COMMERCIAL TESTING COMPANY
Post Office Box 985 • 1215 South Hamilton Street • Dalton, Georgia 30722
Telephone (706) 278-3935 • Facsimile (706) 278-3936

Steady–State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM C 518

Report Number 9908112

Test Number 3056–7241
May 21, 1999

PolyMaster, Inc.
Knoxville, Tennessee

Commercial Testing Company

Jonathan Jackson
(Authorized Signature)

This report is provided for the exclusive use of the client to whom it is addressed. It may be used in its entirety to gain product acceptance from duly constituted authorities. The test results presented in this report apply only to the samples tested and are not necessarily indicative of apparent identical or similar materials. Sample selection and identification were provided by the client, and a sampling plan, if described in the referenced test procedure, was not necessarily followed. This report, or the name of Commercial Testing Company, shall not be used under any circumstance in advertising to the general public.

INTRODUCTION

This report is a presentation of results of a test for the measurement of steady–state thermal transmission properties of a material submitted by PolyMaster, Inc., Knoxville, Tennessee. The material was tested in accordance with the American Society for Testing and Materials (ASTM) Test Method C 518, *Steady–State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.* The heat flow meter provides a comparative, or secondary, method of measurement since only the ratio of the thermal resistance of the specimen being tested to that of a standard specimen is measured absolutely. This method is capable of determining the thermal transmission properties within ± 2% of those determined by ASTM Test Method C 177.

The heat flow meter apparatus establishes steady state unidirectional heat flux through a test specimen situated between two parallel plates maintained at constant but different temperatures. By appropriate calibration of the heat flux transducer, and by measurement of the plate temperatures and plate separation, Fourier's law of heat conduction is used to calculate thermal conductivity, thermal resistance, or resistivity.

The thermal transmission properties of a specimen of a given material may: (1) vary due to variability of the composition of the material; (2) be affected by moisture or other conditions; (3) change with time; (5) change with mean temperature and temperature difference; and, (5) depend upon the prior thermal history. Therefore, it must be recognized that the selection of typical values of thermal transmission properties representative of a material in a particular application should be based on a consideration of these factors and will not necessarily apply, without modification, to all service conditions.

TEST APPARATUS

The test apparatus consists of a hot plate, a cold plate, a heat flow meter, and the necessary electronic measurement devices. The test specimen is held between the two temperature controlled plates, of which one can be raised or lowered to the desired specimen thickness. For these tests, measurements were made using a Fox 304 heat flow meter manufactured by LaserComp, Inc. The test results in a value for the apparent thermal conductivity of the test specimen, k, in units W/m·K. The thermal resistivity, R–Value per inch, in U.S. customary units, is the reciprocal of the product of 6.933 and k.

MATERIAL TESTED AND TEST RESULTS

The client submitted two (2) samples of foam insulation material. One was a **White Very Fragile Foam**. The other was a **Blue–White Fairly Rigid Foam**. Test specimens were prepared from each sample using a band saw equipped with a vacuum platform to hold the sample during the cuts. The finished specimens were nominally 11.5 by 11.5 by 1.3 to 1.6 inches. Table I summarizes the test results. The individual specimen data are presented on the following page.

Table I.

Material	Density (lb/ft^3)	Temperature (°F)	Thermal Conductivity ($Btu{\cdot}in/h{\cdot}ft^2{\cdot}°F$)	Thermal Resistivity ($h{\cdot}ft^2{\cdot}°F/Btu{\cdot}in$)
White Foam	0.70	75.19	0.2419	4.134
White Foam	0.70	50.03	0.2258	4.429
White Foam	0.70	24.90	0.2161	4.627
Blue–White Foam	1.04	75.21	0.2443	4.093
Blue–White Foam	1.04	50.03	0.2283	4.380
Blue–White Foam	1.04	24.90	0.2181	4.585

The data can be represented by two distinct curves as shown in Figure 1. The two curves are approximately 1% apart. Figure 2 shows that the equation, k = 0.20321 + 0.51716E–3 * t, describes all six data with an average absolute deviation of 0.6%. Since the uncertainty of the heat flow meter apparatus is ± 2%, the single curve is the better representation of the data.

