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ASTM E 1354 Caloric Content Determination of "EPDM 35 FST"

A Report To:	**Caoutchouc Pro-Flex Inc.** 212 des Alouettes St-Alphonse de Granby, QC, Canada J0E 2A0
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Submitted by:	Element Fire Testing
Report No.	19-002-581(C) 8 Pages + Appendix
Date:	September 26, 2019

ACCREDITATION To ISO/IEC 17025 for a defined Scope of Testing by the International Accreditation Service

SPECIFICATIONS OF ORDER

Determine Effective Heat of Combustion according to ASTM E 1354 and derive Caloric Content, as per Pro-Flex Inc. reference Purchase Order No. AC-006204 and Element Quotation No. 18-002-580,964 accepted August 6, 2019.

SAMPLE IDENTIFICATION

Rubber compound, identified as:
"EPDM 35 FST"

(Element sample identification number 19-002-S0581)

SUMMARY OF TEST PROCEDURE

Each specimen is mounted into a holder and placed horizontally below a cone-shaped radiant heat source which has been previously calibrated to emit a predetermined heat flux. Testing can occur with or without a spark ignition source. The test is performed in ambient air conditions, while a load cell continuously monitors specimen weight loss.

Exhaust gas flow rate and oxygen concentration are used to determine the amount of heat release, based on the observation that the net heat of combustion is directly related to the amount of oxygen required for combustion. The relationship is that approximately 13.1 x 10^3 kJ of heat are released per 1 kg of oxygen consumed.

In addition to rate of heat release, other specified measurements include mass-loss rate, time to sustained flaming and smoke obscuration.

ASTM E 1354-17

Standard Test Method for Heat and Visible Smoke Release Rates

for Materials and Products Using an Oxygen Consumption Calorimeter

Testing was performed on September 26, 2019 with the sample in the horizontal configuration, utilizing the specimen grid & edge frame, with the specified spark ignition source.

