



Test Report

Classification According to ASTM C612 on HTB Mineral Fiber Board Insulation Supplied by Knauf (Croatia)

Prepared For:

Delfina-Bi Baranda Robles
Knauf Insulation
Trata 32
4220 Škofja Loka
Slovenija

R & D Services, Inc.
P.O. Box 2400
Cookeville, Tennessee 38502-2400

Report: RD14207

A handwritten signature in black ink, appearing to read 'Stuart Ruis', written over a horizontal line.

Stuart Ruis
President

April 21, 2014

The test results in this report apply only to the specimens tested. The tests conform to the respective test methods except for the report requirements. The report includes summary data but a full complement of data is available upon request. This report shall not be reproduced, except in full, without written approval of R & D Services, Inc. This report must not be used by the client to claim product endorsement by R & D Services, Inc., IAS or any other organization.



P.O. Box 2400
Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

April 21, 2014
Delfina-Bi Baranda Robles
Knauf Insulation
Trata 32
4220 Škofja Loka
Slovenija

R & D Services, Inc. has completed tests on "HTB 700" Mineral Fiber Board provided by Knauf Insulation in Novi Marof, Croatia. R & D Services, Inc. received two packages of five boards each (10 boards total) on January 16, 2014. Tests have been completed to verify that the product complies with ASTM C612 requirements for Type IV insulation. The test results are summarized in Table 1 and Table 2.

Table 1

MATERIAL PROPERTY	TEST STANDARD	RESULT	ASTM C612 REQUIREMENT PASS/FAIL
Thermal Conductivity	ASTM C177	See Table 2	See Table 2
Compressive Resistance (kPa)	ASTM C165	20.6	PASS
Linear Shrinkage (% change)	ASTM C356	0.58	PASS
Water Vapor Sorption (Mass %)	ASTM C1104	0.08	PASS
Surface Burning Characteristics	ASTM E84	FSI – 0 SDI – 0	PASS
Odor Emission	ASTM C1304	PASS	PASS
Corrosiveness	ASTM C665; Section 13.8	Steel – PASS	PASS
Corrosiveness	ASTM C795	PASS	PASS
Rigidity	ASTM C1101	RIGID	PASS
Non Fibrous Shot Content (% content)	ASTM C1335	11.0	PASS
Maximum Use Temperature (649 °C)	ASTM C447/C411	No Reaction	PASS
Exothermic Temperature Rise (°C)	ASTM C447/C411	8.3	PASS
Fungi Resistance	ASTM C1338	No Growth	PASS

Table 2

MEAN TEMPERATURE (°C)	THERMAL CONDUCTIVITY (W/m·°K)	ASTM C612 REQUIREMENT (W/m·°K)	PASS/FAIL
24	0.0353	0.036	PASS
38	0.0370	0.039	PASS
92	0.0440	0.049	PASS
150	0.0506	0.063	PASS
205	0.0538	0.079	PASS
260	0.0644	0.101	PASS
316	0.0725	0.123	PASS
371	0.0888	0.144	PASS

Test results on the Knauf Insulation “HTB 700” Mineral Fiber Board show that the product meets the requirements of ASTM C612 for Type IVA (Category 2) classification between 24 and 371 degrees Celsius.



Stuart Ruis

**Apparent Thermal Conductivity of “HTB 700” Mineral Fiber Board
Insulation Manufactured by Knauf Insulation – Croatia
Thermal Conductivity was Determined According to ASTM C177**

Two packages, five pieces each, of nominal 1000 by 1000 by 50 mm “HTB 700” mineral fiber board insulation were received by R&D Services, Inc. on January 16, 2014. The material was manufactured by Knauf Insulation in Novi Marof, Croatia.

Two pieces of were selected from the lot of ten received by R&D Services, Inc. to be measured for thermal conductivity. Two, nominal 305 by 305 by 50 mm, specimens were prepared from the pieces.

