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### APPENDIX A

## AUGER REACTOR DIAGRAM



#### APPENDIX B

# INDIVIDUAL COMPOUND SUMMARY FOR CONTROL AND AAEM PASSIVATED RED OAK

The data in the *Appendix B* is a summary of all the compounds investigated for experiments that used red oak. Please note that all yields are given in mass percentage of dry feedstock.

			Red Oa Contro	ık AAEM lk Passivated l Red Oak	Change	P-value (2-tail)
			(wt. % feedstoc	of (wt. % of k) feedstock)	(Passivated- Control) / Control	
Mass	Balance		·			
	Bio-oil		57.89%	<b>53.02%</b>	-8.4%	0.128
	Biochar		14.35%	<b>6</b> 23.79%	65.8%	0.031
		Sieved	95.72%	6 10.01%	-89.5%	0.007
		Combusted	3.11%	85.64%	2654.1%	0.030
	Non-Condensable Gas		19.29%	6 10.52%	-45.5%	0.128
		Carbon Dioxide	9.10%	4.98%	-45.3%	0.231
		Carbon Monoxide	8.44%	4.40%	-47.9%	0.329
		Light Hydrocarbons (CH4, C2H6, C2H4)	1.75%	1.15%	-34.6%	0.433

ignin Products		12.60%	6.22%	-50.6%	C
Water Insoluble Conter	1t <sup>a</sup>	9.76%	5.03%	-48.5%	C
Phenols		0.51%	0.23%	-54.1%	C
	Anisole (C7H8O) <sup>e</sup>	0.01%	0.00%	-51.7%	C
	Phenol (C6H6O) <sup>e</sup>	0.03%	0.03%	-12.7%	C
	2-methylphenol (C7H8O) <sup>e</sup>	0.04%	0.01%	-59.3%	6
	2,6-dimethylphenol (C8H10O) <sup>e</sup>	0.05%	0.02%	-60.5%	6
	4-methylphenol (C7H8O) <sup>e</sup>	0.09%	0.02%	-76.9%	C

		Red Oak Control	AAEM Passivated Red Oak	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	2,5-dimethylphenol (C8H10O) <sup>e</sup>	0.03%	0.01%	-73.0%	0.002
	2,3-dimethylphenol (C8H10O) <sup>e</sup>	0.03%	0.01%	-79.6%	0.002
	3,5-dimethylphenol (C8H10O) <sup>e</sup>	0.01%	0.00%	-74.1%	0.001
	3-ethylphenol (C8H10O) <sup>e</sup>	0.00%	0.00%	-15.5%	0.042
	4-ethylphenol (C8H10O) <sup>e</sup>	0.02%	0.00%	-72.3%	0.001
	3,4-dimethylphenol (C8H10O) <sup>e</sup>	0.05%	0.04%	-17.7%	0.005
	Phenolic Derivative 1 (C9H8O)**e	0.02%	0.01%	-66.3%	0.001
	4-vinylphenol (C8H8O) <sup>e</sup>	0.01%	0.01%	58.9%	0.002
	1,2-dihydroxybenzene (C6H6O2) <sup>e</sup>	0.06%	0.02%	-67.4%	0.000
	1,4-dihydroxybenzene (C6H6O2)°	0.06%	0.03%	-41.8%	0.001
	1,3-dihydroxybenzene (C6H6O2)°	0.01%	0.01%	-11.1%	0.005
Guaiacols		0.85%	0.47%	-45.3%	0.001
	2-methoxyphenol (C7H8O2) <sup>e</sup>	0.11%	0.05%	-53.3%	0.001
	2-methoxy-4-methylphenol (C8H10O2) <sup>e</sup>	0.10%	0.03%	-72.6%	0.001
	4-ethyl-2-methoxyphenol (C9H12O2) <sup>e</sup>	0.03%	0.01%	-77.6%	0.001
	2-methoxy-4-vinylphenol (C9H10O2)°	0.11%	0.15%	40.4%	0.007
	4-(2-propenyl)-2-methoxyphenol (C10H12O2) <sup>e</sup>	0.03%	0.00%	-88.0%	0.001
	2-methoxy-4-propylphenol (C10H14O2) <sup>e</sup>	0.02%	0.01%	-61.2%	0.001

