Supplemental Information

Mitigation of Iron and Aluminum Powder Deflagrations via Active Explosion Suppression in a 1 m^3 Sphere Vessel

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Supplemental Figures and Tables:

Figure A-1. Thermogravimetric profiles of iron powder mixed with sodium bicarbonate (SBC) inert material (1:1 ratio by weight). Temperature range from 50 °C to 1100 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure A-2. Thermogravimetric profiles of iron powder mixed with monoammonium phosphate (MAP) inert material (1:1 ratio by weight). Temperature range from 50 °C to 1100 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure A-3. Thermogravimetric profiles of iron powder mixed with sodium chloride (Met-L-X) inert material (1:1 ratio by weight). Temperature range from 50 °C to 1100 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure B-1. Thermogravimetric profile for sodium bicarbonate inert material. Temperature range from room temperature to 1300 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure B-2. Thermogravimetric profile for monoammonium phosphate inert material. Temperature range from room temperature to 1300 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure B-3. Thermogravimetric profile for Met-L-X inert material. Temperature range from room temperature to 1300 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure B-4. Differential scanning calorimetry profile for sodium bicarbonate inert material. Temperature range from 50 °C to 1300 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure B-5. Differential scanning calorimetry profile for monoammonium phosphate inert material. Temperature range from 50 °C to 1300 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure B-6. Differential scanning calorimetry profile for Met-L-X inert material. Temperature range from 50 °C to 1300 °C, with a constant heating ramp rate of 10 °C/min (in air).

Figure C-1. Particle size distribution for iron powder [Fe-101].

Mass Loss Profiles for 1:1 Iron/Agent Mixtures

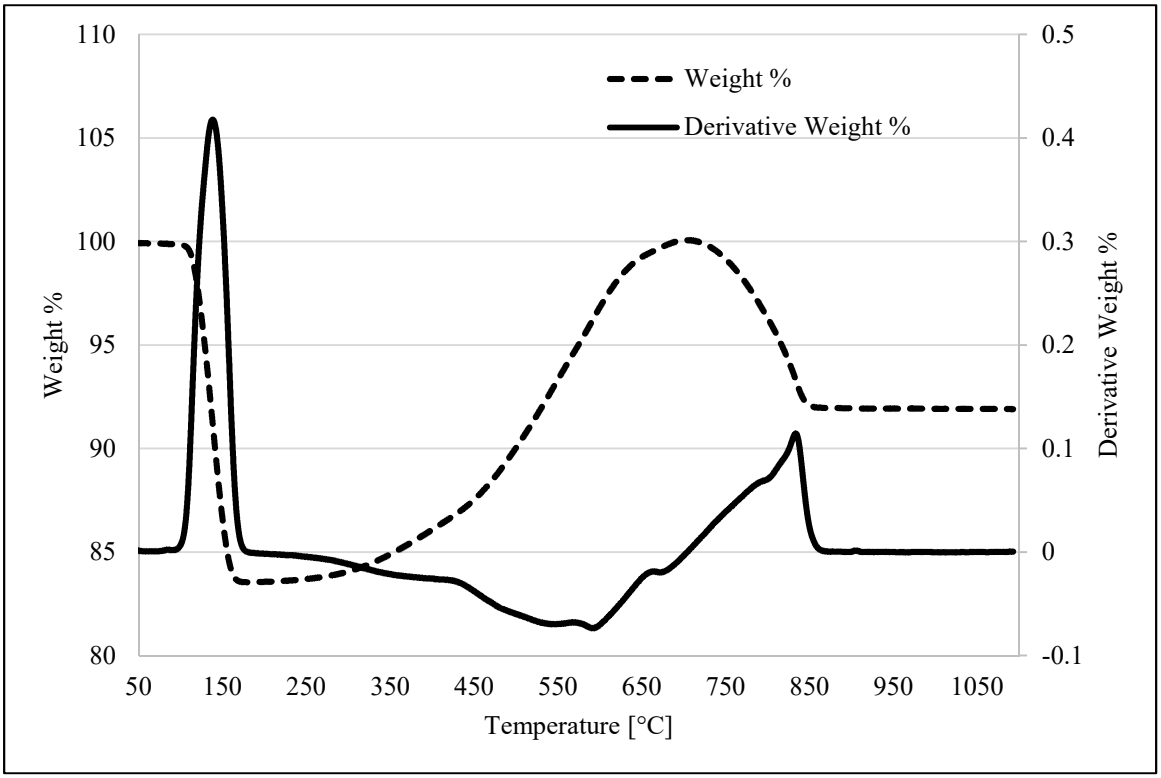

Fig. A-1 (Fe + SBC)

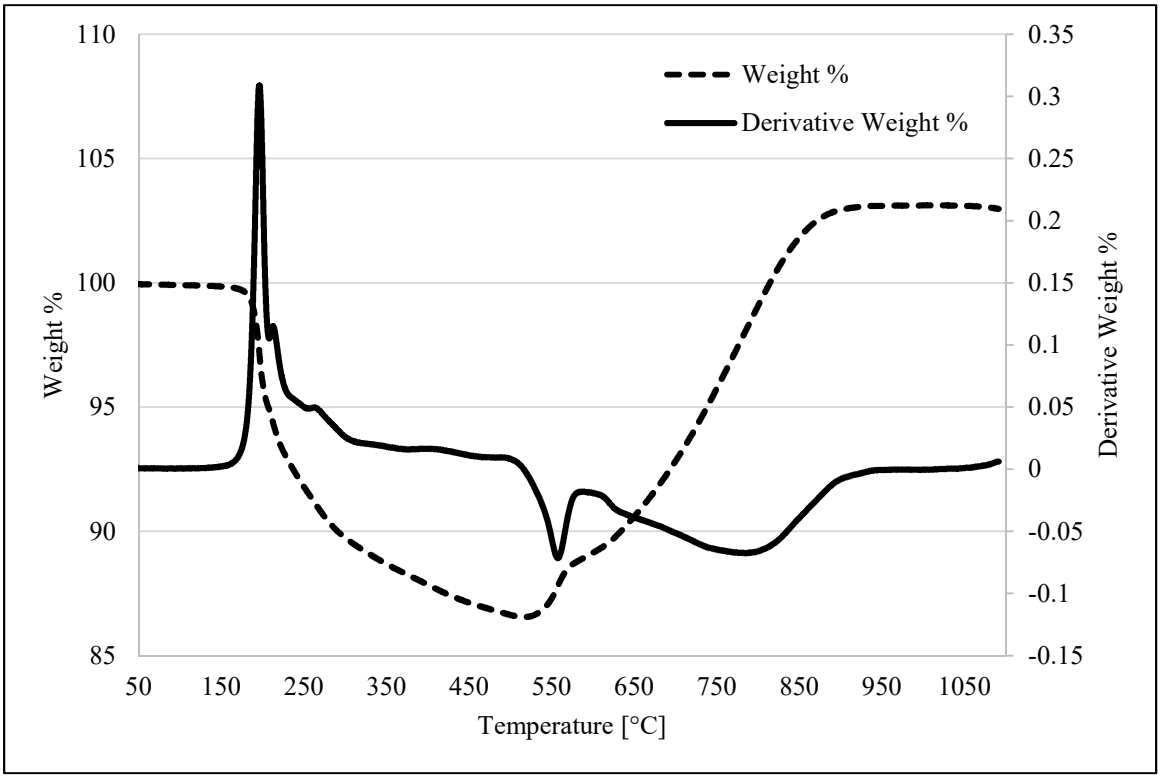

Fig. A-2 (Fe + MAP)