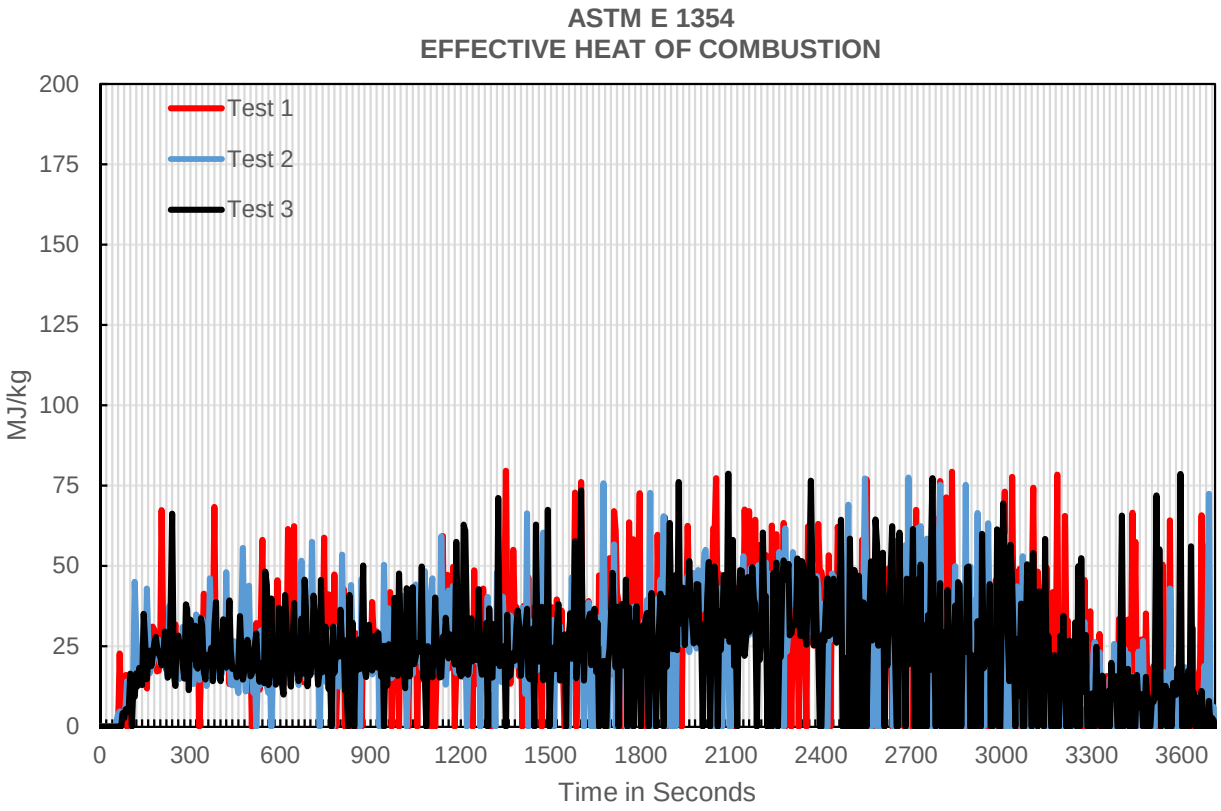
SUMMARY OF TEST RESULTS

	Test #1	Test #2	Test #3	Average	
Heat Flux (kW/m²)	50	50	50		
Exhaust Flow Rate (l/s)	24	24	24		
Specimen Thickness (mm)	13.0	13.0	13.0		
Initial Mass (g)	160.0	160.2	155.9		
Mass at Sustained Flaming (g)	159.3	159.4	155.1		
Final Mass (g)	74.3	75.2	71.7		
Sample Mass Loss (kg/m²)	9.62	9.52	9.43	9.52	
Peak Specific Mass Loss Rate (g/(s·m²))	9.83	9.90	9.00	9.58	
Average Mass Loss Rate (g/(s·m²))	3.08	3.08	3.10	3.08	
Time to Ignition (s)	100	90	100	97	
Time to Flame-out (s)	3600	3600	3600	3600	
Time of Peak Rate of Heat Release (s)	190	175	190	185	
Peak Rate of Heat Release (kW/m²)	140.8	126.5	129.0	132.1	
Average Rate of Heat Release (kW/m²)	84.3	75.6	73.5	77.8	
Total Heat Released (MJ/m²)	295.05	265.43	257.18	272.55	
Average Effective Heat of Combustion (MJ/kg)	30.68	27.88	27.27	28.61	*
Average Effective Heat of Combustion (BTU/lb)	13210.8	12005.5	11742.5	12320	*
Caloric Content (MJ/kg)	16.30	14.65	14.58	15.18	**
Caloric Content (BTU/lb)	7020.0	6308.2	6280.3	6536	**
Peak Extinction Area (m²/kg)	3295.3	2826.4	3894.2	3338.6	
Average Extinction Area (m²/kg)	288.0	249.8	281.7	273.2	