		Red Oak Control	AAEM Passivated Red Oak	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	4-(1-propenyl)-2-methoxyphenol (isomer) (C10H12O2) <sup>e</sup>	0.03%	0.01%	-76.7%	0.001
	3-methoxy-5-methylphenol (C8H10O2) <sup>e</sup>	0.01%	0.01%	-23.7%	0.003
	4-(1-propenyl)-2-methoxyphenol (isomer)(C10H12O2) <sup>e</sup>	0.11%	0.01%	-91.1%	0.001
	4-hydroxy-3-methoxybenzaldehyde (C8H8O3)°	0.07%	0.05%	-25.9%	0.004
	2-methoxy-4-methyl-6-propenylphenol (C11H14O2)*e	0.02%	0.00%	-79.8%	0.000
	2-(4-hydroxy-3-methoxyphenyl)acetaldehyde (C9H10O3)*e	0.04%	0.07%	77.6%	0.007
	1-(4-hydroxy-3-methoxyphenyl)ethanone (C9H10O3)*e	0.08%	0.02%	-76.4%	0.001
	4-hydroxy-3-methoxyphenylacetone (C10H12O3) <sup>e</sup>	0.04%	0.02%	-44.8%	0.004
	4-(3-hydroxy-1-propenyl)-2-methoxyphenol (C10H12O3)e	0.01%	0.01%	0.7%	0.530
	4-hydroxy-3-methoxycinnamaldehyde (C10H10O3) <sup>e</sup>	0.05%	0.03%	-37.1%	0.008
	3-(4-hydroxy-3-methoxyphenyl)-2-propenal (isomer) (C10H10O3)*e	0.01%	0.00%	-94.6%	0.001
Syringols		1.47%	0.49%	-66.6%	0.001
	2,6-dimethoxyphenol (C8H10O3) <sup>e</sup>	0.31%	0.16%	-48.7%	0.004
	2,6-dimethoxy-4-methylphenol (C9H12O3) <sup>e</sup>	0.22%	0.08%	-64.7%	0.003
	2,6-dimethoxy-4-ethylphenol (C10H14O3)*e	0.08%	0.02%	-70.0%	0.002
	2,6-dimethoxy-4-vinylphenol (C10H12O3)*e	0.19%	0.04%	-81.3%	0.002
	4-(2-propenyl)-2,6-dimethoxyphenol (C11H14O3)e	0.11%	0.02%	-85.8%	0.002
	4-(1-propenyl)-2,6-dimethoxyphenol (isomer 1) (C11H14O3)*e	0.07%	0.01%	-86.5%	0.001

			Red Oak Control	AAEM Passivated Red Oak	Change	P-value (2-tail)
			(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
		4-(1-propenyl)-2,6-dimethoxyphenol (isomer 2) (C11H14O3)*e	0.24%	0.01%	-95.2%	0.002
		3,5-dimethoxy-4-hydroxybenzaldehyde (C9H10O4) <sup>e</sup>	0.05%	0.02%	-54.1%	0.003
		2-(4-hydroxy-3,5-dimethoxyphenyl)acetaldehyde (C9H10O3)*e	0.03%	0.05%	100.8%	0.010
		3,5-dimethoxy-4-hydroxyacetophenone (C10H12O4) <sup>e</sup>	0.08%	0.04%	-50.3%	0.004
		3,5-dimethoxy-4-hydroxyacetophenone (isomer) (C10H12O4)*e	0.03%	0.02%	-15.0%	0.050
		4-(3-hydroxy-1-propenyl)-2,6-dimethoxyphenol (C11H14O4)e	0.02%	0.00%	-78.6%	0.002
		3-(4-hydroxy-3,5-dimethoxyphenyl)-prop-2-enal (C11H12O4)°	0.05%	0.01%	-70.3%	0.003
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	Carbohydrate Products					
	Sugars		6.08%	17.01%	179.6%	0.032
	Anhydrosugars		5.20%	15.42%	196.4%	0.035
		Cellobiosan <sup>e</sup>	0.57%	0.98%	71.9%	0.233
		Galactose <sup>c</sup>	1.02%	2.17%	112.2%	0.114
		Levoglucosan <sup>e</sup>	2.64%	11.00%	316.0%	0.036
		Levoglucosan-Furanose <sup>e</sup>	0.02%	0.52%	2772.9%	0.056