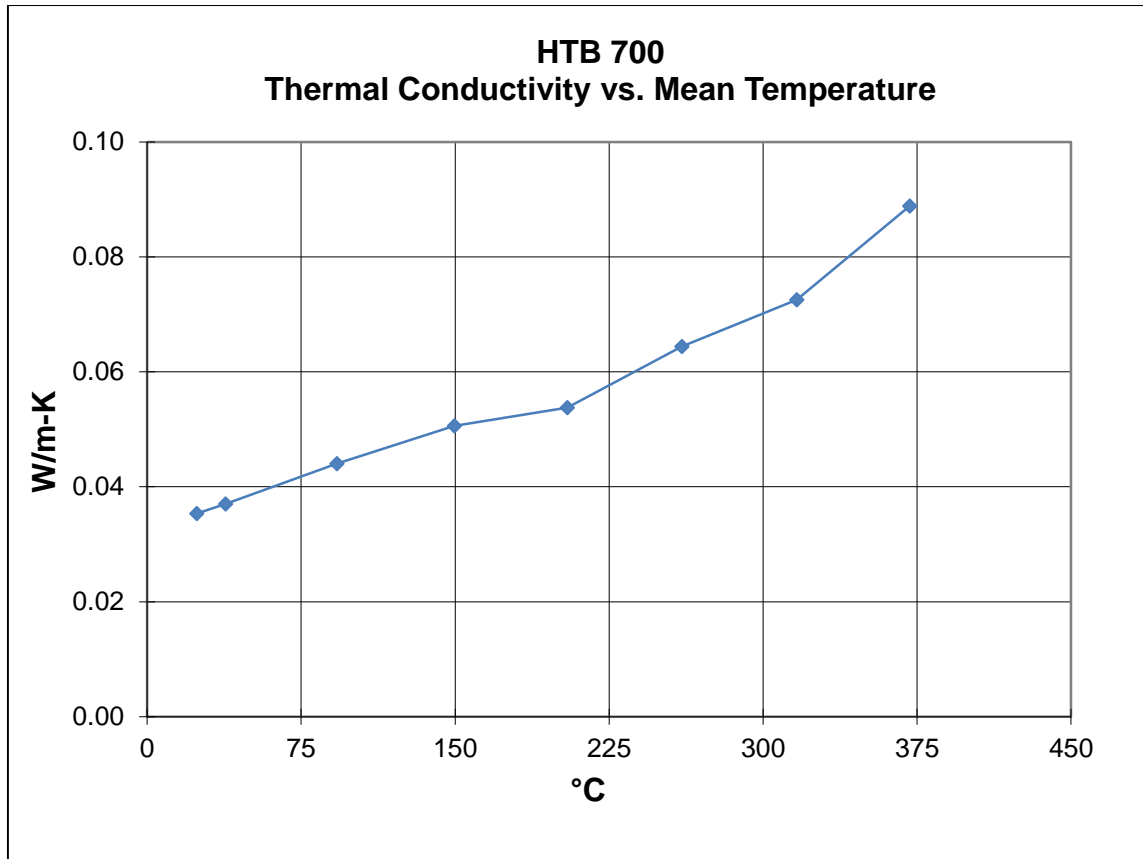
Apparent thermal conductivity measurements were performed according to ASTM C177-10, utilizing a Holometrix Model TCFGM guarded hot-plate instrument. The specimen was measured at eight mean temperatures from 24 - 371 °C. A summary of the results is shown in Table 1. A graphical summary of results is shown in Figure 1.

Table 1: Summary of Results

Product	Test Thickness (mm)	Test Density (kg/m ³)	Mean Test Temperature (°C)	Apparent Thermal Conductivity (W/m·k)	Thermal Resistance (m ² ·k/W)
HTB 700	53.9	136	24	0.0353	1.52
			38	0.0370	1.46
			92	0.0440	1.22
			150	0.0506	1.06
			205	0.0538	1.00
			260	0.0644	0.836
			316	0.0725	0.743
			371	0.0888	0.606

The tests contained in this report were subcontracted to NETZSCH Instruments North America, LLC. Results are shown in NETZSCH Report Number 621003126-1.

Figure 1: Graphical Summary of Results





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Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Compressive Strength Test Report

Test Number: RD141420CS

Date of Test: January 30, 2014

Specimen Number: 1211140116-17,18

Date of Manufacture: Unknown

Report Prepared For: Knauf Insulation (Slovenija) / Delfina-Bi Baranda Robles

Description of Material Tested: "HTB 700" Mineral Fiber Board Insulation.

Test Method: ASTM C612-10 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation" Section 12.4; ASTM C165-07 (2012) "Standard Test Method for Measuring Compressive Properties of Thermal Insulations", Procedure A.

Description of Test:

ASTM C165 results in data for the decrease in thickness of a test specimen expressed as a fraction of initial thickness. Test specimens are subjected to a downward compressive force to produce a relationship between applied force and specimen thickness. These data are used to determine the stress (force per unit area) required to reduce the specimen thickness by 10% of its initial value. Material is conditioned in the laboratory at 70 ± 4 F and $50 \pm 5\%$ RH prior to testing. An Instron Model 4400R Universal Testing Machine is used for this test to compress up to 13% of the initial thickness. A preload of less than 1 % was applied to the specimens prior to testing.

Results:

Number of specimens tested: 4
Average initial thickness of specimens: 2.03 inches
Average area of specimen perpendicular to applied force: 25.37 sq. in.
Cross-head speed: 0.1 in./min.

Specimen	Applied Force @ 10% Compression (lbf)	Stress @ 10% Compression (lbf/in ²)	Applied Force @ 10% Compression (N)	Stress @ 10% Compression (kPa)
A	77.57	3.07	345.05	21.17
B	80.38	3.14	357.55	21.65
C	72.40	2.86	322.05	19.72
D	73.54	2.90	327.12	19.99
Average	76.0	3.0	337.94	20.63
Standard Deviation	3.7	0.1	16.4	0.9

The average value observed for the stress at 10% compression was 20.63 kPa (3.0 lbf/in²). This satisfies the physical requirements of Table 1 in ASTM C612.

Reviewed By:

4/21/2014

Date:



P.O. Box 2400
Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Linear Shrinkage of Thermal Insulation Report

Test Number: RD14141419LS

Date of Test: February 26-27, 2014

Specimen Number: 1211140116-17,18

Date of Manufacture: Unknown

Report Prepared For: Knauf Insulation (Slovenija)/ Delfina-Bi Baranda Robles

Background

The linear shrinkage of mineral fiber insulation due to exposure to short-term high temperature has been determined in accordance with ASTM C612-10 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation"; Section 12.5 and ASTM C356, "Standard Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat". The specimens are conditioned and exposed to high temperature conditions for 24 hours. The average linear shrinkage of four specimens is measured and used to calculate the linear shrinkage percent of the samples expressed as a percentage of the length measured before exposure.