* Total heat produced per unit mass of material consumed

** Total heat produced per unit mass of material tested

TEST RESULTS

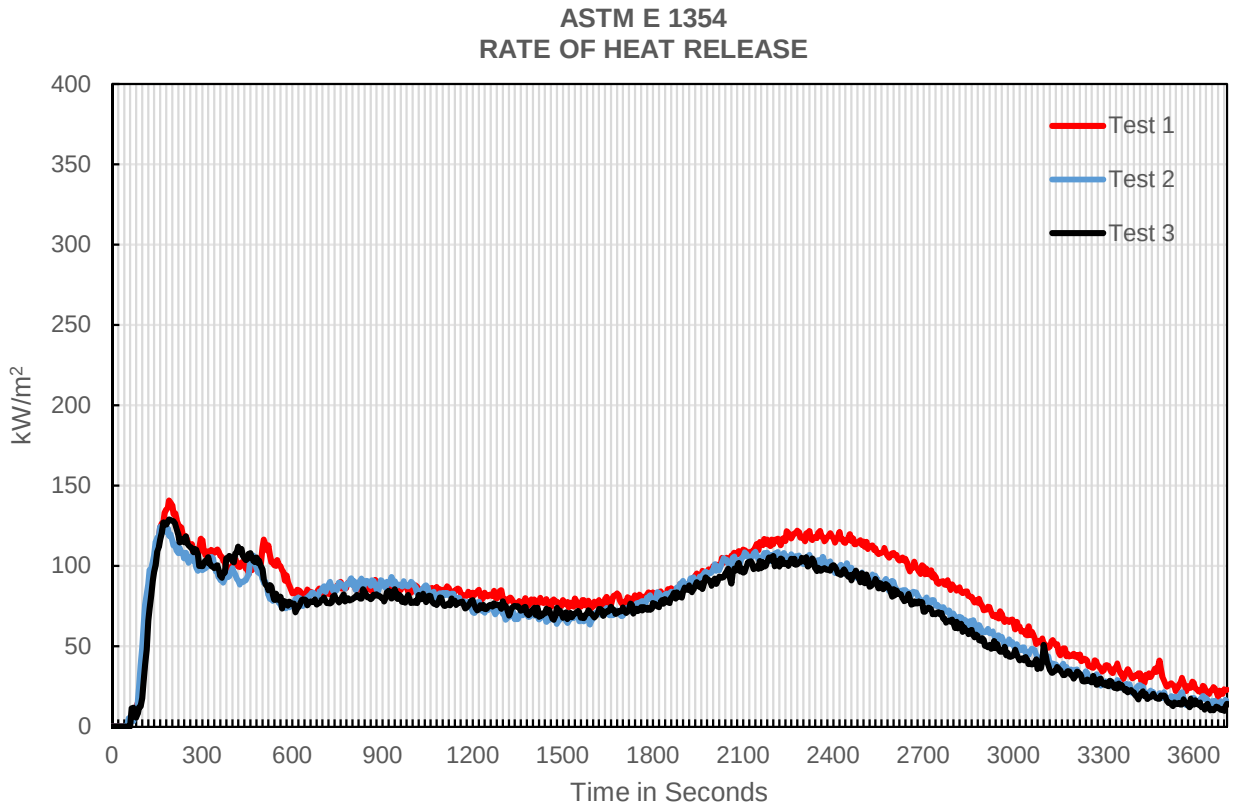


Test	#1	#2	#3	Average
Average Heat of Combustion (MJ/kg)*	30.68	27.88	27.27	28.61
Heat of Combustion @ 60 s (MJ/kg)**	16.75	16.85	16.77	16.79
Heat of Combustion @ 180 s (MJ/kg)**	21.61	19.79	20.66	20.69
Heat of Combustion @ 300 s (MJ/kg)**	22.17	20.39	20.84	21.14

* Averaged over the period starting when 10% of the ultimate mass loss occurred and ending at the time when 90% of the ultimate mass loss occurred.

** Averages, or projected averages over the 60, 180 or 300 second periods starting when 10% of the ultimate mass loss occurred.

TEST RESULTS (continued)