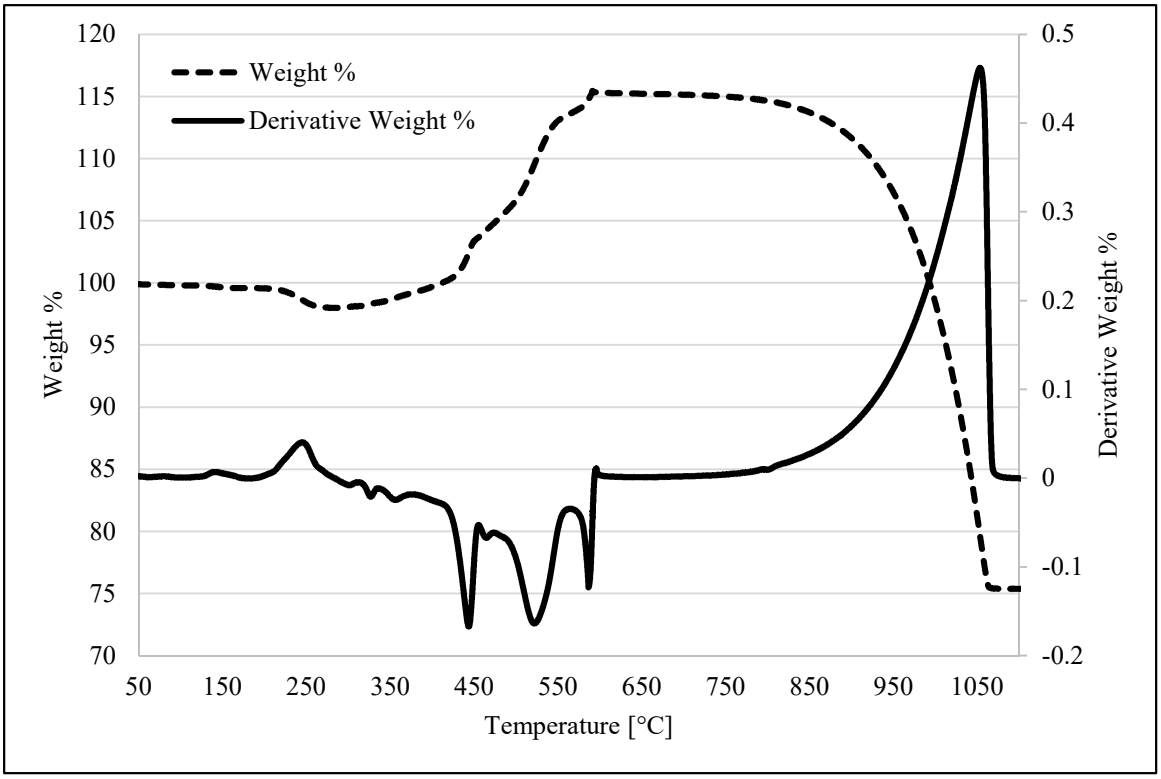

Fig. A-3 (Fe + Met-L-X)

TGA & DSC Profiles for Inert Materials

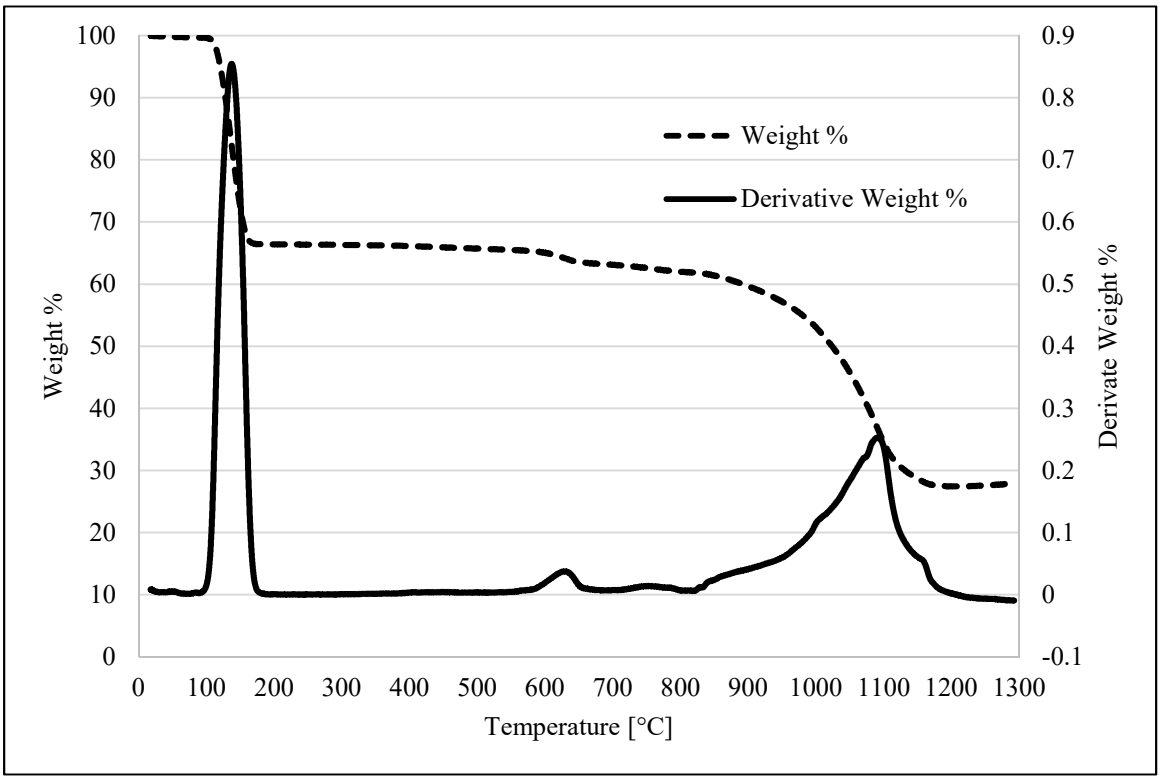

Fig. B-1 (Mass Loss - SBC)

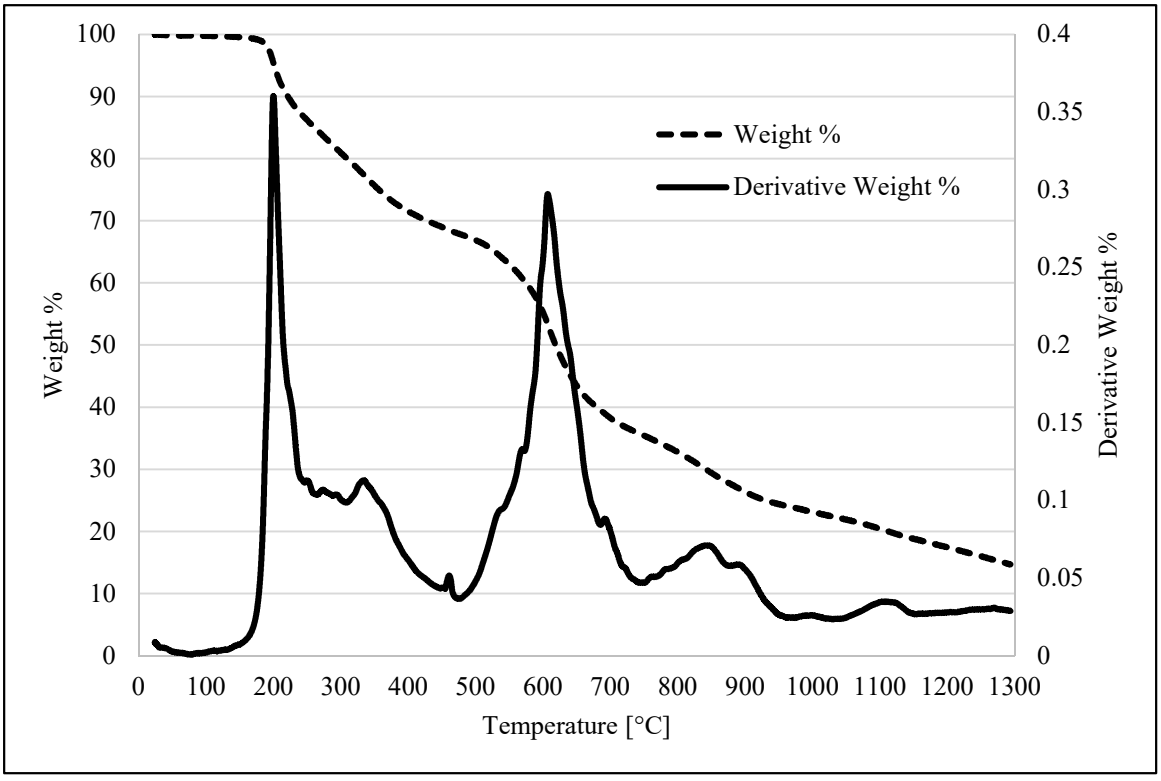

Fig. B-2 (Mass Loss - MAP)