0.94%

0.11%

0.03%

0.74%

0.33%

0.01%

-21.0%

202.9%

-51.6%

0.335

0.002

0.002

Xylosan<sup>c</sup>

Levoglucosenone (C6H6O3)e

Levoglucosan Dehydration Products

		Red Oak Control	AAEM Passivated Red Oak	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	1,4:3,6-dianhydro-a-D-glucopyranose (C6H8O4) <sup>e</sup>	0.08%	0.31%	301.2%	0.002
Unknown Anhydrosugar Derivat	ives	0.77%	1.26%	63.4%	0.002
	Carbohydrate Derivative 2 (C5H8O3)***	0.14%	0.01%	-92.7%	0.001
	Carbohydrate Derivative 3 (C5H6O3)***	0.08%	0.02%	-77.5%	0.002
	Carbohydrate Derivative 4 (C6H8O3)***	0.06%	0.03%	-56.0%	0.008
	Carbohydrate Derivative 5 (C6H8O4)**e	0.06%	0.01%	-87.2%	0.002
	Carbohydrate Derivative 6 (C6H8O4)**e	0.03%	0.01%	-55.0%	0.013
	Carbohydrate Derivative 7 (C6H8O3)***	0.10%	0.03%	-68.3%	0.003
	Carbohydrate Derivative 8 (C7H10O5)***	0.01%	0.26%	4782.7%	0.003
	Carbohydrate Derivative 9 (C7H10O5)***	0.09%	0.49%	449.5%	0.002
	Carbohydrate Derivative 10 (C6H8O4)**e	0.11%	0.11%	-4.8%	0.040
	Carbohydrate Derivative 11 (C9H12O6)**e	0.02%	0.18%	666.6%	0.002
	Carbohydrate Derivative 12 (C8H12O6)**e	0.01%	0.03%	179.8%	0.006
	Carbohydrate Derivative 13 (C6H12O6)**e	0.06%	0.08%	40.2%	0.011
arbohydrate Dehydration Products		2.93%	1.55%	-47.0%	0.001
Cyclopentanes		0.66%	0.19%	-71.0%	0.000
	2-methyl-2-cyclopenten-1-one (C6H8O) <sup>e</sup>	0.01%	0.00%	-95.2%	0.008
	2-hydroxy-2-cyclopenten-1-one (C5H6O2)*e	0.44%	0.12%	-72.4%	0.001

		Red Oak Control	AAEM Passivated Red Oak	Change	
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	3-methyl-2-cyclopenten-1-one (C6H8O) <sup>e</sup>	0.02%	0.01%	-23.9%	
	3-methyl-1,2-cyclopentanedione (C6H8O2) <sup>e</sup>	0.19%	0.06%	-70.5%	
Furans		0.79%	0.92%	16.3%	
	2-methylfuran (C5H6O) <sup>e</sup>	0.10%	0.04%	-56.9%	
	2-furaldehyde (C5H4O2) <sup>e</sup>	0.34%	0.58%	72.1%	
	2-furanmethanol (C5H6O2) <sup>e</sup>	0.04%	0.06%	28.2%	
	5-methyl-2-furaldehyde (C6H6O2) <sup>e</sup>	0.09%	0.04%	-50.4%	
	3-furanmethanol (C5H6O2) <sup>e</sup>	0.05%	0.06%	37.1%	
	5-(hydroxymethyl)-2-furaldehyde (C6H6O3) <sup>e</sup>	0.17%	0.12%	-26.9%	
Lactones		0.54%	0.13%	-75.3%	
	dihydro-2(3H)-Furanone (C4H6O2)*e	0.10%	0.03%	-71.0%	
	2(5H)Furanone (C4H4O2)°	0.28%	0.05%	-82.0%	
	5-methyl-2(5H)-Furanone (C5H6O2)*e	0.04%	0.02%	-52.4%	
	3-methyl-2(5H)-furanone (C5H6O2) <sup>e</sup>	0.05%	0.01%	-74.4%	
	4-hydroxy-5-methyl-3-furanone (C5H6O3) <sup>e</sup>	0.01%	0.01%	-27.8%	
	4-methyl-5H-furan-2-one (C5H6O2)*e	0.06%	0.02%	-73.8%	
Misc. Furans		0.38%	0.18%	-53.1%	
	Furan Derivative 3 (C5H4O)**	0.01%	0.00%	-72.9%	