Description of Test Specimens

The material used in this test was "HTB 700" Mineral Fiber Board Insulation supplied by Knauf Insulation (Croatia). Four samples approximately 306 by 152 by 54 mm were used. The test was conducted at 649 °C.

Test Results

	Specimen 1	Specimen 2	Specimen 3	Specimen 4
Initial Length (mm)	305.7	306.0	305.0	306.0
Initial Width (mm)	153.7	149.0	150.3	153.3
Initial Thickness (mm)	55.00	53.67	54.67	53.33
Final Length (mm)	304.3	304.0	303.0	304.3
Final Width (mm)	152.3	148.7	150.3	152.3
Final Thickness (mm)	57.67	58.00	57.33	57.00
Change in Length (mm)	1.4	2.0	2.0	1.7
Linear Shrinkage (%)	-0.458	-0.654	-0.656	-0.556

Result:

The average observed linear shrinkage of the test specimens was -0.58 %. This satisfies the physical requirements in Table 1 of ASTM C612.


Reviewed By:

4/21/2014
Date:

Water Vapor Sorption Test Report

Test Number: RD141418WVDate of Test: January 30 – February 3, 2014Specimen Number: 1211140116-17,18Date of Manufacture: UnknownDescription of Test Specimen: “HTB 700” Mineral Fiber Board InsulationReport Prepared For: Knauf Insulation (Slovenija)/ Delfina-Bi Baranda Robles


Test Method: ASTM C612-10 “Standard Specification for Mineral Fiber Block and Board Thermal Insulation” Section 12.6; ASTM C 1104/C 1104M-00 (Reapproved 2006), “Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation”.

The procedure used to test blanket, board, or pipe insulation products is contained in Section 8 of ASTM C 1104/C 1104M-00 (2006). The procedure is carried out for three specimens of the product. The volume of each test specimen is determined from measurements of the length, width, and thickness. The dry weight of the test specimens is determined after drying to steady state in a 102 to 121 °C environment. The test specimens are brought to a uniform temperature of 60°C before being transferred to an environmental chamber maintained at 49 ± 2 °C and 95 ± 3 % relative humidity. The test specimens remain in the environmental chamber for 96 ± 4 hours. At the end of the 96 hour exposure the specimens are sealed in a water impermeable bag and allowed to cool before final weighing. The increase in weight due to the exposure is used to calculate mass % and volume % water sorption relative to the moisture-free material.

Results:

Specimen:	1	2	3
Volume (cm ³):	1254.92	1244.76	1220.60
Moisture-free Mass (g):	198.81	177.50	170.02
Mass after test (g):	199.02	177.69	170.07
Mass % sorbed:	0.11	0.11	0.03
Volume % sorbed:	0.017	0.015	0.004
Average Mass % sorbed:	0.08		
Average Volume % sorbed:	0.012		

The average observed mass % sorbed of the test specimens was 0.08 %. This satisfies the physical requirements in Table 1 of ASTM C612.


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Date:



P.O. Box 2400
Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Odor Emission Test Report

Test Number: RD141417OE

Date of Test: January 31, 2014

Specimen Number: 1211140116-17,18

Date of Manufacture: Unknown

Description of Test Specimen: "HTB 700" Mineral Fiber Board Insulation

Test Method: ASTM C612-10 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation" Section 12.8; ASTM C 1304-08 (Reapproved 2013) "Test Method for Assessing the Odor Emission of Thermal Insulation Materials".

Report Prepared For: Knauf Insulation (Slovenija)/ Delfina-Bi Baranda Robles

Judge	1	2	3	4	5
Odor (Yes/No)	Yes	No	Yes	Yes	No
Odor (Objectionable/Pleasant/Otherwise)	Otherwise		Otherwise	Otherwise	
Odor (Weak/Strong)	Weak		Weak	Weak	

Pass / Fail

Pass

A handwritten signature in black ink, appearing to read 'Steve Ruy', is written over a horizontal line.

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Date:



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Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Corrosiveness Test Report

Test Number: RD141416CO

Date of Test: January 30- February 3, 2014

Specimen Number: 1211140116-17,18

Date of Manufacture: Unknown

Description of Test Specimen: "HTB 700" Mineral Fiber Board Insulation.

Test Method: ASTM C612-10 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation" Section 12.9; ASTM C 665-12, Section 13.8, "Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing".

Report Prepared For: Knauf Insulation (Slovenija)/ Delfina-Bi Baranda Robles

Procedure

Five specially cleaned steel plates were individually sandwiched between two layers of "HTB 700" Mineral Fiber Board Insulation. Five plates of steel were also prepared with sterilized cotton as control specimens.

This report presents the results of tests for corrosiveness conducted on "HTB 700" Mineral Fiber Board Insulation supplied by Knauf Insulation (Croatia). Testing on the steel coupons was completed on February 3, 2014

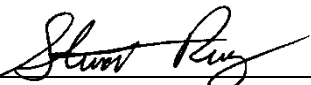
The prepared specimens were held by woven metal screens and suspended in an environmental chamber at 49 ± 2 °C and 95 ± 3 % RH. The steel specimens were allowed to remain in the chamber for 96 ± 2 hours.

Specimens were removed and post cleaned. The coupons were numbered and a panel of four judges examined the surfaces of each coupon and ranked them based on their best estimate of corrosiveness. Upon completion of the judges' rankings, the arithmetic sum of the rankings for each coupon was calculated. The sums were then ranked from the lowest total to the highest total. The new rankings established were totaled for the controls only. If this sum is greater than or equal to 21 for the controls, then there is no statistical difference between the control and the test plates and the insulation passes.