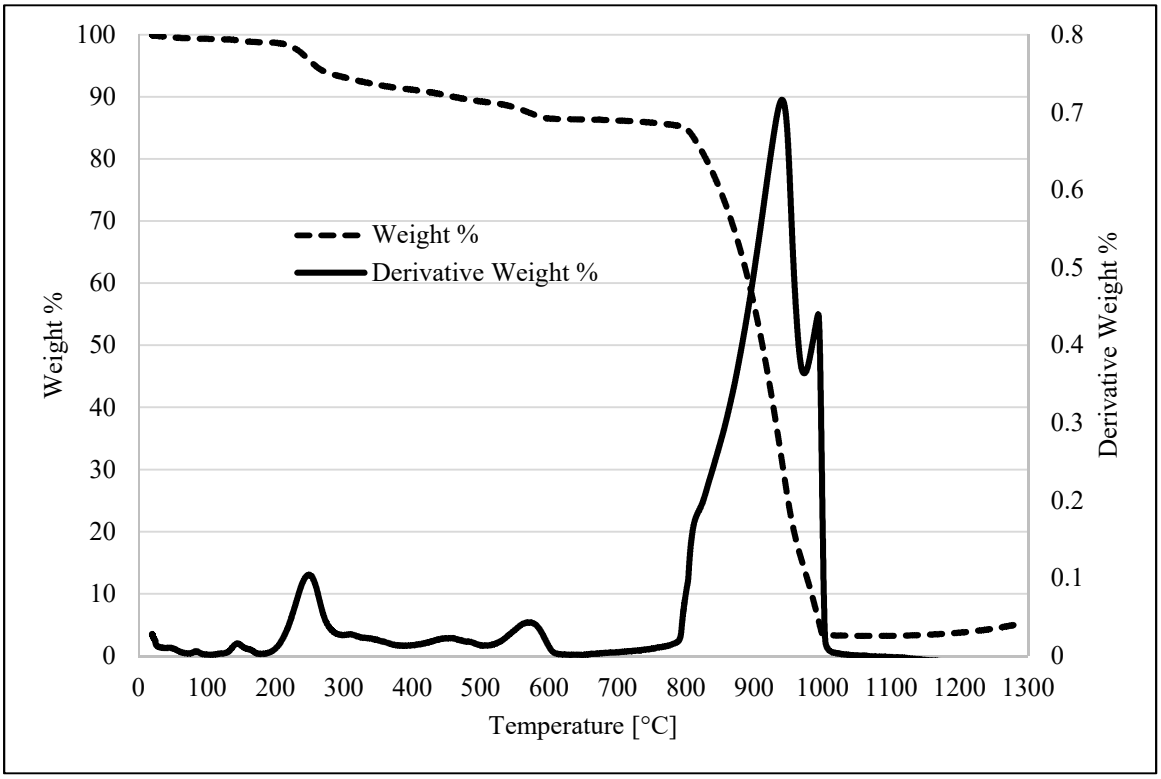

Fig. B-3 (Mass Loss – Met-L-X)

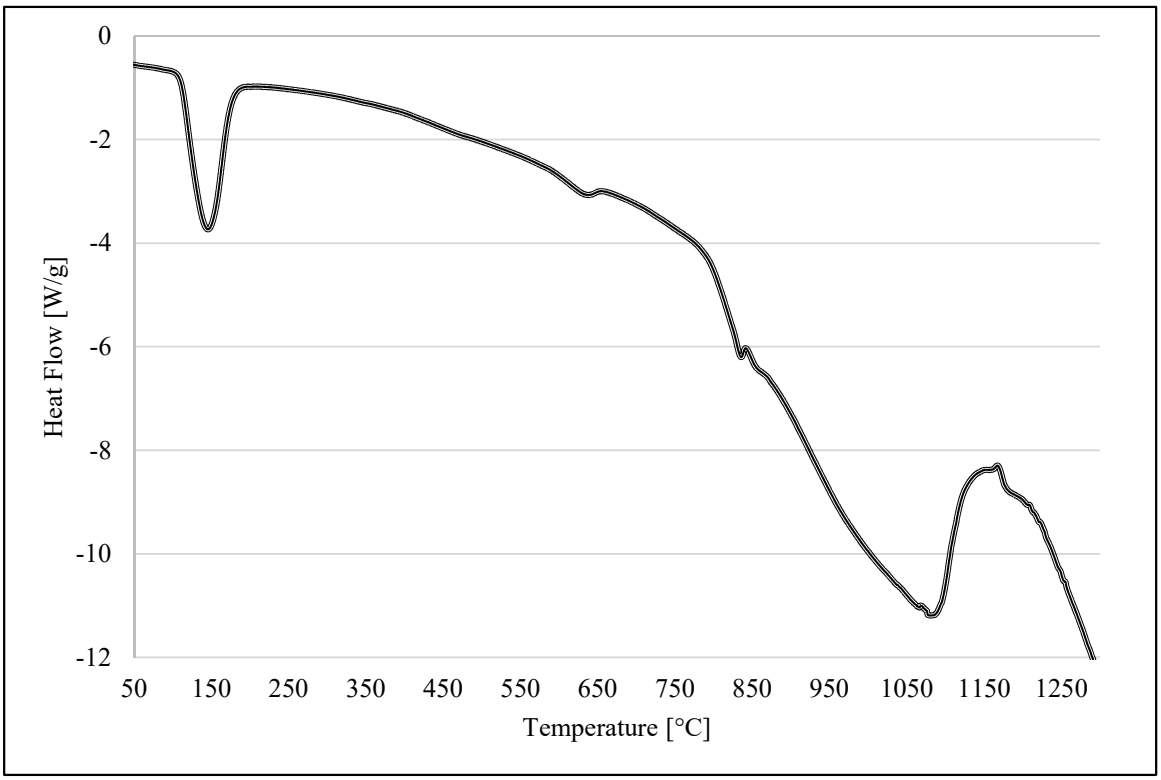

Fig. B-4 (Heat Flow - SBC)

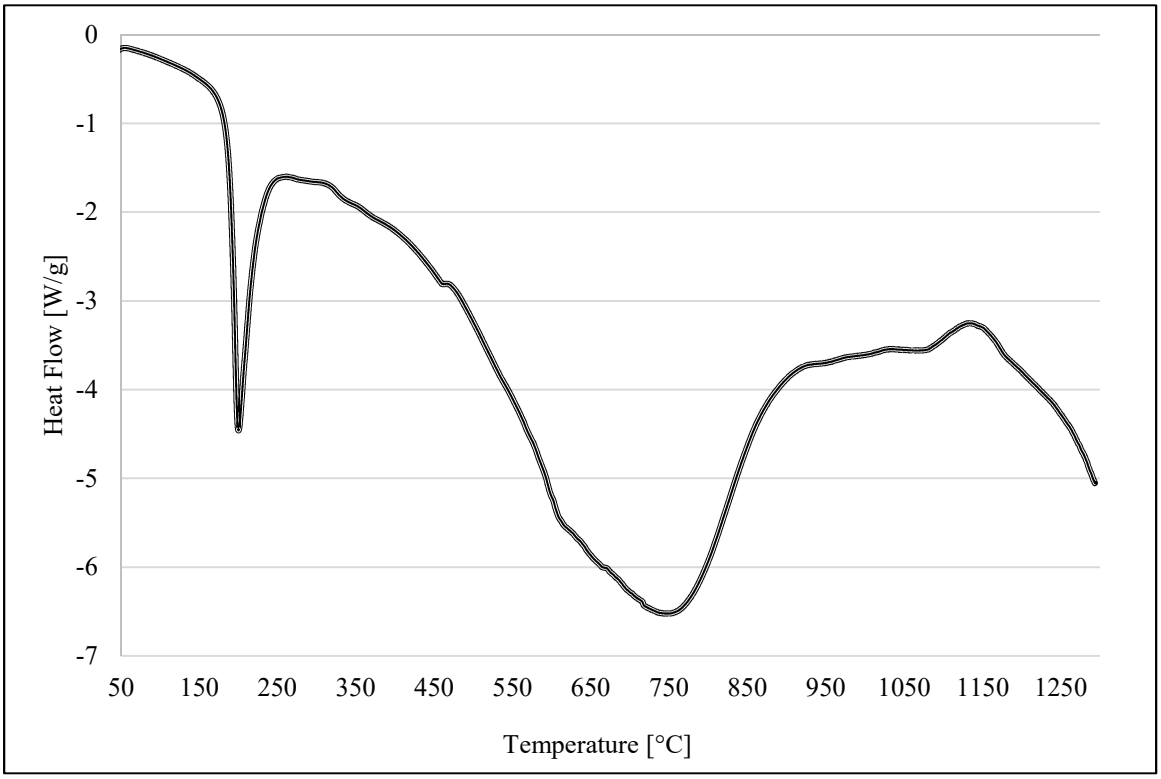

Fig. B-5 (Heat Flow - MAP)