			Red Oak Control	AAEM Passivated Red Oak	Change	P-value (2-tail)
			(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
		Furan Derivative 1 (C5H6O2)**e	0.02%	0.01%	-51.8%	0.001
		Furan Derivative 2 (C6H6O2)**e	0.03%	0.02%	-32.3%	0.005
		Furan Derivative 4 (C6H8O)**e	0.03%	0.01%	-70.7%	0.002
		Furan Derivative 16A (C5H6O3)**e	0.28%	0.13%	-53.4%	0.002
	Pyrans		0.05%	0.05%	-8.0%	0.050
		Carbohydrate Derivative 1 (C5H8O3)***	0.03%	0.03%	-2.0%	0.282
		2H-Pyran-2-one (C5H4O2) <sup>e</sup>	0.02%	0.01%	-19.0%	0.009
	Tetrahydrofurans		0.52%	0.09%	-82.7%	0.001
		2,5-dimethoxytetrahydrofuran (isomer) (C6H12O3) <sup>e</sup>	0.22%	0.03%	-84.5%	0.001
		2,5-dimethoxytetrahydrofuran (isomer) (C6H12O3) <sup>e</sup>	0.25%	0.04%	-82.6%	0.001
		(S)-(+)-3-hydroxytetrahydrofuran (C4H8O2)°	0.06%	0.01%	-77.0%	0.002
Т	otal Sugars		7.76%	15.88%	104.5%	0.018
	Xylose Hydrolyzable Sugars <sup>b</sup>		1.26%	3.25%	157.3%	0.033
	Glucose Hydrolyzable Sugars <sup>b</sup>		4.66%	12.63%	170.9%	0.011
	Sorbitol Hydrolyzable Sugars <sup>b</sup>		1.84%	0.00%	-100.0%	0.053
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L	ight Oxygenates		7.76%	4.21%	-45.8%	0.039
	Alcohols		0.30%	0.34%	16.0%	0.002

		Red Oak Control	AAEM Passivated Red Oak	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	Methanol (CH4O) <sup>f</sup>	0.24%	0.29%	20.4%	0.002
	Ethanol (C2H6O) <sup>f</sup>	0.04%	0.04%	-0.8%	0.023
	2-Propanol (C3H8O) <sup>f</sup>	0.01%	0.00%	-45.7%	0.012
	1-Propanol (C3H8O) <sup>f</sup>	0.01%	0.01%	3.1%	0.076
Aldehydes		1.06%	0.47%	-55.5%	0.005
	Acetaldehyde (C2H4O) <sup>f</sup>	0.02%	0.02%	-12.6%	0.016
	Glycolaldehyde (C2H4O2)*e	1.04%	0.45%	-56.5%	0.005
Carboxylic Acids		4.93%	3.08%	-37.5%	0.075
	Acetic Acid <sup>g</sup>	3.63%	2.57%	-29.3%	0.120
	Butanoic Acide	0.06%	0.02%	-64.8%	0.217
	Formic Acid <sup>g</sup>	0.62%	0.17%	-72.0%	0.034
	Glycolic Acid <sup>g</sup>	0.39%	0.14%	-65.4%	0.183
	Proponoic Acid <sup>g</sup>	0.23%	0.18%	-20.4%	0.203
Misc. Light Oxygenates		1.47%	0.31%	-78.9%	0.001
	Acetone (C3H6O) <sup>f</sup>	0.03%	0.05%	110.8%	0.003
	2,3-butanedione (C4H6O2) <sup>e</sup>	0.09%	0.05%	-48.8%	0.005
	Hydroxyacetone (C3H6O2) <sup>e</sup>	0.81%	0.12%	-84.8%	0.001
	1-hydroxy-2-butanone (C4H8O2) <sup>e</sup>	0.08%	0.02%	-75.5%	0.004

		Red Oak Control	AAEM Passivated Red Oak	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	Light Oxygenate 1 (C4H6O3)**e	0.20%	0.03%	-87.4%	0.003
	Light Oxygenate 2 (C4H6O3)**e	0.12%	0.01%	-87.7%	0.001
	Light Oxygenate 3 (C6H10O2)**e	0.06%	0.01%	-89.3%	0.002
	Acetoxyacetone (C5H8O3) <sup>e</sup>	0.07%	0.02%	-73.2%	0.001
	Reaction Water <sup>a</sup>	12.78%	15.52%	21.5%	0.164
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Total Bio-oil Accounted	68.78%	82.15%	

- \*- Identified via GC/MS
- \*\* Molecular formula determine via GC-TOF
- <sup>a</sup> Karl Fischer Titration
- <sup>b</sup> Acid Hydrolysis HPLC
- ° Water Soluble Sugar Analysis
- <sup>d</sup> Water Insoluble Analysis
- e GC/FID
- <sup>f</sup> GC/FID Low Boiling Compounds Method
- g Ion Chromatography

### APPENDIX C

### INDIVIDUAL COMPOUND SUMMARY FOR CONTROL AND AAEM PASSIVATED SWITCHGRASS

The data in the *Appendix C* is a summary of all the compounds investigated for experiments with switchgrass. Please note that all yields are given in mass percentage of dry feedstock.

			Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
			(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
Mass	Balance					
	Bio-oil		54.29%	56.70%	4.4%	0.266
	Biochar		21.20%	27.58%	30.1%	0.123
		Sieved	96.88%	50.32%	-48.1%	0.017
		Combusted	3.13%	49.68%	1489.8%	0.017
	Non-Condensable Gas		13.20%	7.19%	-45.6%	0.040
		Carbon Dioxide	8.28%	4.90%	-40.8%	0.094
		Carbon Monoxide	4.10%	1.92%	-53.1%	0.048
		Light Hydrocarbons (CH4, C2H6, C2H4)	0.82%	0.36%	-55.8%	0.121

oil Composition					
Lignin Products		11.42%	8.96%	-21.6%	0.087
Water Insoluble Content	ęd	9.00%	7.73%	-14.1%	0.167
Phenols		1.06%	0.39%	-63.5%	0.001
	Anisole (C7H8O) <sup>e</sup>	0.01%	0.00%	-78.0%	0.005
	Phenol (C6H6O) <sup>e</sup>	0.10%	0.05%	-49.3%	0.001
	2-methylphenol (C7H8O) <sup>e</sup>	0.05%	0.01%	-81.0%	0.001
	2,6-dimethylphenol (C8H10O)e	0.06%	0.02%	-67.3%	0.001
	4-methylphenol (C7H8O) <sup>e</sup>	0.10%	0.03%	-71.8%	0.001
1					

		Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	2,5-dimethylphenol (C8H10O) <sup>e</sup>	0.03%	0.01%	-69.5%	0.001
	2,3-dimethylphenol (C8H10O) <sup>e</sup>	0.03%	0.02%	-33.3%	0.006
	3,5-dimethylphenol (C8H10O) <sup>e</sup>	0.01%	0.00%	-58.4%	0.003
	3-ethylphenol (C8H10O) <sup>e</sup>	0.10%	0.04%	-62.2%	0.001
	4-ethylphenol (C8H10O) <sup>e</sup>	0.00%	0.01%	239.3%	0.006
	3,4-dimethylphenol (C8H10O) <sup>e</sup>	0.06%	0.01%	-88.1%	0.001
	Phenolic Derivative 1 (C9H8O)**e	0.02%	0.02%	0.7%	0.238
	4-vinylphenol (C8H8O) <sup>e</sup>	0.40%	0.11%	-72.0%	0.001
	1,2-dihydroxybenzene (C6H6O2) <sup>e</sup>	0.03%	0.02%	-30.2%	0.009
	1,4-dihydroxybenzene (C6H6O2)°	0.05%	0.04%	-35.1%	0.002
	1,3-dihydroxybenzene (C6H6O2) <sup>e</sup>	0.01%	0.00%	-69.5%	0.000
Guaiacols		0.90%	0.57%	-36.4%	0.002
	2-methoxyphenol (C7H8O2)°	0.14%	0.08%	-38.7%	0.002
	2-methoxy-4-methylphenol (C8H10O2) <sup>e</sup>	0.08%	0.09%	18.0%	0.015
	4-ethyl-2-methoxyphenol (C9H12O2) <sup>e</sup>	0.04%	0.02%	-39.9%	0.002
	2-methoxy-4-vinylphenol (C9H10O2) <sup>e</sup>	0.29%	0.16%	-44.8%	0.003
	4-(2-propenyl)-2-methoxyphenol (C10H12O2) <sup>e</sup>	0.03%	0.01%	-77.5%	0.002
	2-methoxy-4-propylphenol (C10H14O2) <sup>e</sup>	0.02%	0.00%	-70.9%	0.001

		Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	4-(1-propenyl)-2-methoxyphenol (isomer) (C10H12O2) <sup>e</sup>	0.02%	0.03%	36.5%	0.036
	3-methoxy-5-methylphenol (C8H10O2) <sup>e</sup>	0.01%	0.00%	-42.6%	0.005
	4-(1-propenyl)-2-methoxyphenol (isomer)(C10H12O2)e	0.08%	0.01%	-84.0%	0.001
	4-hydroxy-3-methoxybenzaldehyde (C8H8O3)e	0.06%	0.04%	-40.5%	0.002
	2-methoxy-4-methyl-6-propenylphenol (C11H14O2)*e	0.01%	0.00%	-72.1%	0.006
	2-(4-hydroxy-3-methoxyphenyl)acetaldehyde (C9H10O3)*e	0.01%	0.02%	30.1%	0.003
	1-(4-hydroxy-3-methoxyphenyl)ethanone (C9H10O3)*e	0.06%	0.02%	-66.3%	0.000
	4-hydroxy-3-methoxyphenylacetone (C10H12O3) <sup>e</sup>	0.03%	0.04%	45.8%	0.001
	4-(3-hydroxy-1-propenyl)-2-methoxyphenol (C10H12O3) <sup>e</sup>	0.00%	0.01%	106.2%	0.000
	4-hydroxy-3-methoxycinnamaldehyde (C10H10O3) <sup>e</sup>	0.02%	0.03%	71.6%	0.001
	3-(4-hydroxy-3-methoxyphenyl)-2-propenal (isomer) (C10H10O3)*e	0.01%	0.00%	-100.0%	0.004
Syringols		0.45%	0.26%	-41.8%	0.001
	2,6-dimethoxyphenol (C8H10O3) <sup>e</sup>	0.12%	0.08%	-30.7%	0.001
	2,6-dimethoxy-4-methylphenol (C9H12O3) <sup>e</sup>	0.05%	0.04%	-16.4%	0.008
	2,6-dimethoxy-4-ethylphenol (C10H14O3)*e	0.03%	0.01%	-60.3%	0.001
	2,6-dimethoxy-4-vinylphenol (C10H12O3)*e	0.06%	0.01%	-88.6%	0.000
	4-(2-propenyl)-2,6-dimethoxyphenol (C11H14O3) <sup>e</sup>	0.03%	0.01%	-62.5%	0.001
	4-(1-propenyl)-2,6-dimethoxyphenol (isomer 1) (C11H14O3)*°	0.02%	0.02%	-23.7%	0.002

			Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
			(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
		4-(1-propenyl)-2,6-dimethoxyphenol (isomer 2) (C11H14O3)*e	0.07%	0.02%	-78.1%	0.001
		3,5-dimethoxy-4-hydroxybenzaldehyde (C9H10O4)e	0.02%	0.03%	33.3%	0.031
		2-(4-hydroxy-3,5-dimethoxyphenyl)acetaldehyde (C9H10O3)*e	0.00%	0.01%	206.8%	0.013
		3,5-dimethoxy-4-hydroxyacetophenone (C10H12O4)e	0.02%	0.02%	-16.0%	0.004
		3,5-dimethoxy-4-hydroxyacetophenone (isomer) (C10H12O4)*e	0.01%	0.01%	28.1%	0.018
		4-(3-hydroxy-1-propenyl)-2,6-dimethoxyphenol (C11H14O4)e	0.01%	0.00%	-72.5%	0.002
		3-(4-hydroxy-3,5-dimethoxyphenyl)-prop-2-enal (C11H12O4) <sup>e</sup>	0.01%	0.00%	-48.5%	0.010
(	Carbohydrate Products					
Ś	Sugars		4.37%	13.05%	198.5%	0.047
	Anhydrosugars		3.49%	11.75%	236.4%	0.050
		Cellobiosan <sup>e</sup>	0.25%	0.93%	271.1%	0.051
		Galactose <sup>c</sup>	0.60%	1.64%	170.5%	0.138
		Levoglucosan <sup>c</sup>	1.70%	8.30%	388.2%	0.057
		Levoglucosan-Furanose <sup>e</sup>	0.02%	0.33%	1260.3%	0.067