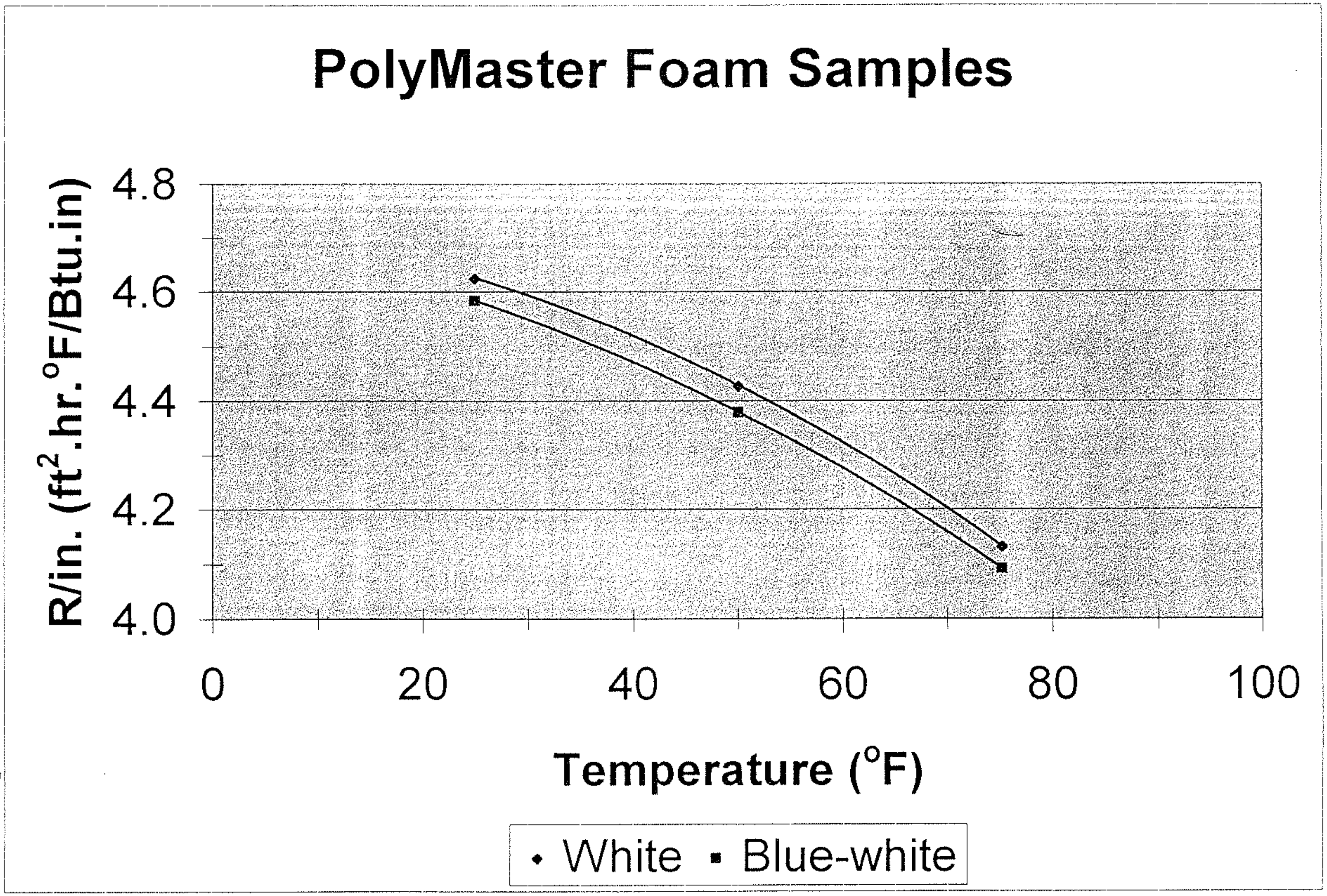
TEST DATA

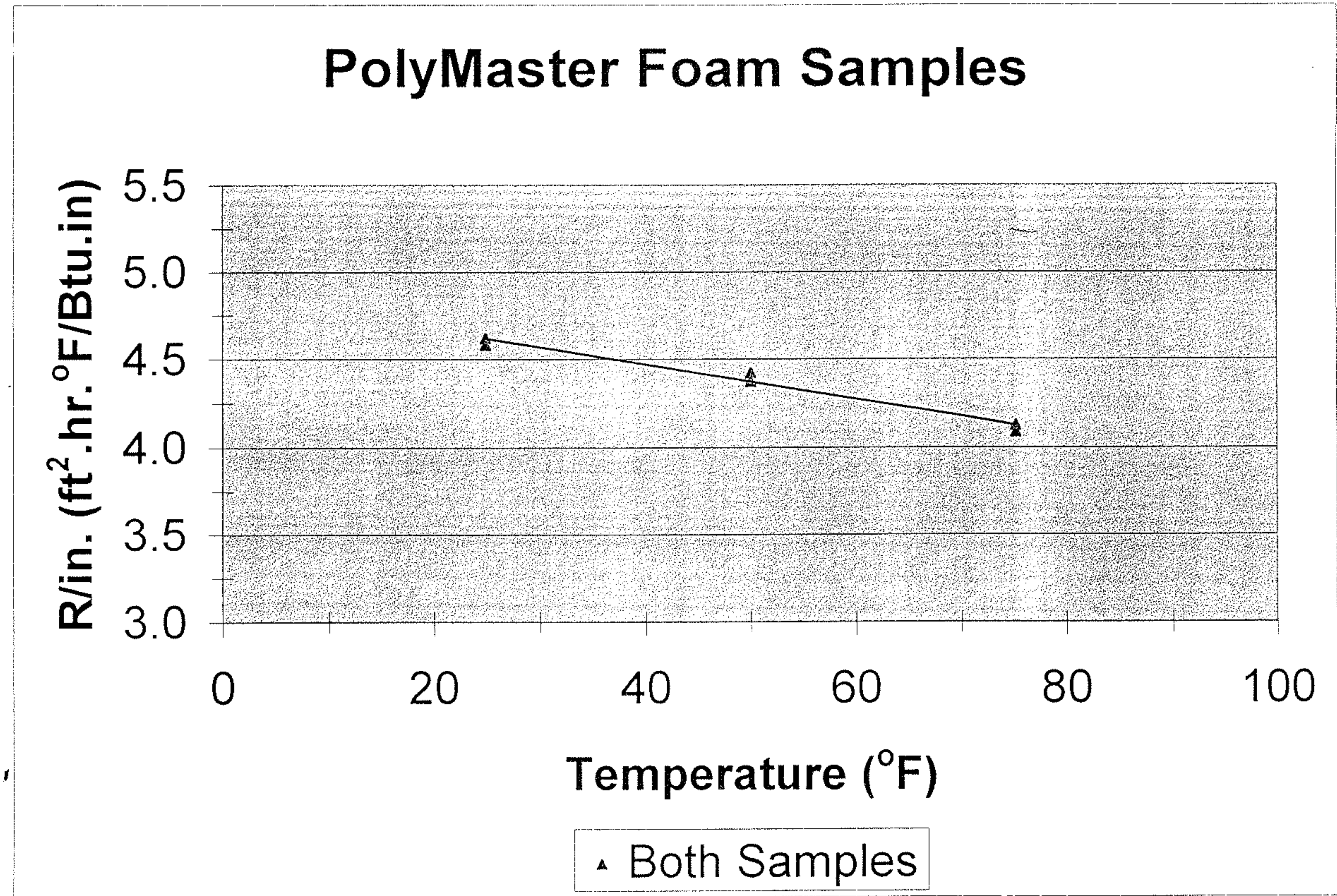
White Foam, Very Fragile

Heat Flow Meter	12 x 12	12 x 12	12 x 12	inches
Specimen Thickness	1.591	1.591	1.591	inches
Specimen Density	0.70	0.70	0.70	lb/ft^3
Cold Plate Temperature	5.00	30.22	55.38	°F
Hot Plate Temperature	44.80	69.84	95.00	°F
Average Temperature	24.90	50.03	75.19	°F
Apparent Thermal Conductivity	0.2161	0.2258	0.2419	$Btu \cdot in/h \cdot ft^2 \cdot °F$
Thermal Resistivity, R per inch	4.627	4.429	4.134	$h \cdot ft^2 \cdot °F/Btu \cdot in$
Thermal Resistance of Specimen	7.36	7.05	6.58	$h \cdot ft^2 \cdot °F/Btu$
Test Time	2	2	2.5	hours

Blue–White Foam, Fairly Rigid

Heat Flow Meter	12 x 12	12 x 12	12 x 12	inches
Specimen Thickness	1.280	1.280	1.280	inches
Specimen Density	1.04	1.04	1.04	lb/ft^3
Cold Plate Temperature	5.00	30.22	55.40	°F
Hot Plate Temperature	44.80	69.84	95.02	°F
Average Temperature	24.90	50.03	75.21	°F
Apparent Thermal Conductivity	0.2181	0.2283	0.2443	$Btu \cdot in/h \cdot ft^2 \cdot °F$
Thermal Resistivity, R per inch	4.585	4.380	4.093	$h \cdot ft^2 \cdot °F/Btu \cdot in$
Thermal Resistance of Specimen	5.87	5.61	5.24	$h \cdot ft^2 \cdot °F/Btu$
Test Time	2	2	2.5	hours


PolyMaster Foam Samples
R/in. (ft2.hr.°F/Btu.in)
4.8
4.6
4.4
4.2
4.0
0
20
40
60
80
100
Temperature (°F)
White
Blue-white


PolyMaster Foam Samples
R/in. (ft2.hr.°F/Btu.in)
5.5
5.0
4.5
4.0
3.5
3.0
0
20
40
60
80
100
Temperature (°F)
Both Samples