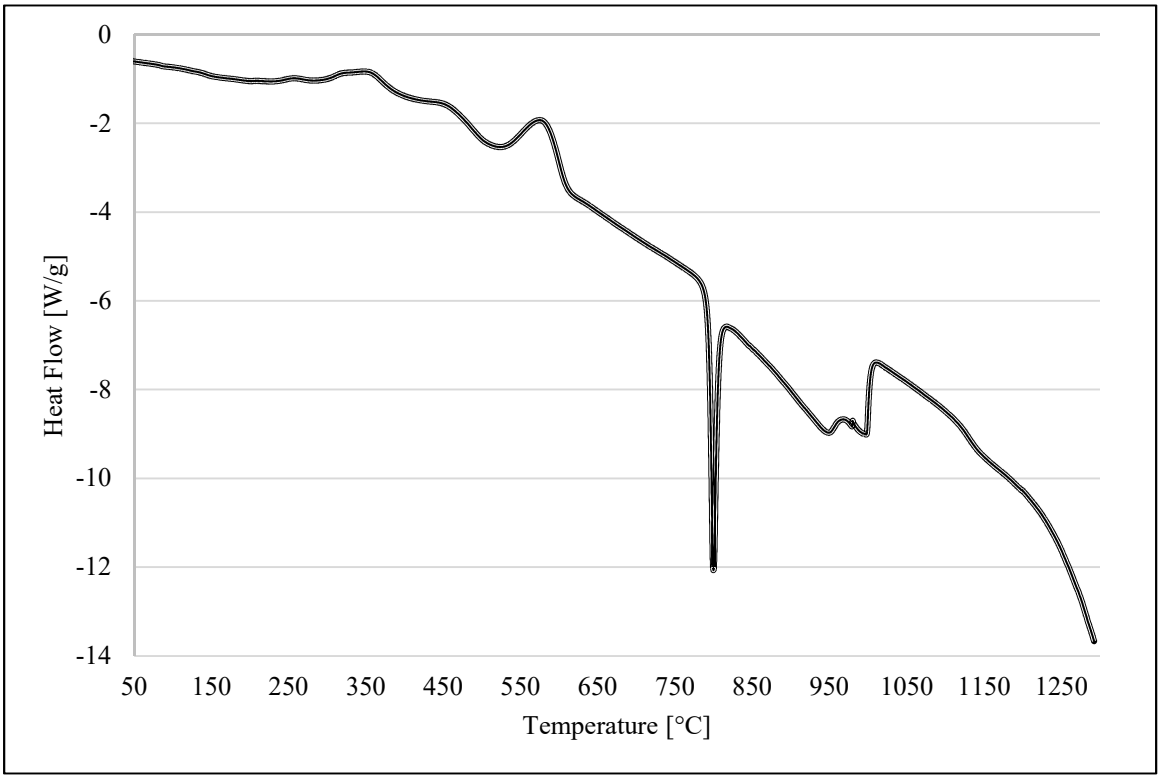

Fig. B-6 (Met-L-X)

Particle Size Analysis (PSA) Distributions Profiles for Fuels and Agents

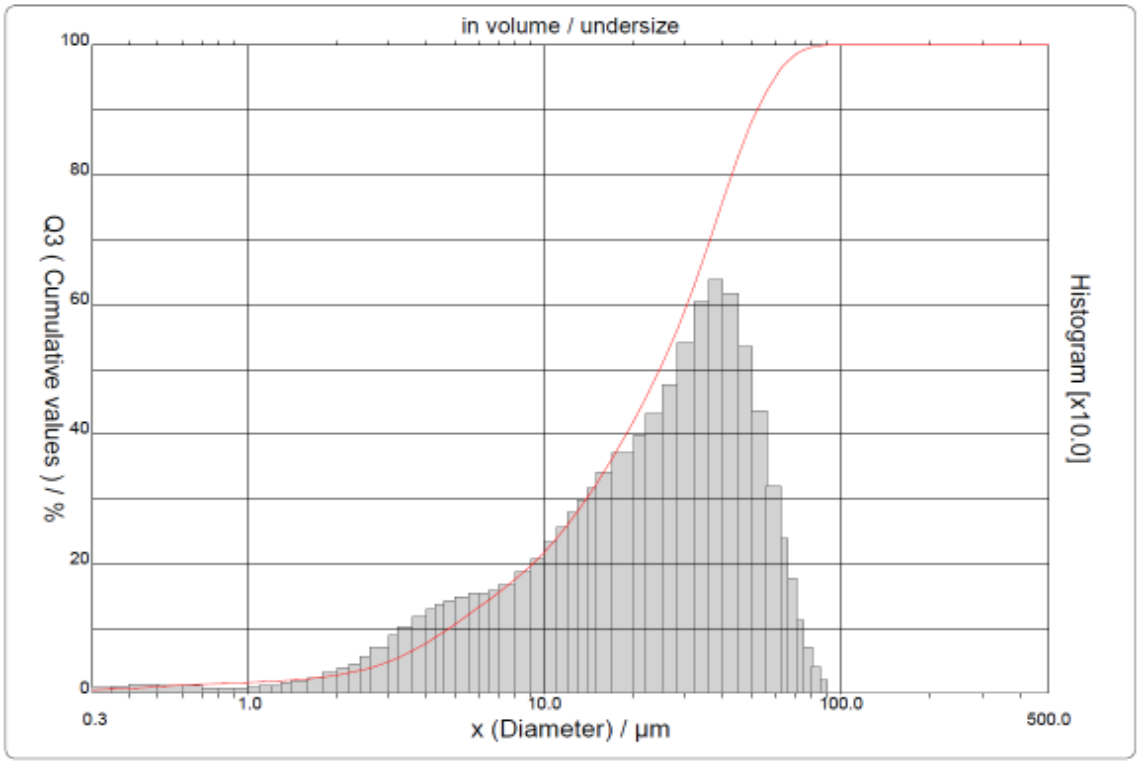

Fig. C-1 (Fe-101 - Iron Powder)