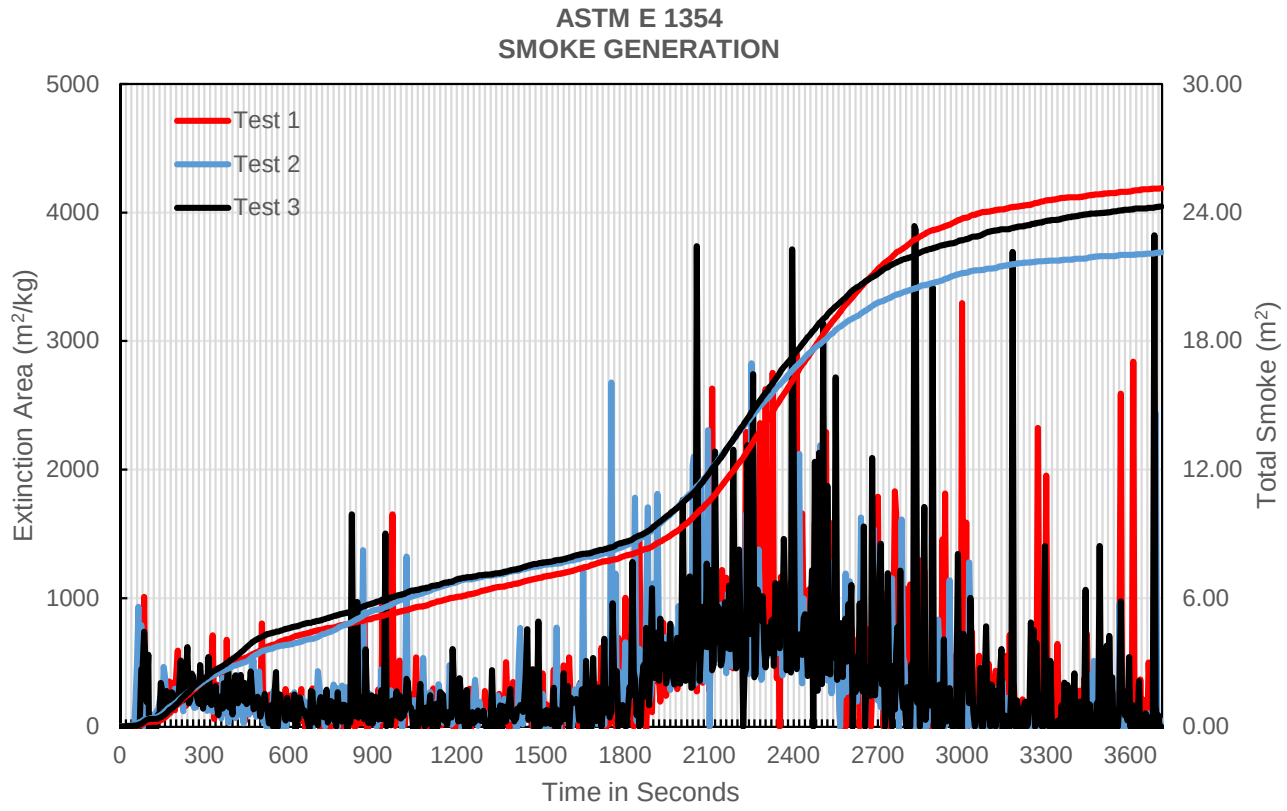


Test	#1	#2	#3	Average
Peak Rate of Heat Release (kW/m²)	140.8	126.5	129.0	132.1
Average Heat Release Rate (kW/m²)*	84.3	75.6	73.5	77.8
Heat Release Rate @ 60 s (kW/m²)**	82.6	82.4	76.0	80.3
Heat Release Rate @ 180 s (kW/m²)**	110.4	103.2	105.1	106.2
Heat Release Rate @ 300 s (kW/m²)**	108.9	100.9	103.5	104.4

* Averaged over the test period (from ignition to flameout).

** Averages, or projected averages over the first 60, 180 or 300 seconds after ignition.

TEST RESULTS (continued)