Observations:

	Number	Sum	Rank	Total
Steel	1	29	7	40
	2	32	8.5	
	3	32	8.5	
	4	23	6	
	5	36	10	

The rankings of the control plates did total 21 or greater, therefore there is deemed to be no statistical difference in the test plates and the controls and the insulation Passes.


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Date:



P.O. Box 2400
Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Rigidity Test Report

Test Number: RD141476RD

Date of Test: February 12, 2014

Specimen Number: 1211140116-17,18

Date of Manufacture: Unknown

Description of Test Specimen: "HTB 700" Mineral Fiber Board Insulation

Test Method: ASTM C612-10 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation" Section 12.11; ASTM C1101-06 (2012), "Standard Test Methods for Classifying the Flexibility or Rigidity of Mineral Fiber Blanket and Board Insulation."

Report Prepared For: Knauf Insulation (Slovenija) / Delfina-Bi Baranda Robles

Procedure

This test method covers the procedure for the classification of mineral fiber insulation as flexible, resilient flexible, semi-rigid, or rigid. Three test specimens measuring 32 by 12 inches at full thickness are prepared and conditioned for a minimum of 24 hours at 70 ± 2 °F and 50 ± 5 % relative humidity.

The test for rigidity was conducted according to section 7.4 of ASTM C1101. The specimens were placed on two horizontal, parallel 0.5 inch NPS steel pipes spaced 30 inches apart. After 5 minutes, the sag of the insulation was measured to the nearest 0.05 in. (1.3 mm) at the center of the span, from a straight line connecting two points on the insulation's surface directly above the supports. If the sag is less than 0.5 inches (13 mm), the product is classified as rigid.

Results

Sample	1	2	3
Sag Less Than 0.5 inch	YES	YES	YES
Classification	Rigid	Rigid	Rigid

Conclusion

The "HTB 700" mineral fiber board insulation is classified as rigid based on the results of the specimens tested. This satisfies the physical requirement of ASTM C612, section 7.5.

A handwritten signature in black ink, appearing to read 'Steve Ruz', is written over a horizontal line.

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4/21/2014

Date:



P.O. Box 2400
Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Non-Fibrous Content Test Report

Test Number: RD141477NF

Date of Test: February 24, 2014

Specimen Number: 1211140116-17,18

Date of Manufacture: Unknown

Description of Test Specimen: "HTB 700" Mineral Fiber Board Insulation

Test Method: ASTM C612-10 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation" Section 12.2; ASTM C1335-12, "Standard Test Method for Measuring Non-Fibrous Content of Man-Made Rock and Slag Mineral Fiber Insulation".

Report Prepared For: Knauf Insulation (Slovenija) / Delfina-Bi Baranda Robles

Background

This test procedure determines the non-fibrous content (shot) of man-made rock and slag mineral fiber insulation. The procedure involves a dry sieve analysis method to distinguish between fiberized and non-fiberized (shot) portions of a specimen of man-made rock and slag mineral fiber insulation.

Three 10 gram specimens are prepared. Test specimens are conditioned at high temperature for 15 minutes and allowed to cool to room temperature. The specimens are placed into a nest of three sieves and shaken for 20 minutes using a Tyler model RX-24 portable sieve shaker. The non-fibrous (shot) content remaining in each sieve is weighed. The percentage of non-fibrous content is calculated using the equation in Section 8 of ASTM C1335.

Test Results

Conditioning Temperature: 593 °C

Type of Sieves Used: Number 20, 50 and 100; brass

	Specimen 1	Specimen 2	Specimen 3
Initial Mass of Specimen (g)	10.7058	9.1753	10.1765
Mass of Specimen After Conditioning (g)	10.5384	9.0175	10.0218
Mass of Non-Fibrous Material in No. 20 Sieve (g)	0.0013	0.0019	0.0059
Mass of Non-Fibrous Material in No. 50 Sieve (g)	0.1170	0.1187	0.1310
Mass of Non-Fibrous Material in No. 100 Sieve (g)	0.9743	0.8730	0.0373
Total Mass of Non-Fibrous Material (g)	1.0926	0.9936	1.1742
Non-Fibrous Content (%)	10.4	11.0	11.7

Conclusion:

The average observed non-fibrous content of the test specimens was 11.0%. This satisfies the physical requirements of Section 7.6 in ASTM C612.

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4/21/2014

Date:



P.O. Box 2400
Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Hot Surface Performance of High-Temperature Thermal Insulation

Test Number: RD141672HS Date of Manufacture: Unknown

Specimen Number: 1211140116-9 Date of Test: April 10-14, 2014

Description of Test Specimen: “HTB 700” Mineral Fiber Board Insulation.

Report Prepared For: Knauf Insulation (Slovenija)

Contact Person: Delfina-Bi Baranda Robles

Test Methods: ASTM C411, “Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation”.

ASTM C612, “Standard Specification for Mineral Fiber Block and Board Thermal Insulation”.

ASTM C447, “Standard Practice for Estimating the Maximum Use Temperature of Thermal Insulations”.

Description of Test

ASTM C 411 tests the performance of a thermal insulation intended for high temperature applications when the insulation is in continuous contact with a hot surface at a controlled temperature for a period of 96 hours. Visible signs of flaming, glowing, smoldering, or smoking results in termination of the test. The electrical power to the heater is turned off at the end of 96 hours and the test specimen was allowed to cool to room temperature. After cooling the test specimen was removed from the hot plate for evaluation.