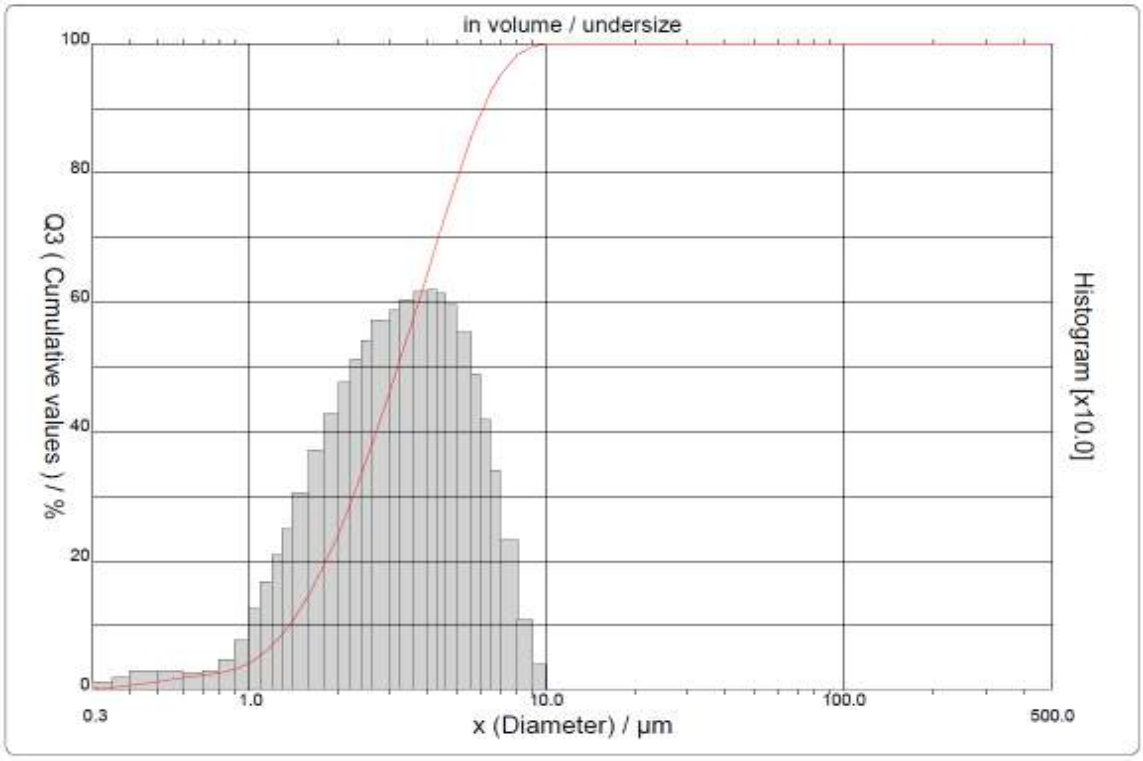

Fig. C-2 (Al-100 - Aluminum Powder)

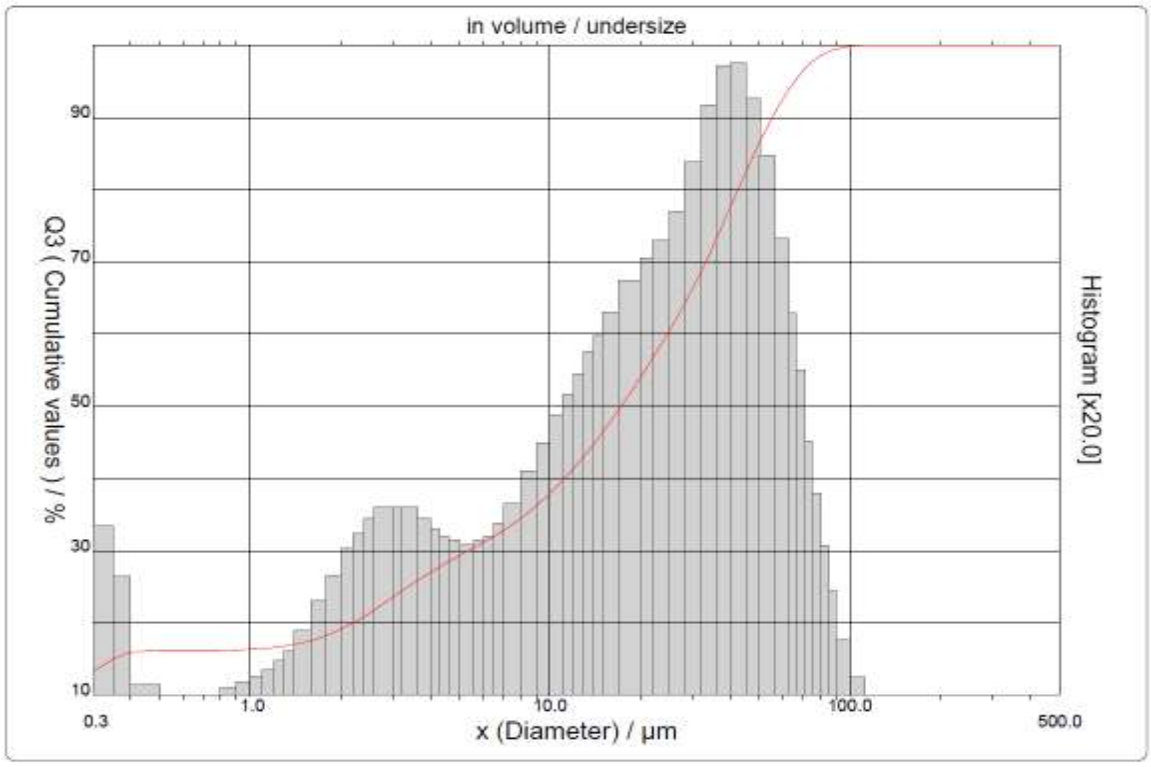

Fig. C-3 (SBC)

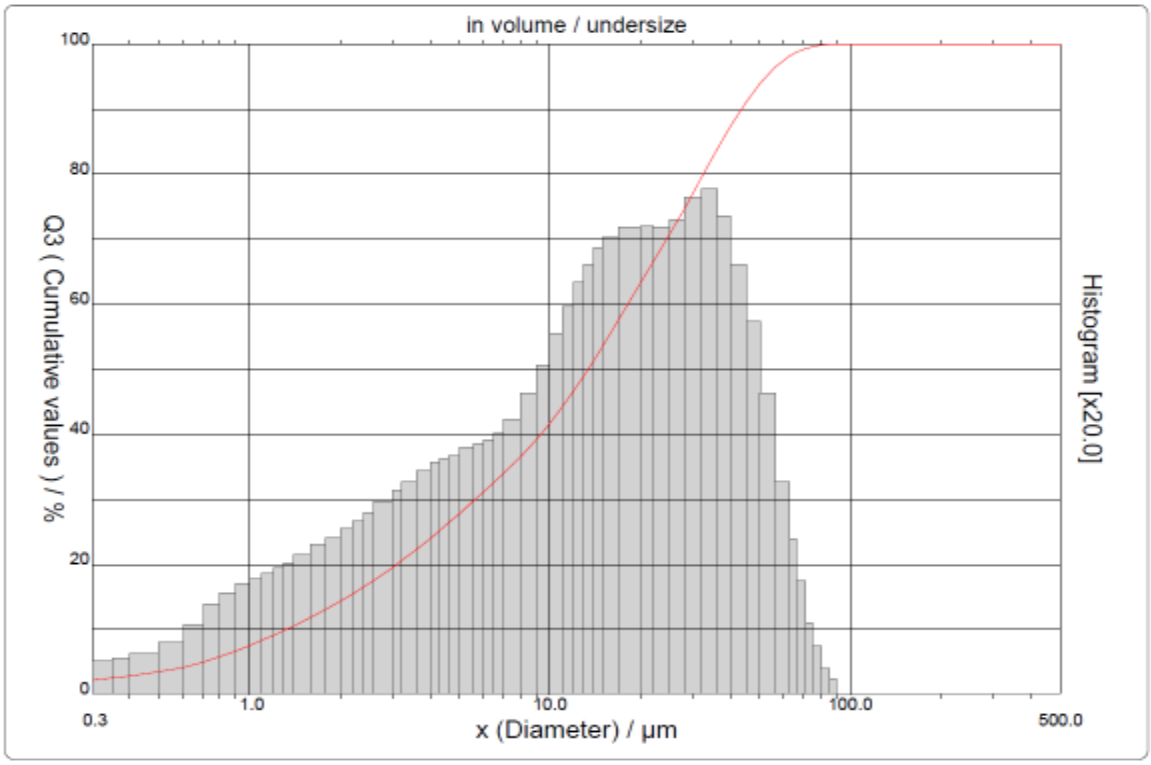

Fig. C-4 (MAP)