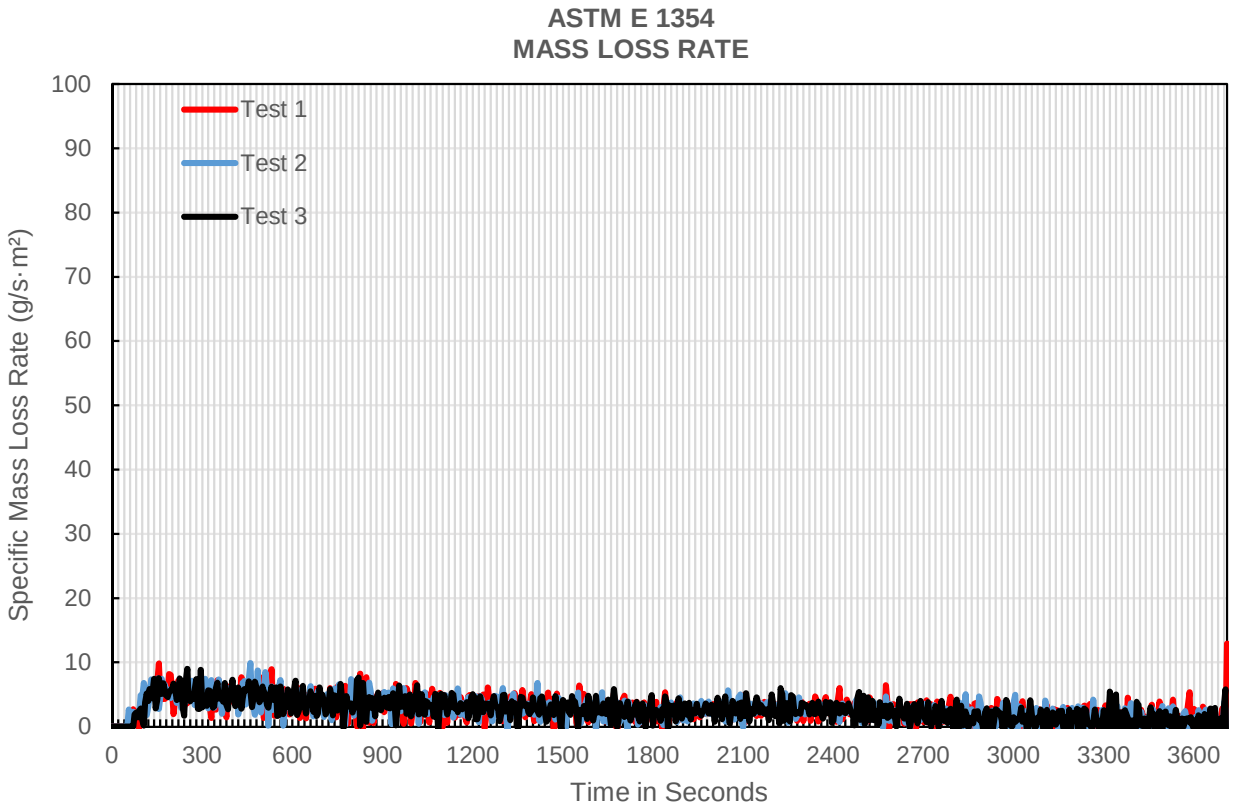


Test	#1	#2	#3	Average
Peak Extinction Area (m²/kg)	3295.3	2826.4	3894.2	3338.6
Average Extinction Area (m²/kg)*	288.0	249.8	281.7	273.2
Extinction Area @ 60 s (m²/kg)**	78.4	95.1	83.0	85.5
Extinction Area @ 180 s (m²/kg)**	207.4	181.6	209.2	199.4
Extinction Area @ 300 s (m²/kg)**	207.3	179.9	211.4	199.5
Total Smoke (m²)	24.8	21.7	23.8	23.4

* Averaged over the test period (from ignition to flameout).

** Averages, or projected averages over the first 60, 180 or 300 seconds after ignition.

TEST RESULTS (continued)



Test	#1	#2	#3	Average
Peak Mass Loss Rate (g/(s·m²))	9.83	9.90	9.00	9.58
Average Specific Mass Loss Rate (g/(s·m²))*	3.08	3.08	3.10	3.08
Mass Loss Rate @ 60 s (g/s)**	0.04	0.04	0.04	0.04
Mass Loss Rate @ 180 s (g/s)**	0.05	0.05	0.05	0.05
Mass Loss Rate @ 300 s (g/s)**	0.04	0.04	0.04	0.04

* Averaged over the period starting when 10% of the ultimate mass loss occurred and ending at the time when 90% of the ultimate mass loss occurred.

** Averages, or projected averages over the 60, 180 or 300 second periods starting when 10% of the ultimate mass loss occurred.

CONCLUSIONS

The rubber compound identified in this report, affords an average Effective Heat of Combustion of 28.61 MJ/kg (12320 BTU/lb) of consumed material when tested according to ASTM E 1354 at an imposed heat flux of 50 kW/m². Based on the initial mass of each specimen, this calculates to an overall average Caloric Content of 15.18 MJ/kg (6536 BTU/lb).

Note: This is an uncontrolled electronic copy of the report. Signatures are on file with the original.

Mel Garces,
Senior Technologist.

Ian Smith,
Technical Manager.

APPENDIX

(1 Page)

ASTM E 1354 Definitions

ASTM E 1354 DEFINITIONS

In evaluating the data produced by the oxygen consumption (cone) calorimeter, the following definitions and comments are offered:

Time to Ignition

Also known as ignition delay time, this parameter provides a measure of the propensity of a material to ignite, as measured by the time to sustained ignition at a given heat flux. It can also be considered to be related to the volatility of the degradation products, and the time required to achieve a critical fuel concentration in the vapour phase. This gasification rate is temperature dependent: the higher the imposed heat flux, the shorter the time to ignition.

Effective Heat of Combustion

This is the measured heat release divided by the mass loss for a specified time period, and therefore represents the calorific value of only the consumed portion of the tested material. Caloric content under the test conditions can be derived by dividing the total heat released by the original mass of the material under test. It generally differs from the theoretical heat of combustion, since the latter involves complete combustion - a phenomenon which rarely takes place in an actual fire, in normal air.

Heat Release Rate

HRR is the heat evolved per unit time and is highly dependent on the applied heat flux: the higher the flux, the greater the HRR. HRR curves can fluctuate significantly with time and it is generally considered that the average HRR can be a better predictor of full-scale fire performance than the peak value.

Total Heat Release

This is the integrated area under the HRR curve over the test period, expressed in MJ/m^2. If one knows the total surface area of a material used in a room or transit vehicle, this value is more properly used to estimate potential heat load than is the more commonly used "caloric content", which is based upon the weight of material used.

Mass Loss Rate

This is roughly correlatable with heat release rate because it is the rate at which the test material is degraded to produce combustible fuels. The peak mass loss rate and average mass loss rate are derivative terms generated by the load cell.

Extinction Area

This refers to the "yield" of smoke which, through mathematical manipulation, is expressed as an area per unit mass.

Additional Values

In addition to average values for the test, data averaged to the 60, 180 and 300 second marks after ignition are also typically provided. For example, where materials burn for different lengths of time, it is more technically sound to compare the average heat release rates over the first 1, 3 or 5 minutes of burning, than to compare the test average results, which encompass differing time periods.