The plate has a heated surface of 610 by 610 mm (24 by 24 inches). The temperature of the plate is recorded in four locations. The temperature of the specimen was measured at 25 mm increments measured from the hot surface through the entire thickness of the test specimen to the surface exposed to the room. The plate was heated to 649°C using a sacrificial piece of insulation. Once the plate was heated to the test temperature, the sacrificial piece of insulation was removed from the plate and four layers of the specimen were placed on the test apparatus and held at a constant temperature for 96 hours.

Conditions and Observations

1. The product was identified as “HTB 700” Mineral Fiber Board Insulation. The material was supplied by Knauf Insulation in Novi Marof, Croatia.
2. The specimen was cut into four 24 by 24 inch pieces and placed on the plate after the plate was heated to the test temperature.
3. The test temperature was 649 +/- 15 °C. The average plate temperature during the test was 650.4 °C.
4. There was no warpage observed after the 96 hour exposure.
5. There was no flexibility change observed.
6. No cracking or delamination was observed.
7. There was no evidence of flaming, glowing, smoldering or melting during the 96 hour test. There was no evidence of melting or fiber degradation.
8. No smoking was observed during the test.
9. Discoloration was observed in each layer.
10. There was no exothermic reaction observed during the test.
11. Figure 1 is a photograph of layer 1 prior to testing and Figure 2 is a photograph of layer 1 after testing. Figure 3 is a photograph of layer 2 prior to testing and Figure 4 is a photograph of layer 2 after testing. Figure 5 is a photograph of layer 3 prior to testing and Figure 6 is a photograph of layer 3 after testing. Figure 7 is a photograph of layer 4 prior to testing and Figure 8 is a photograph of layer 4 after testing. Figure 9 is the temperature profile for the first 4 hours of the test. Figure 10 is the temperature profile for the duration of the test.
12. Table 1 contains physical characteristics before testing. Table 2 contains the mass change of the material after testing. Table 3 contains temperature and exothermic reaction data of the test specimen during testing.

Conclusion

The “HTB 700” mineral fiber board insulation manufactured by Knauf Insulation in Novi Marof, Croatia meets the requirements of ASTM C612-10, “Standard Specification for Mineral Fiber Block and Board thermal Insulation” when tested according to ASTM C411-11, “Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation” and ASTM C447-10 “Standard Practice for Estimating the Maximum Use Temperature of Thermal Insulations” at a surface temperature of 649°C for a Type IV, Grade A product.

	Length (mm)	Width (mm)	Thickness (mm)	Mass (g)	Density (kg/m ³)
Layer 1 (exposed to plate)	609.6	611.1	54.0	2987.4	148.5
Layer 2	611.1	609.6	54.0	2703.7	134.4
Layer 3	609.6	609.6	56.0	2801.1	134.6
Layer 4 (exposed to room)	616.0	612.9	54.0	2773.1	136.0

Table 1 – Dimensions and Mass Before Testing

	Mass (g)	Mass Loss (%)
Layer 1 (exposed to plate)	2946.9	1.4
Layer 2	2668.5	1.3
Layer 3	2762.5	1.4
Layer 4 (exposed to room)	2757.5	0.6

Table 2 – Mass Change After Testing

Distance of Temperature Measurement From Hot Surface (mm)	Maximum Temperature (°C)	Maximum Exotherm Temperature (°C)	Dwell Temperature (°C)
25	659.2	8.3	594.4
50	625.4	-25.5	562.8
75	569.4	-81.6	508.6
100	516.5	-134.5	456.0
125	452.8	-198.2	379.8
150	373.3	-277.7	291.6
175	253.2	-397.8	192.3
200	179.5	-471.5	140
Surface	60	-591.0	49.8

Table 3 – Exothermic Temperature Data

Note - An exothermic reaction was recorded. The exotherm is the maximum temperature difference between the plate temperature and the measurement location when the measurement location exceeds the plate temperature. A negative number indicates no exotherm was observed. The maximum exotherm observed was 8.3 °C which is less than the maximum allowed exotherm of 111 °C allowed by ASTM C612.