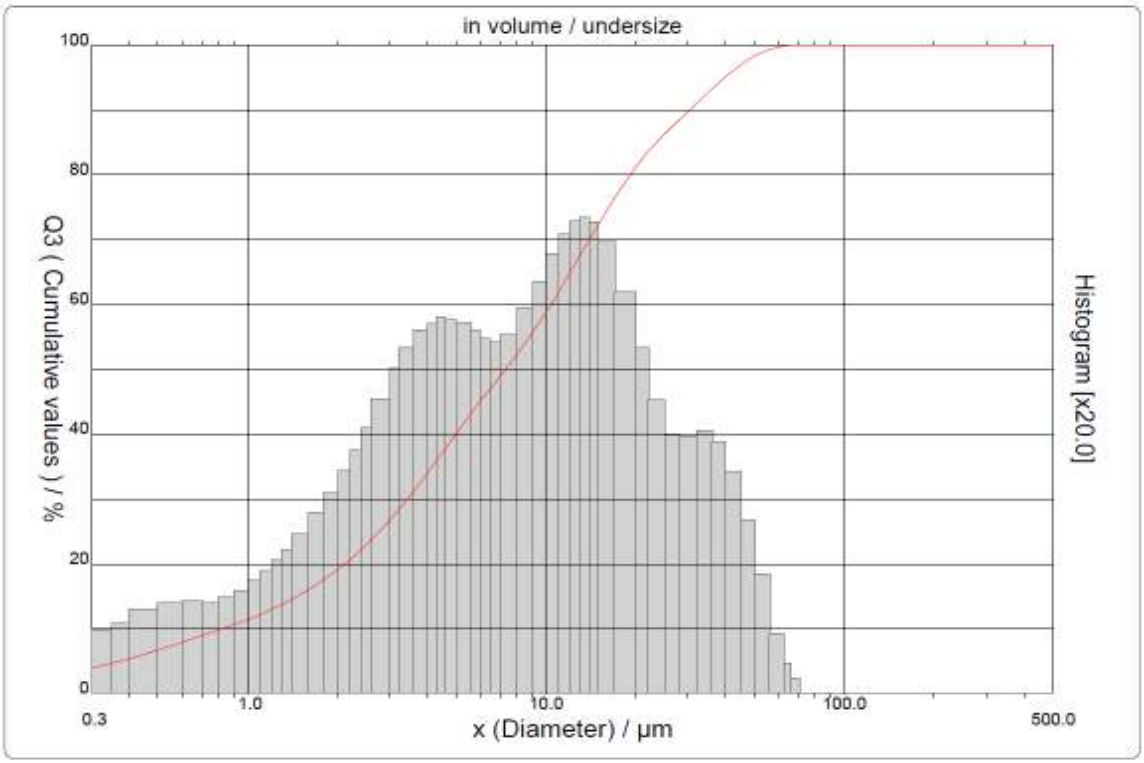

Fig. C-5 (Met-L-X)

Fuel:	Iron (Fe-101)	Aluminum (Al-100)
D10	4.76 µm	1.37 µm
D50	24.49 µm	3.18 µm
D90	52.3 µm	6.15 µm
Mean Diameter	26.86 µm	3.51 µm

Fig. C-6 (Statistical Data - Fuels)

Suppressant:	SBC	MAP	Met-L-X
D10	0.13 µm	1.33 µm	1.23 µm
D50	17.29 µm	13.42 µm	10.47 µm
D90	55.16 µm	43.47 µm	46.34 µm
Mean Diameter	23.11 µm	18.36 µm	17.63 µm

Fig. C-7 (Statistical Data – Suppressant Agents)

Suppressant Agent Evolved Gas Analysis via Mass Spectrometry (NETZSCH)

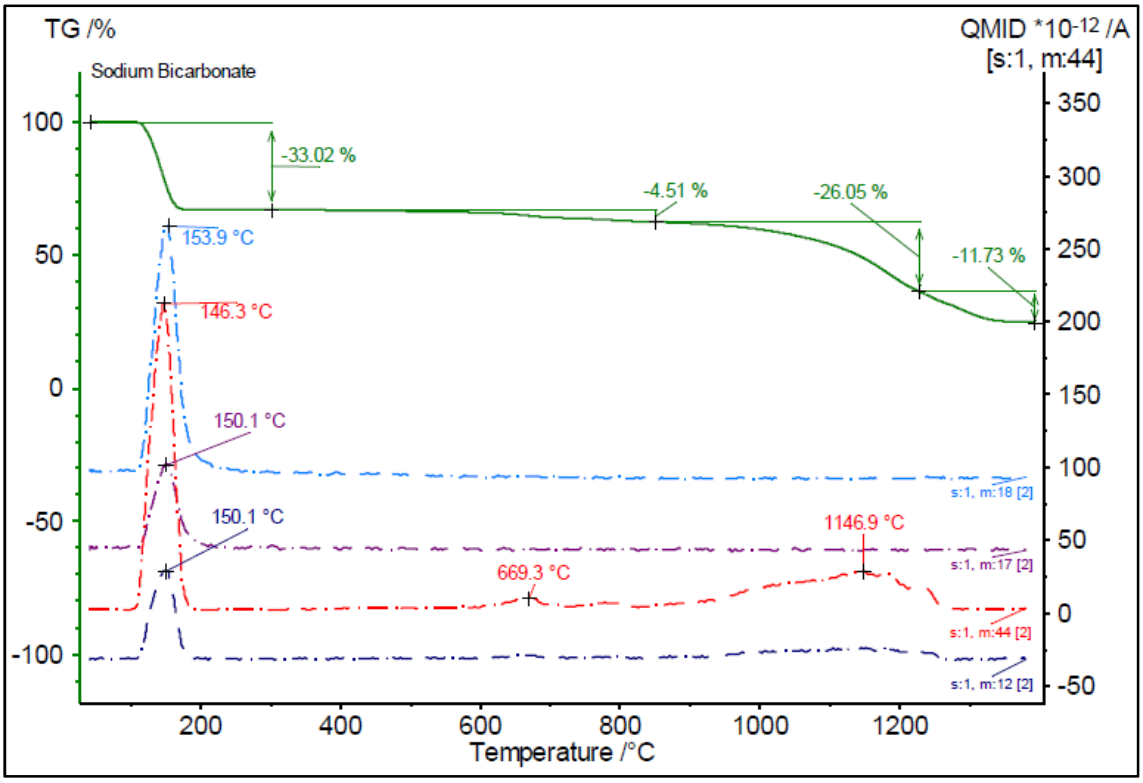

Fig. D-1 (MS Analysis – SBC, Plot 1 of 1)

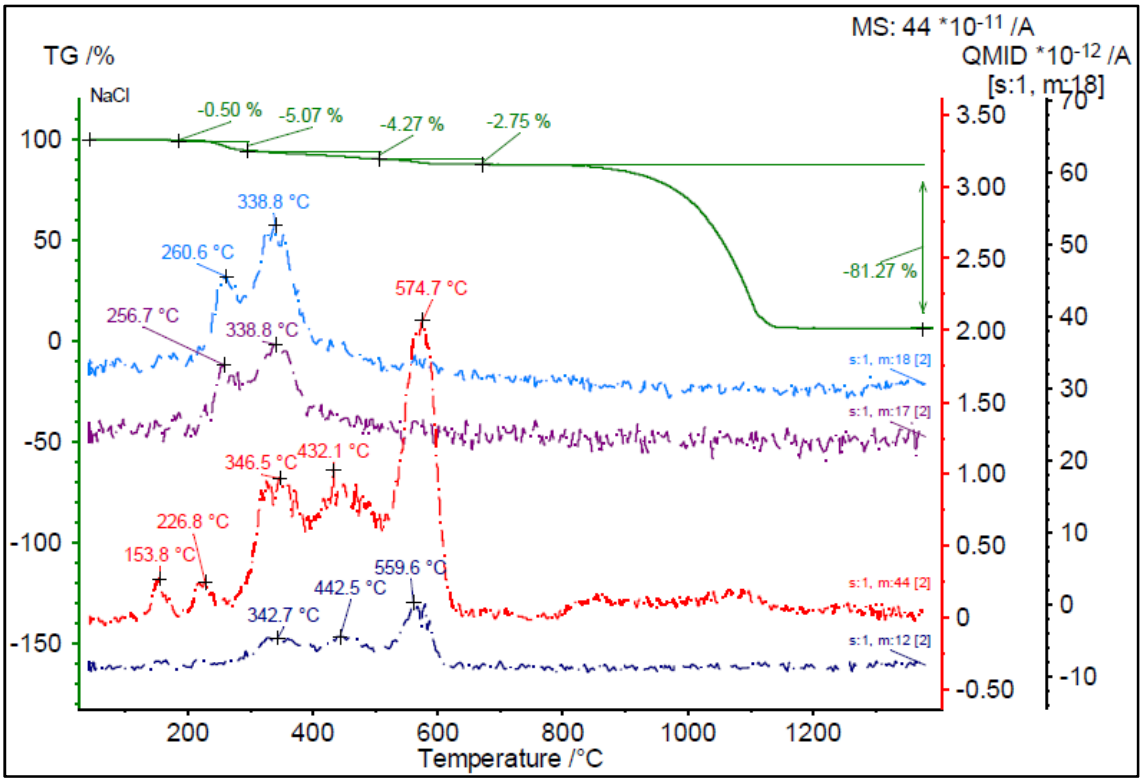

Fig. D-2 (MS Analysis – Met-L-X, Plot 1 of 3)

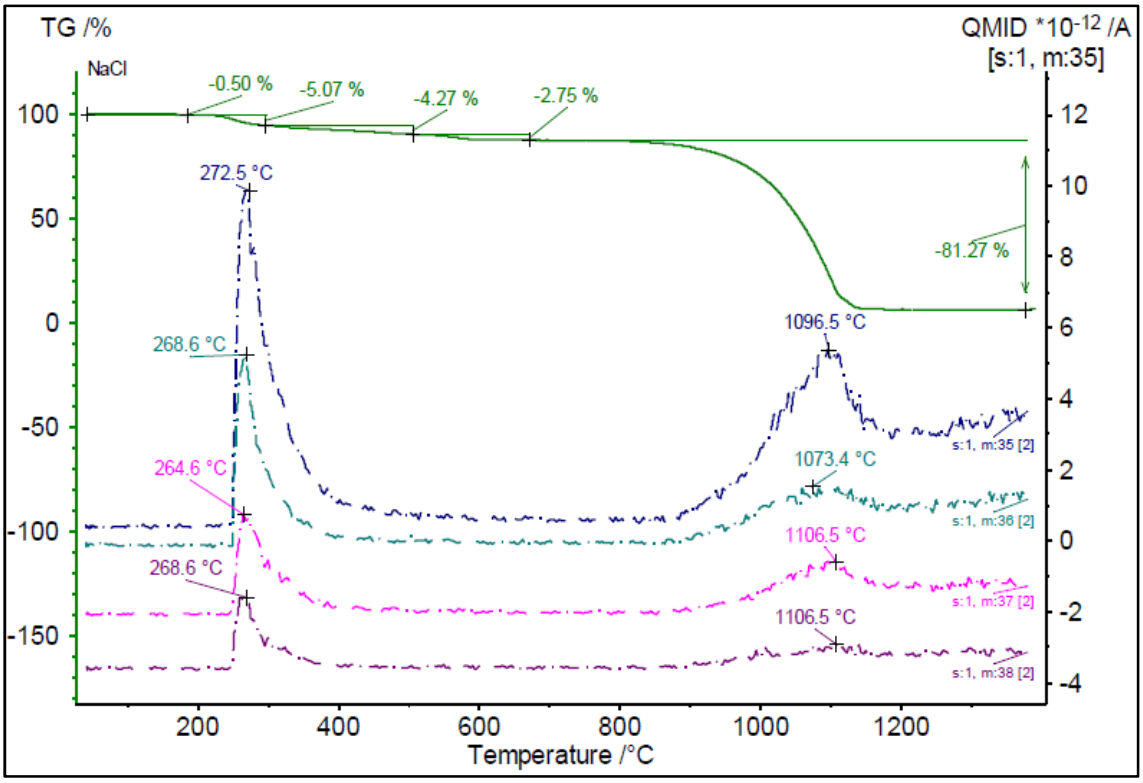

Fig. D-3 (MS Analysis – Met-L-X, Plot 2 of 3)

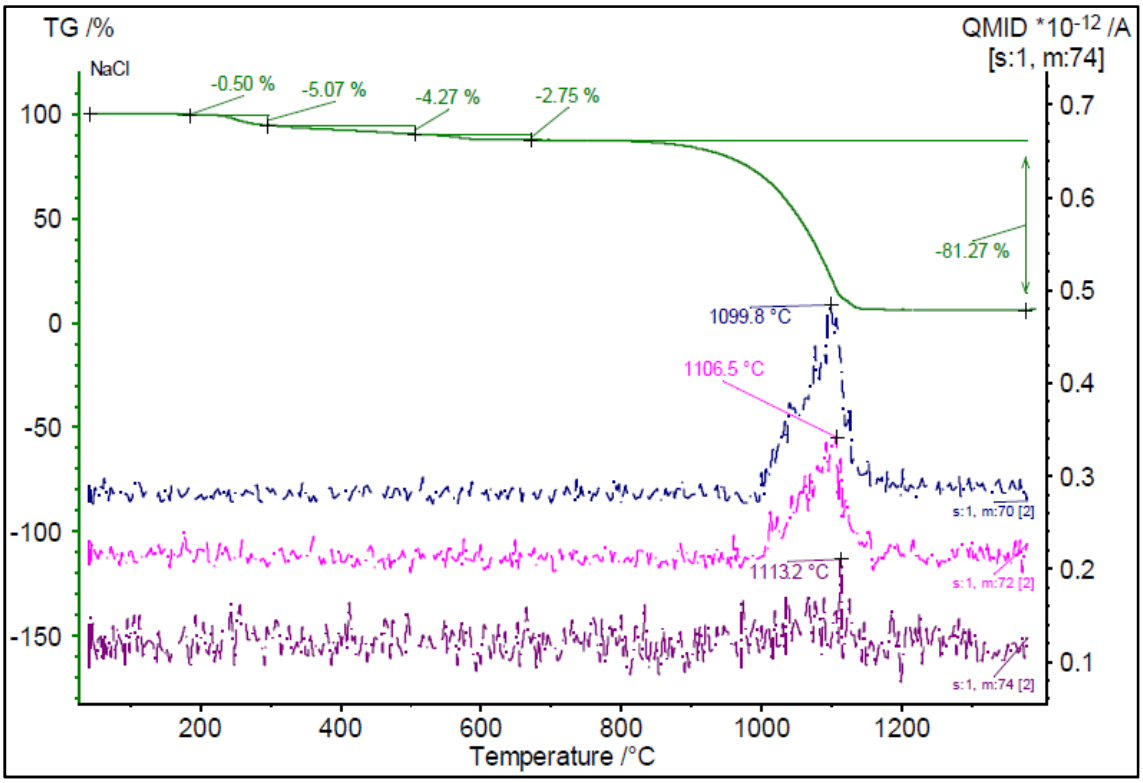

Fig. D-4 (MS Analysis – Met-L-X, Plot 3 of 3)

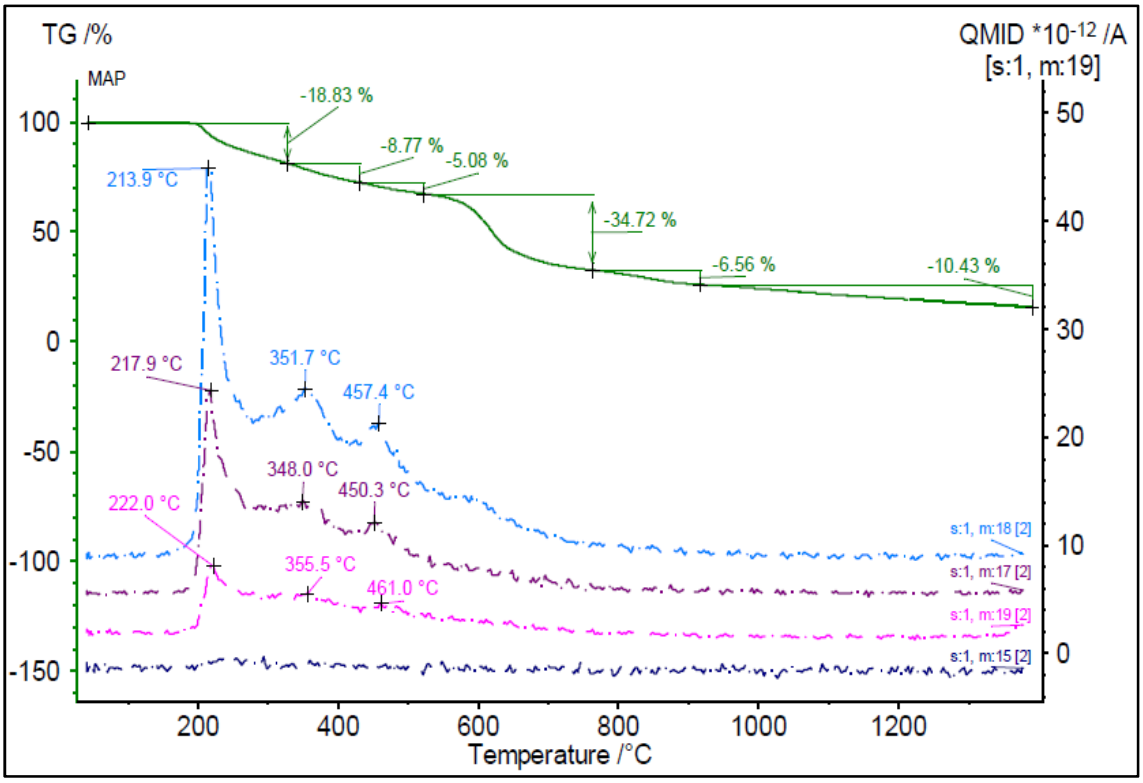

Fig. D-5 (MS Analysis – MAP, Plot 1 of 3)