Xylosan<sup>c</sup>

Levoglucosenone (C6H6O3)e

Levoglucosan Dehydration Products

0.169

0.001

0.003

-39.4%

414.9%

385.3%

0.55%

0.67%

0.11%

0.91%

0.13%

0.02%

			Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
			(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
		1,4:3,6-dianhydro-a-D-glucopyranose (C6H8O4)e	0.11%	0.55%	421.5%	0.000
	Unknown Anhydrosugar Derivatives		0.75%	0.63%	-16.2%	0.004
		Carbohydrate Derivative 2 (C5H8O3)**e	0.17%	0.06%	-64.0%	0.003
		Carbohydrate Derivative 3 (C5H6O3)**e	0.07%	0.01%	-90.1%	0.001
		Carbohydrate Derivative 4 (C6H8O3)**e	0.05%	0.05%	5.5%	0.063
		Carbohydrate Derivative 5 (C6H8O4)**e	0.04%	0.00%	-93.5%	0.001
		Carbohydrate Derivative 6 (C6H8O4)**e	0.06%	0.07%	24.7%	0.008
		Carbohydrate Derivative 7 (C6H8O3)**e	0.11%	0.01%	-94.8%	0.002
		Carbohydrate Derivative 8 (C7H10O5)**e	0.02%	0.00%	-80.9%	0.005
		Carbohydrate Derivative 9 (C7H10O5)**e	0.09%	0.08%	-12.2%	0.018
		Carbohydrate Derivative 10 (C6H8O4)**e	0.06%	0.25%	292.6%	0.001
		Carbohydrate Derivative 11 (C9H12O6)**e	0.01%	0.01%	-21.5%	0.004
		Carbohydrate Derivative 12 (C8H12O6)**e	0.01%	0.02%	83.4%	0.001
		Carbohydrate Derivative 13 (C6H12O6)**e	0.03%	0.05%	54.0%	0.001
C	arbohydrate Dehydration Products		3.30%	2.63%	-20.2%	0.002
	Cyclopentanes		0.68%	0.21%	-68.8%	0.001
		2-methyl-2-cyclopenten-1-one (C6H8O) <sup>e</sup>	0.01%	0.00%	-100.0%	0.003
		2-hydroxy-2-cyclopenten-1-one (C5H6O2)*e	0.45%	0.14%	-69.0%	0.001

		Switchgrass Control	AAEM Passivated Switchgrass	Change	P-valı (2-tai
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
-	3-methyl-2-cyclopenten-1-one (C6H8O) <sup>e</sup>	0.02%	0.01%	-68.0%	0.00
	3-methyl-1,2-cyclopentanedione (C6H8O2) <sup>e</sup>	0.20%	0.07%	-66.3%	0.00
Furans		0.98%	1.67%	71.0%	0.00
	2-methylfuran (C5H6O) <sup>e</sup>	0.10%	0.02%	-77.2%	0.00
	2-furaldehyde (C5H4O2) <sup>e</sup>	0.54%	1.23%	127.9%	0.00
	2-furanmethanol (C5H6O2) <sup>e</sup>	0.05%	0.11%	108.4%	0.00
	5-methyl-2-furaldehyde (C6H6O2)°	0.10%	0.07%	-29.8%	0.0
	3-furanmethanol (C5H6O2) <sup>e</sup>	0.04%	0.09%	147.8%	0.00
	5-(hydroxymethyl)-2-furaldehyde (C6H6O3)°	0.15%	0.15%	1.1%	0.1
Lactones		0.51%	0.19%	-63.0%	0.0
	dihydro-2(3H)-Furanone (C4H6O2)*e	0.09%	0.02%	-80.7%	0.0
	2(5H)Furanone (C4H4O2) <sup>e</sup>	0.27%	0.06%	-77.5%	0.0
	5-methyl-2(5H)-Furanone (C5H6O2)*e	0.04%	0.02%	-38.3%	0.0
	3-methyl-2(5H)-furanone (C5H6O2)°	0.05%	0.02%	-66.5%	0.0
	4-hydroxy-5-methyl-3-furanone (C5H6O3)°	0.01%	0.04%	202.3%	0.0
	4-methyl-5H-furan-2-one (C5H6O2)*e	0.04%	0.03%	-39.6%	0.0
Misc. Furans		0.59%	0.47%	-20.4%	0.0
	Furan Derivative 3 (C5H4O)**e	0.00%	0.00%	-82.4%	0.0

		Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	Furan Derivative 1 (C5H6O2)**e	0.02%	0.01%	-59.9%	0.004
	Furan Derivative 2 (C6H6O2)**e	0.05%	0.13%	188.5%	0.001
	Furan Derivative 4 (C6H8O)**e	0.03%	0.01%	-73.1%	0.002
	Furan Derivative 16A (C5H6O3)**e	0.49%	0.32%	-34.4%	0.004
Pyrans		0.05%	0.05%	-5.7%	0.018
	Carbohydrate Derivative 1 (C5H8O3)**e	0.03%	0.03%	-22.1%	0.006
	2H-Pyran-2-one (C5H4O2) <sup>e</sup>	0.01%	0.02%	33.7%	0.004
Tetrahydrofurans		0.49%	0.04%	-91.3%	0.000
	2,5-dimethoxytetrahydrofuran (isomer) (C6H12O3) <sup>e</sup>	0.20%	0.02%	-89.9%	0.001
	2,5-dimethoxytetrahydrofuran (isomer) (C6H12O3)e	0.24%	0.01%	-94.9%	0.000
	(S)-(+)-3-hydroxytetrahydrofuran (C4H8O2) <sup>e</sup>	0.05%	0.01%	-80.7%	0.003
Total Sugars		4.50%	16.15%	258.9%	0.017
Xylose Hydrolyzable Sugars <sup>b</sup>		1.31%	3.20%	144.9%	0.074
Glucose Hydrolyzable Sugars <sup>b</sup>		2.55%	12.95%	408.0%	0.013
Sorbitol Hydrolyzable Sugars <sup>b</sup>		0.64%	0.00%	-100.0%	0.054
Light Oxygenates		6.84%	3.26%	-52.4%	0.043
Alcohols		0.18%	0.13%	-29.1%	0.001

		Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	Methanol (CH4O) <sup>f</sup>	0.14%	0.10%	-28.3%	0.001
	Ethanol (C2H6O) <sup>f</sup>	0.03%	0.02%	-40.4%	0.003
	2-Propanol (C3H8O) <sup>f</sup>	0.01%	0.00%	-38.0%	0.000
	1-Propanol (C3H8O) <sup>f</sup>	0.00%	0.01%	23.3%	0.028
Aldehydes		0.74%	0.50%	-32.4%	0.004
	Acetaldehyde (C2H4O) <sup>f</sup>	0.02%	0.01%	-33.8%	0.000
	Glycolaldehyde (C2H4O2)*e	0.73%	0.49%	-32.4%	0.004
Carboxylic Acids		4.17%	2.36%	-43.5%	0.084
	Acetic Acid <sup>g</sup>	3.02%	1.71%	-43.3%	0.110
	Butanoic Acid <sup>e</sup>	0.05%	0.01%	-79.5%	0.117
	Formic Acid <sup>g</sup>	0.52%	0.26%	-50.3%	0.163
	Glycolic Acid <sup>g</sup>	0.37%	0.23%	-37.9%	0.140
	Proponoic Acid <sup>g</sup>	0.21%	0.15%	-30.5%	0.180
Misc. Light Oxygenates		1.75%	0.27%	-84.5%	0.000
	Acetone (C3H6O) <sup>f</sup>	0.02%	0.04%	62.4%	0.000
	2,3-butanedione (C4H6O2)°	0.10%	0.05%	-51.3%	0.001
	Hydroxyacetone (C3H6O2) <sup>e</sup>	1.00%	0.11%	-88.9%	0.000
	1-hydroxy-2-butanone (C4H8O2) <sup>e</sup>	0.10%	0.02%	-82.7%	0.000

		Switchgrass Control	AAEM Passivated Switchgrass	Change	P-value (2-tail)
		(wt. % of feedstock)	(wt. % of feedstock)	(Passivated- Control) / Control	
	Light Oxygenate 1 (C4H6O3)**e	0.25%	0.03%	-88.5%	0.000
	Light Oxygenate 2 (C4H6O3)**e	0.10%	0.01%	-90.7%	0.001
	Light Oxygenate 3 (C6H10O2)**e	0.05%	0.01%	-89.8%	0.003
	Acetoxyacetone (C5H8O3) <sup>e</sup>	0.13%	0.01%	-89.4%	0.001
	Reaction Water <sup>a</sup>	14.65%	16.44%	12.2%	0.198
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Total Bio-oil Accounted	72.26%	76.71%

- \*- Identified via GC/MS
- \*\* Molecular formula determine via GC-TOF
- <sup>a</sup> Karl Fischer Titration
- <sup>b</sup> Acid Hydrolysis HPLC
- <sup>c</sup> Water Soluble Sugar Analysis
- <sup>d</sup> Water Insoluble Analysis
- e GC/FID
- <sup>f</sup> GC/FID Low Boiling Compounds Method
- g Ion Chromatography