Fabric Testing Report

CLIENT: RBH DESIGNS

ADDRESS: 41 Crossroads Plaza
West Hartford, CT 06117

DATE: April 5, 2015

SUBJECT: Thermal Characteristics of a VaprThrm barrier in an Insulated Test Garment

April 5, 2015

Ryan Hannigan
RBH Designs, LLC
Suite 109
41 Crossroads Plaza
West Hartford, CT 06117

Dear Mr. Hannigan:

This report presents the results of our performance evaluation of the presence of a VaprThrm vapor barrier in an insulated structure.

The objective of the performance evaluation was to observe the impact of a VaprThrm membrane on the insulating value of a sample garment.

The test demonstrated that the presence of the polyurethane barrier membrane reduced heat transfer through the test sample by approximately 46%. This is a substantial reduction in heat loss for a garment addition that adds minimal weight.

The test results are described below.

Please call me if you have any questions concerning this report. We look forward to working with you in the future.

Very truly yours,

Stephen A. Seeber

RBH Designs manufactures clothing that places a vapor barrier between the wearer and the garment insulation. The vapor barrier will prevent moisture from both sensible and insensible perspiration from accumulating in garment insulation. Garment insulation will suffer diminished insulating capability as moisture accumulates within. Thus, the presence of the vapor barrier should result in reduced heat transfer from an insulated garment that would otherwise be subject to moisture accumulation in the insulation.

The objective of this test is to illustrate whether and to what extent the inclusion of a vapor barrier will reduce heat loss in cold ambient air conditions. This can be measured in three ways:

1) When viewed with an infrared imager, as heat transfer through a garment increases, the surface temperature will rise (when body temperature is greater than ambient temperature). The heat transfer performance of two garments placed in similar environments can be judged simply by comparing surface temperatures. The better performing insulation will produce reduced surface temperatures when the ambient temperature is below body temperature.

2) Using average surface temperature data acquired with the thermal imager, both radiant and convective losses from a garment can be calculated. These data may be used to quantitatively assess heat transfer through the garments.

3) The test appliances used for this test produce heat and water vapor from a internal electric heating element. The power consumption of the test appliances can be compared to assess differences in heat transfer through alternative garments.

Test setup.

The test setup consists of two 9 gallon kettles. Each kettle has two welded fittings. The bottom fitting contains a 400 watt heating element. The top fitting contains a thermowell with a temperature sensing device. Each kettle is filled with water. A temperature controller senses the water temperature in the kettle and controls the heating element to achieve the desired water temperature. The dead band of each controller is set for 1^{o}F. The sides and bottom of the kettles are insulated with 3/8” closed cell foam. The water temperature in each kettle is set to approximate the vapor pressure differential occurring between human skin at 90oF and an outside ambient temperature of freezing.

The power consumption of each kettle is monitored by an in line power monitoring device that measures current, volts, kwh and other electrical parameters.

Surface temperatures of the test garments are monitored by a FLIR SC660 thermal imager. Thermal images are recorded and stored to computer hard drive at 10 second intervals for the duration of the test. The thermal data is acquired and analyzed using Flir ResearchIR software.

The test samples are installed horizontally at the top of open kettle. The thermal imager is positioned to look directly down at the kettles.

The test was conducted during a 13 hour over night period. The kettles were placed outside. The ambient temperature was approximately 25^{o}F during the test. Winds were calm.

At the start of the test, each sample was weighed. Each sample was weighed again at the end of the sample. This measure indicated how much water was retained in the samples.

Test samples

Two samples were tested simultaneously. Each sample measured approximately 26 x 29 inches. The samples were constructed as follow:

Non barrier:

- Brushed tricot polyester face
- Climashield Apex fiberfill (6.0 ounce)
- Brushed tricot polyester lining

Vapor Barrier:

- Brushed tricot polyester face
- Climashield Apex fiberfill (6.0 ounce)
- Barrier film (1 mil PU)
- Brushed tricot lining

During the test the vapor barrier sample was placed so that the barrier faced the down toward the hot water in the kettle.

The test appliances, with test samples installed along with the thermal imager are shown below:

Test Results

The kettle water temperature was set for 124°F. This resulted in a lid temperature of approximately 94°F. This should produce a temperature on the bottom of the samples of about 90°F.

The test was continued for 13 hours.

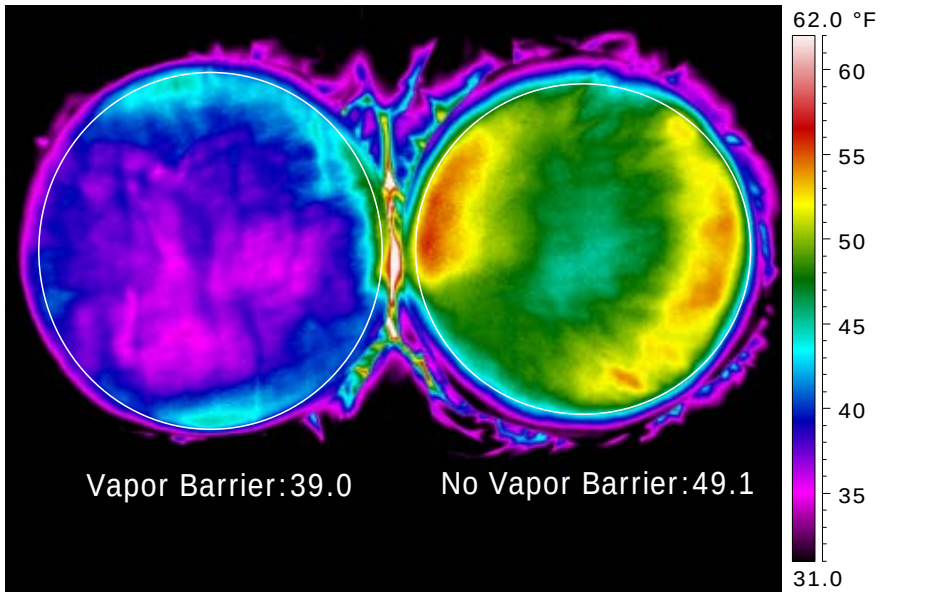
At the completion of the test, measured and calculated results are as follow:

	Vapor Barrier	**No Barrier**	**Difference**
Average surface temp	39°F	49.1°F	10.1°F
% Water weight in test (test area only)	18	204	186%
Watt loss Calculated	4.83	8.88	46% or 4.05 watts
Watt loss Measured*	0	6.9 watts/hr	6.9 watts

*This shows the difference in total kw/hour for the entire kettle loss. The calculated value is from the radiometric data for only the test area of the sample. Note that the different methodologies vary by about 2.85 watts/hr. This is a large percentage difference but not unreasonable given the low energy levels measured here. Either measure shows a substantial change in heat transfer between the test samples.

During the course of the test, the vapor transfer through the No Barrier sample not only wetted the insulation, thereby increasing heat transfer, but the vapor condensed on the face fabric. This would provide another mechanism for wetting the insulation and further degrading the insulation performance. The accumulated condensation is shown in the photograph, below.

The following page shows infrared images at the beginning and end of the test.



Final: Sample Temperatures