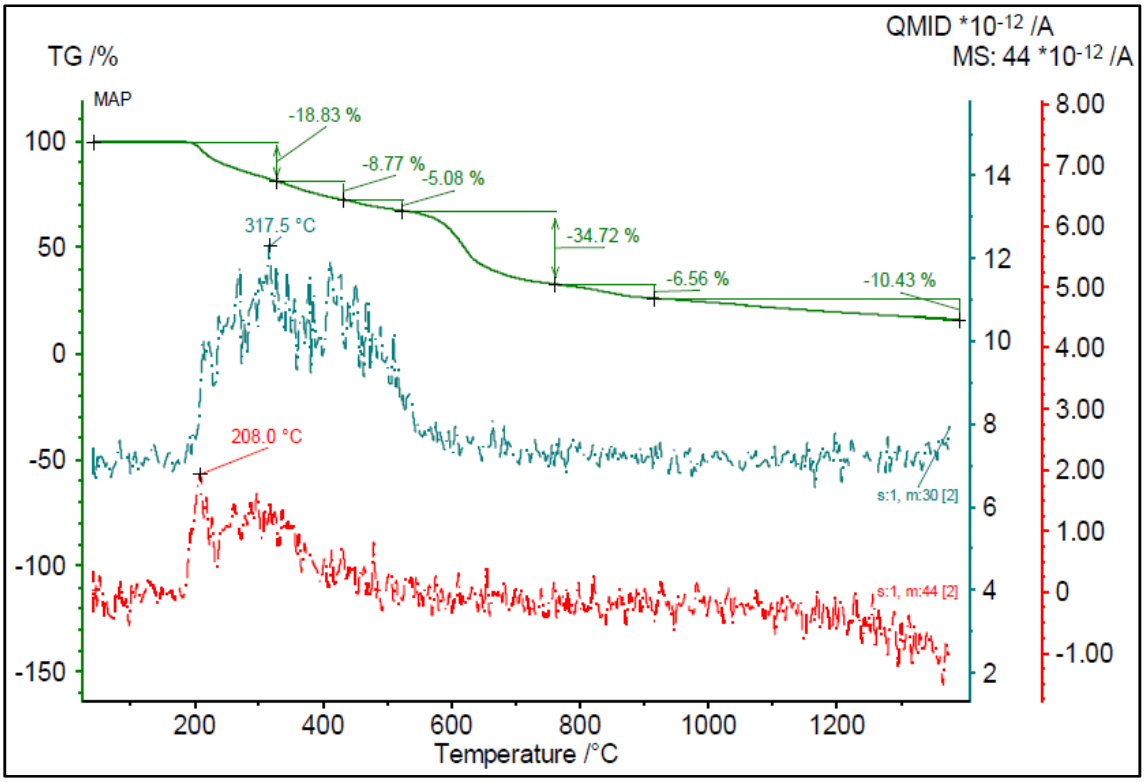

Fig. D-6 (MS Analysis – MAP, Plot 2 of 3)

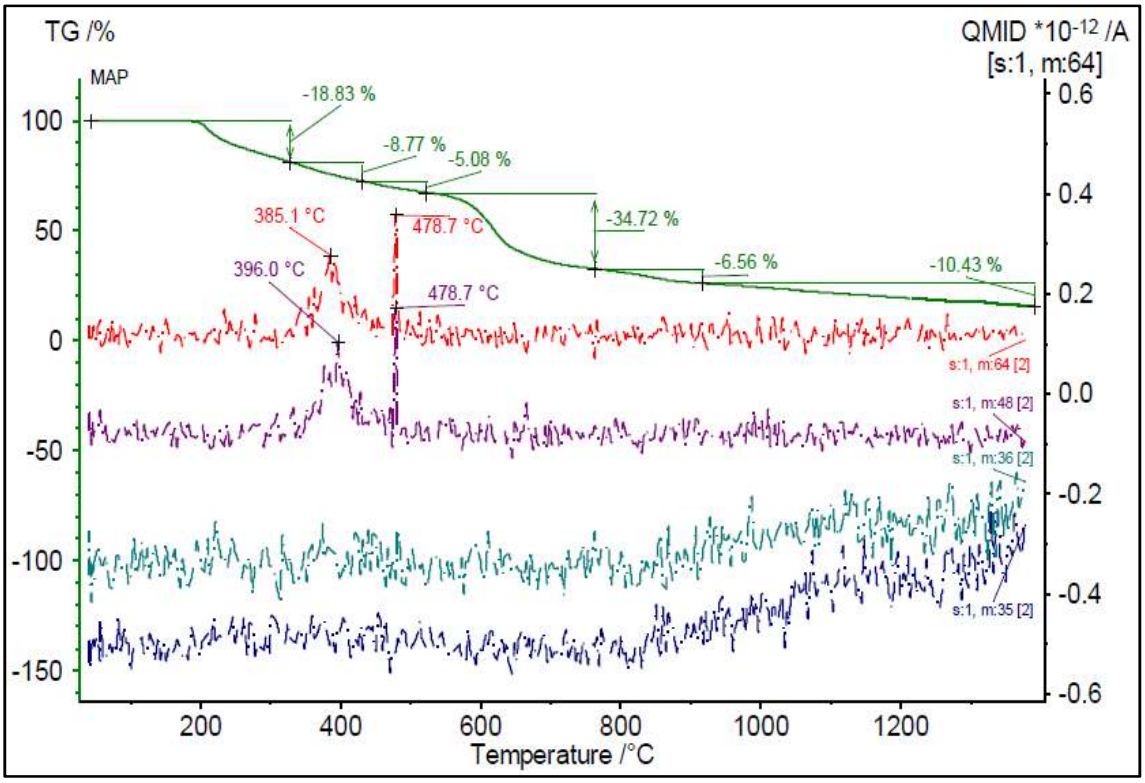

Fig. D-7 (MS Analysis – MAP, Plot 3 of 3)

Open-Air Dispersion Testing

Suppressant Material	Packed Density (kg/L)	Agent Fill Weight (kg)
SBC	1.33	9.07
Met-L-X	0.89	5.90
MAP	0.63	4.08

Table E-1 (Measured Suppressant Agent Packed Densities and Agent Fill Weights during Open-Air Dispersion Testing)

	SBC (Test 1 & 1-R1, AVG)		**Met-L-X (Test 2 & 2-R1, AVG)**		**MAP (Test 3 & 3-R1, AVG)**	
	Instantaneous Inverse Velocity	Bulk Inverse Velocity	Instantaneous Inverse Velocity	Bulk Inverse Velocity	Instantaneous Inverse Velocity	Bulk Inverse Velocity
Target Throw Distance (ft)	Inverse Velocity (ms/ft)	Inverse Velocity (ms/ft)	Inverse Velocity (ms/ft)	Inverse Velocity (ms/ft)	Inverse Velocity (ms/ft)	Inverse Velocity (ms/ft)
3	1.95	1.88	2.10	1.93	1.86	1.81
6	5.50	3.11	5.76	3.20	8.12	3.38
9	7.81	4.99	7.39	4.55	10.45	5.13
12	7.65	5.44	8.64	5.48	11.24	6.71
15	8.89	5.96	9.87	6.27	16.81	7.64

Table E-2 (Average Inverse Velocity Numerical Data)