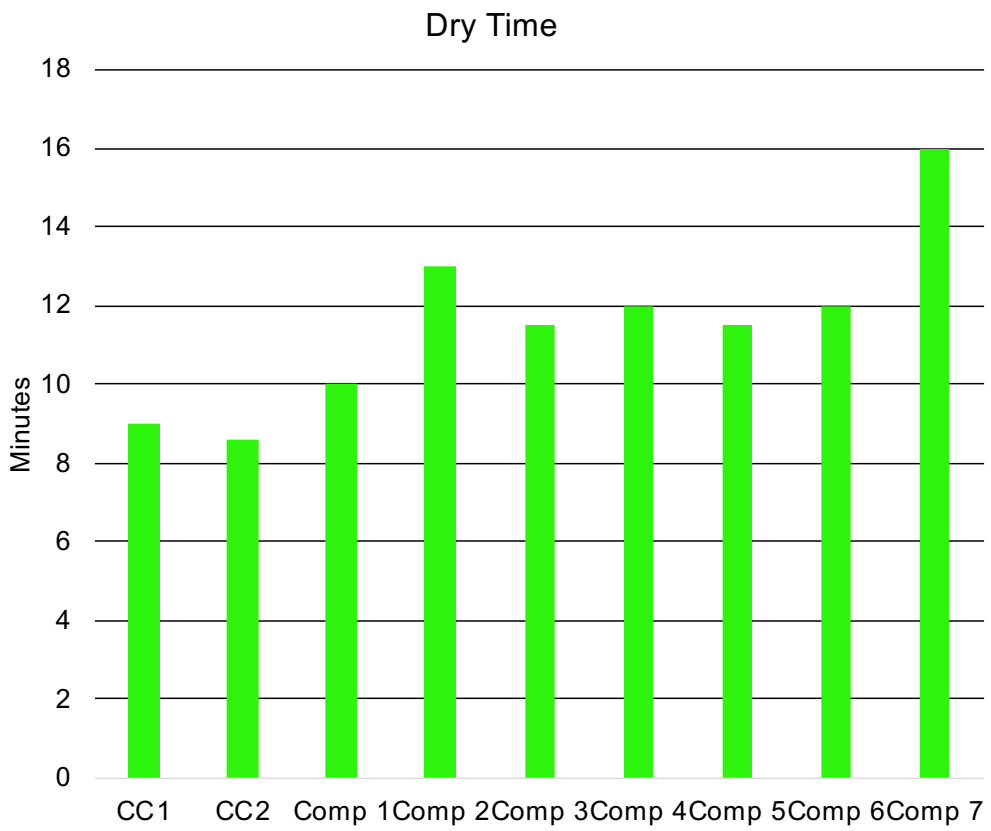


Figure 9. WATson Drying Time of select Coolcore fabrics against market competition.

Conclusions

- With positive results from wear test studies, customer support, and testing that aligned; Coolcore felt confident using the Hohenstein WATson test as it's standard for validating functional cooling in apparel.
- The comparison of two industry standard wicking tests to WATson does not invalidate those tests; rather highlights challenges of exemplifying new technology performance that is not easily defined by tests that were never intended to measure a specific performance function.
- The science principle of theory and testing to prove that theory remains constant for purpose of discovery.
- As technology evolves & we continue to push product innovation… so must we continue to push the methodology with how the performance of such technology can be accurately demonstrated.

What’s Next?

Fabric Innovation

Year-round Thermoregulation Fabrics

Repreve ®
Recycled Plastic

FOR U.S. CUSTOMERS

- Not Harmful - chemical-free thermoregulation technology
- Collaboration creates fabrics combining recycled plastics and chemical-free performance fibers
- An eco-responsible business model
- Both companies have created the optimal solution to sustainable, performance fabrics

Coolcore In Space!

OBJECTIVE:

To evaluate performance apparel & fabrics and determine enhanced evaporative heat loss for astronauts on board the ISS.

- Distribute moisture quickly through the garment
- T-Shirt / Material 3 (Coolcore) with highest evaporative heat loss came out best performing
- Findings will help to improve development of thermoregulating textiles for the wellbeing of humans living and working in space.

SPACEX spacenet HOHENSTEIN

Thank You!