Figure 1. Layer 1 Before Testing

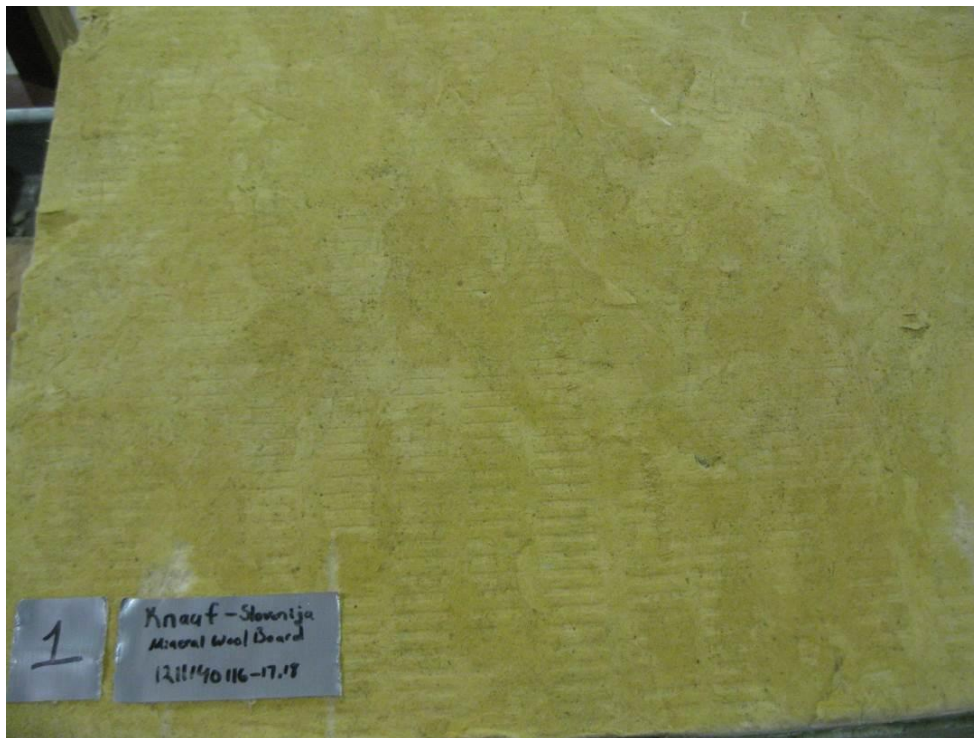


Figure 2. Layer 1 After Testing



Figure 3. Layer 2 Before Testing

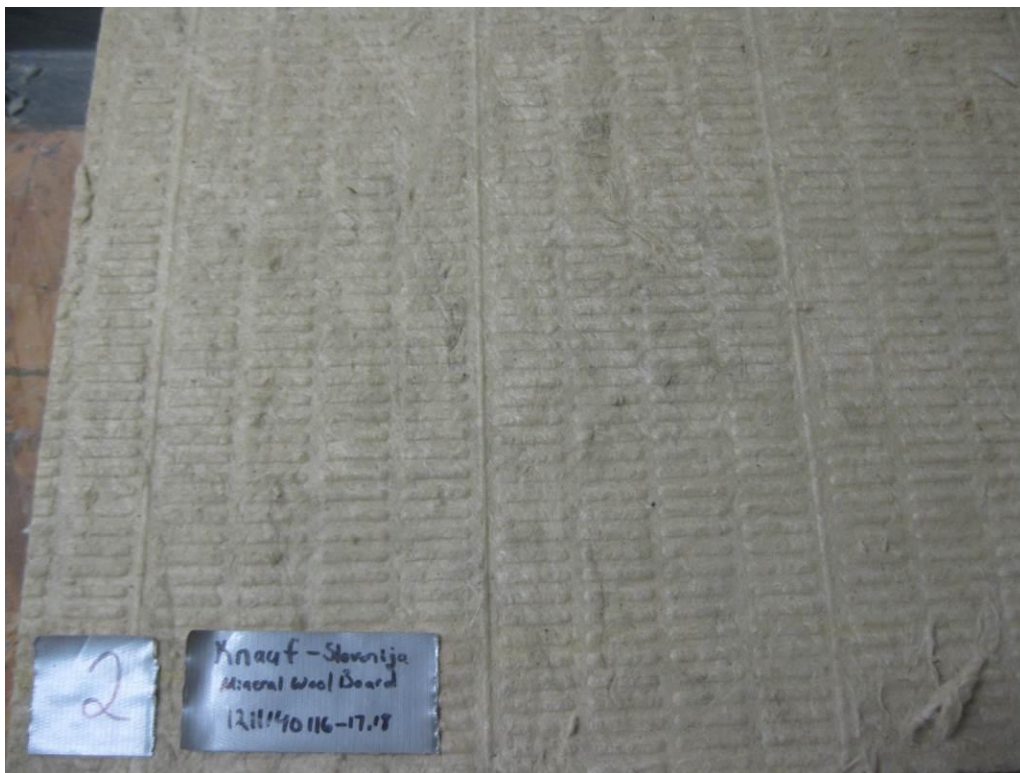


Figure 4. Layer 2 After Testing



Figure 5. Layer 3 Before Testing

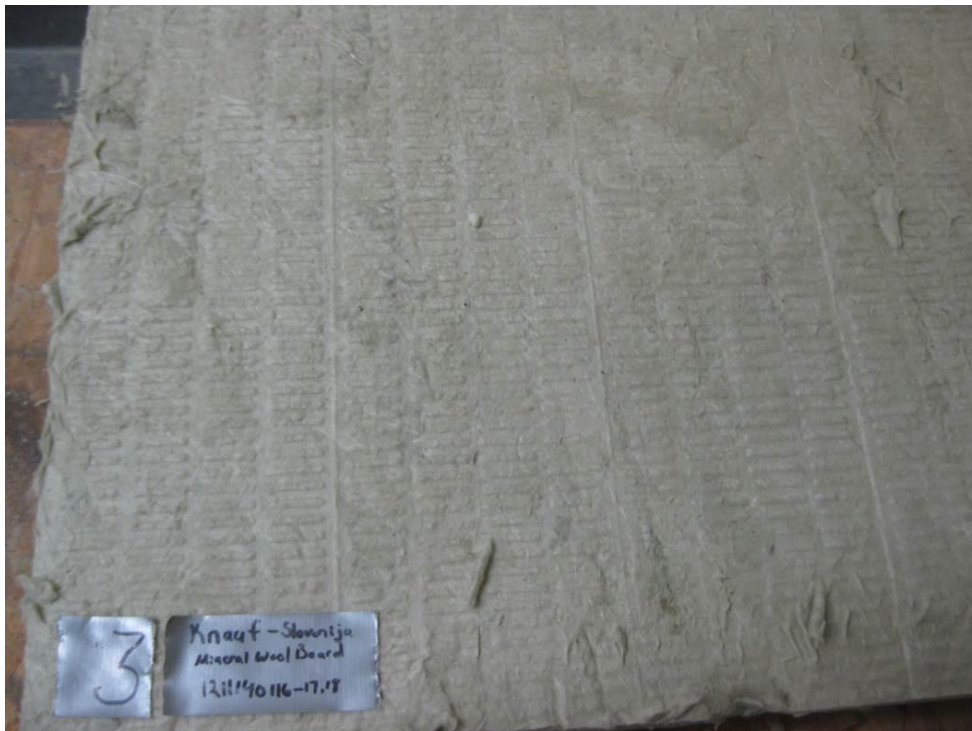


Figure 6. Layer 3 After Testing



Figure 7. Layer 4 Before Testing

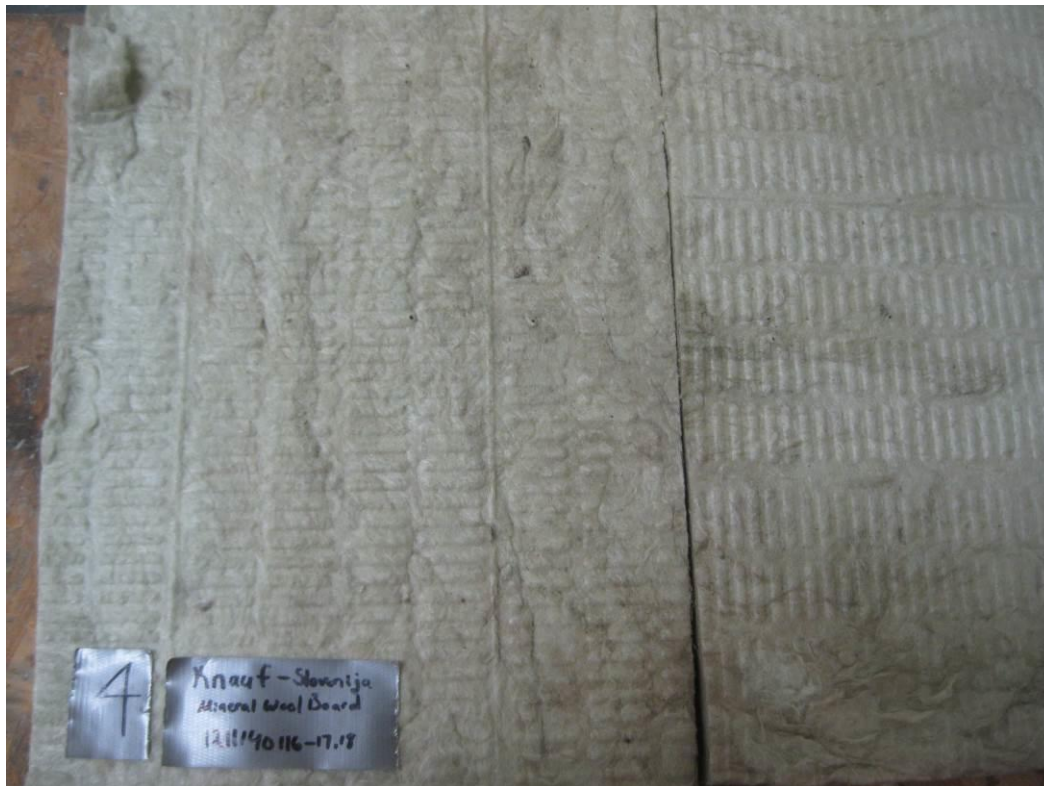


Figure 8. Layer 4 After Testing

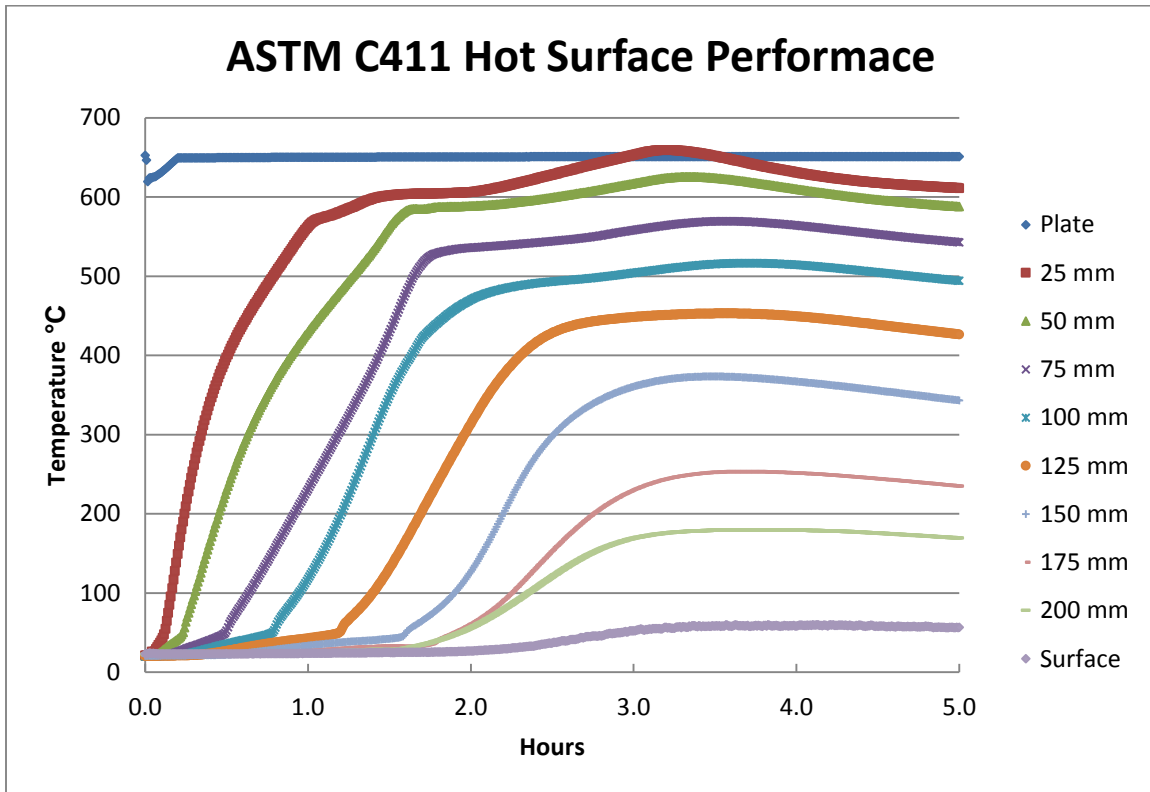


Figure 9- Temperature Profile for the First 5 Hours of Testing

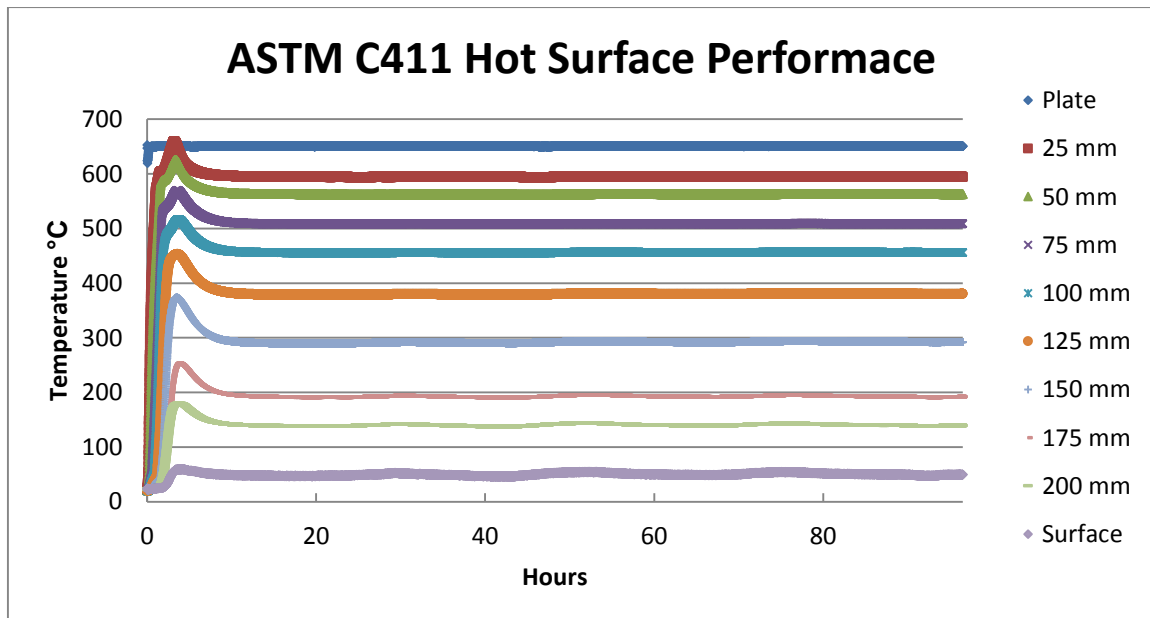


Figure 10- Temperature Profile for the Duration of Testing



P.O. Box 2400
Cookeville, Tennessee 38502-2400
Phone: 931-372-8871
Fax: 931-525-3896

Fungi Resistance Test Report

Test Number: RD141415FR

Date of Test: January 23 – February 20, 2014

Specimen Number: 1211140116-17,18

Date of Manufacture: Unknown

Description of Test Specimen: “HTB 700” Mineral Fiber Board Insulation.

Test Method: ASTM C612-10 “Standard Specification for Mineral Fiber Block and Board Thermal Insulation” Section 12.12; ASTM C 1338-08, “Standard Test Method for Determining Fungi Resistance of Insulating Materials and Facings.

Report Prepared For: Knauf Insulation (Slovenija)/ Delfina-Bi Baranda Robles

Test specimens and comparative material are exposed to a 28 day inoculation period. After the inoculation period the specimens are removed from test chamber and evaluated under 40X magnification. Each of the test specimens are determined to have no fungal growth, fungal growth no greater than the comparative material, or fungal growth greater than the comparative material.

<u>Specimen</u>	<u>Fungal Growth Comparison</u>
1	No growth.
2	No growth.
3	No growth.

Comparative Material: Birch

The pass/fail result: Pass

Basis for the pass/fail result: Three of three specimens passed.

Carla King
Evaluation:

4/21/2014
Date:

Shunt Ray
Review:

4/21/2014
Date: