

Order #

651

Order Status

Order Fulfilled

Report #

651-4661-ICPF

Date of Report

6th July 2018

Report for: Daniel Hayes, Celignis Limited, 111 Brookfield Hall, Castletroy, Limerick, Ireland

Sample Name - Dairy Sludge

Biogas and Biomethane Potential (BMP) - Summary Data

Proximate Analysis

Total Solids (% Wet Basis)

78.38

Volatile Solids (% Dry Basis)

57.53

Volatile Solids (% Wet Basis)

45.09

Biogas and Biomethane Potential

Biogas Production			Biomethane Potential		
L/kg VS	L/kg Dry Mass	L/kg Wet Mass	L/kg VS	L/kg Dry Mass	L/kg Wet Mass
633.6	364.5	285.7	358.6	206.3	161.7

Weighted Biogas Composition

At Day	Methane (%)	CO ₂ (%)	Oxygen (%)	H ₂ S (ppm)	Ammonia (ppm)
28	56.6	37.9	0.4	178	80
21	56.4	38.1	0.4	179	80
14	56.1	38.4	0.4	180	80
7	55.9	38.6	0.4	181	80
3	54.4	39.9	0.4	169	78

Biogas Composition During Periods

Between Days	Methane (%)	CO ₂ (%)	Oxygen (%)	H ₂ S (ppm)	Ammonia (ppm)
1 and 3	54.4	39.9	0.4	169	78
4 and 7	61.7	33.7	0.2	227	90
8 and 14	61.0	34.1	0.3	158	78
15 and 21	62.0	33.1	0.3	153	80
22 and 28	61.9	33.0	0.3	158	82

- Results after 28 days of digestion (test complete).
- Gas yields and composition are inoculum-subtracted, unless otherwise stated.
- Insufficient net gas for days 8 to 14, composition not inoculum-subtracted.
- Insufficient net gas for days 15 to 21, composition not inoculum-subtracted.
- Insufficient net gas for days 22 to 28, composition not inoculum-subtracted.

Lab Manager Signature:


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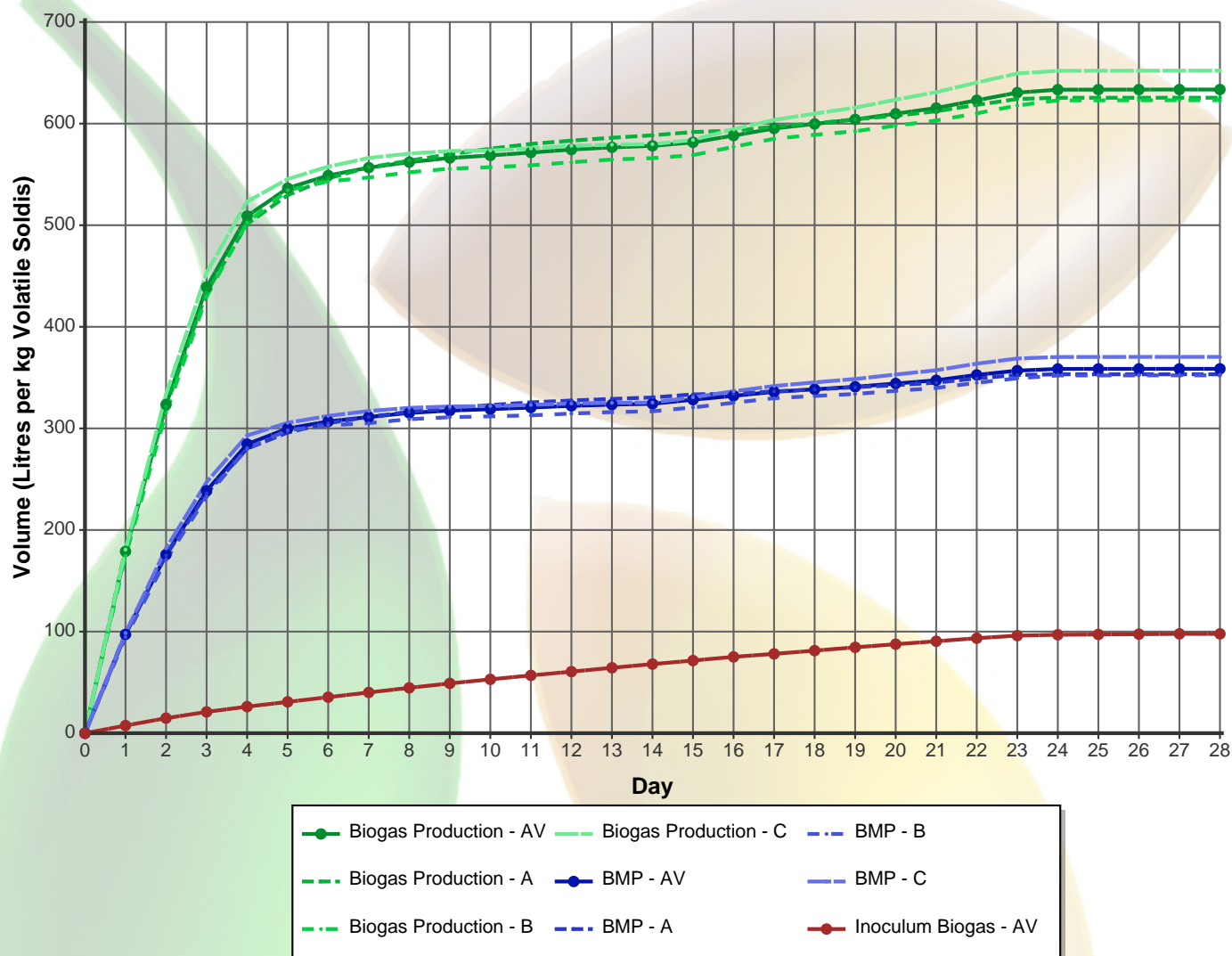
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Report for: Daniel Hayes, Celignis Limited, 111 Brookfield Hall, Castletroy, Limerick, Ireland

Sample Name - Dairy Sludge
Plot of Biogas and Biomethane Potential (BMP) - Inoculum Subtracted


Days of Digestion

28 (Digestion Complete)

Max. biogas production reached at day

28

70% of total biogas reached at day

4

80% of total biogas reached at day

4

90% of total biogas reached at day

11

1% gas production reached at day

9

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Report for: Daniel Hayes, Celignis Limited, 111 Brookfield Hall, Castletroy, Limerick, Ireland

Sample Name - Dairy Sludge**Thermal Analysis - Summary Data**

Test	Method Reference	Units	As-Received	Dry Mass Basis	Dry Ash-Free Basis
Moisture	EN 14774-1:2009	%	21.62	-	-
Ash	EN 14775:2009	%	33.29	42.47	-
Carbon	EN 15104:2011	%	25.26	32.23	56.03
Hydrogen	EN 15104:2011	%	3.62	4.62	8.04
Nitrogen	EN 15104:2011	%	4.55	5.81	10.10
Sulphur	EN 15104:2011	%	0.28	0.36	0.63
Oxygen	By Difference	%	11.36	14.50	25.20

- Data at www.celignis.com/output/analytical_customer_view.php?editid1=21608

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Report for: Daniel Hayes, Celignis Limited, 111 Brookfield Hall, Castletroy, Limerick, Ireland

Sample Name - Dairy Sludge**Proximate Analysis - Replicate Data****Dry Matter Basis (% Dry Mass)**

Test	Method Reference	Average	Replicate 1	Replicate 2	Standard Deviation
Volatile Solids	Calculated from Ash	57.53	57.53	57.52	0.01
Ash	EN14775:2009	42.47	42.47	42.48	0.01

Fresh Matter Basis (% Wet Mass)

Test	Method Reference	Average	Replicate 1	Replicate 2	Standard Deviation
Total Solids	Calculated from Moisture	78.38	78.43	78.32	0.08
Moisture Content	14774-1:2009	21.62	21.57	21.68	0.08
Volatile Solids	Calculated	45.09	45.09	45.08	0.01
Ash	Calculated	33.29	33.29	33.30	0.01

Additional Sample and Digestion Details

Sample Type (Solid/Liquid/Slurry)	Solid
Sample Consistency	Homogeneous
Sample pH	6.80 (Neutral)
Inoculum to Substrate Ratio (VS-basis)	4:1
Digester Volume to Headspace Ratio	7:3
Temperature of Digestion	37 °C
Additional Comments:	None

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Sample Name - Dairy Sludge

Biogas and Biomethane Potential (BMP) - Replicate Data

Biogas Production

Basis	Average	Replicate A	Replicate B	Replicate C	Standard Deviation
Volatile Solids (L/kg-VS)	633.6	625.5	623.1	652.2	16.1
Dry Matter (L/kg-DM)	364.5	359.8	358.5	375.2	9.3
Fresh Matter (L/kg-FM)	285.7	282.0	281.0	294.1	7.3

Biomethane Potential (BMP)

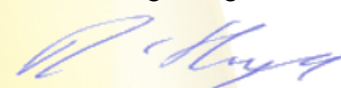
Basis	Average	Replicate A	Replicate B	Replicate C	Standard Deviation
Volatile Solids (L/kg-VS)	358.6	353.3	352.3	370.4	10.2
Dry Matter (L/kg-DM)	206.3	203.2	202.6	213.1	5.9
Fresh Matter (L/kg-FM)	161.7	159.3	158.8	167.0	4.6

Inoculum Biogas Production

Basis	Average	Replicate A	Replicate B	Replicate C	Standard Deviation
Volatile Solids (L/kg-VS)	98.0	106.5	93.9	93.7	7.3

- Results after 28 days of digestion (test complete).
- Gas yields and composition are inoculum-subtracted, unless otherwise stated.

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Report for: Daniel Hayes, Celignis Limited, 111 Brookfield Hall, Castletroy, Limerick, Ireland

Sample Name - Dairy Sludge
Biogas Composition - Period Data

	% of Final Net Biogas Volume	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Hydrogen Sulphide (ppm)	Ammonia (ppm)
Between Days 1 and 3						
Biogas	69.3	54.3	39.9	0.4	150	74
Inoculum		53.8	40.2	0.5	50	56
Inoculum-Subtracted		54.4	39.9	0.4	169	78
Weighted (Days 1 to 3)		54.4	39.9	0.4	169	78
Between Days 4 and 7						
Biogas	18.6	61.0	34.1	0.3	158	78
Inoculum		60.0	34.6	0.4	52	61
Inoculum-Subtracted		61.7	33.7	0.2	227	90
Weighted (Days 1 to 7)		55.9	38.6	0.4	181	80
Between Days 8 and 14						
Biogas	3.4	61.0	34.1	0.3	158	78
Inoculum		61.5	33.0	0.9	61	47
Inoculum-Subtracted		Insufficient net gas produced in period, no inoculum subtraction				
Weighted (Days 1 to 14)		56.1	38.4	0.4	180	80
Between Days 15 and 21						
Biogas	5.9	62.0	33.1	0.3	153	80
Inoculum		61.2	34.7	0.4	55	65
Inoculum-Subtracted		Insufficient net gas produced in period, no inoculum subtraction				
Weighted (Days 1 to 21)		56.4	38.1	0.4	179	80
Between Days 22 and 28						
Biogas	2.9	61.9	33.0	0.3	158	82
Inoculum		61.0	33.6	0.3	55	69
Inoculum-Subtracted		Insufficient net gas produced in period, no inoculum subtraction				
Weighted (Days 1 to 28)		56.6	37.9	0.4	178	80

- Results after 28 days of digestion (test complete).

Lab Manager Signature:

- Gas yields and composition are inoculum-subtracted, unless otherwise stated.


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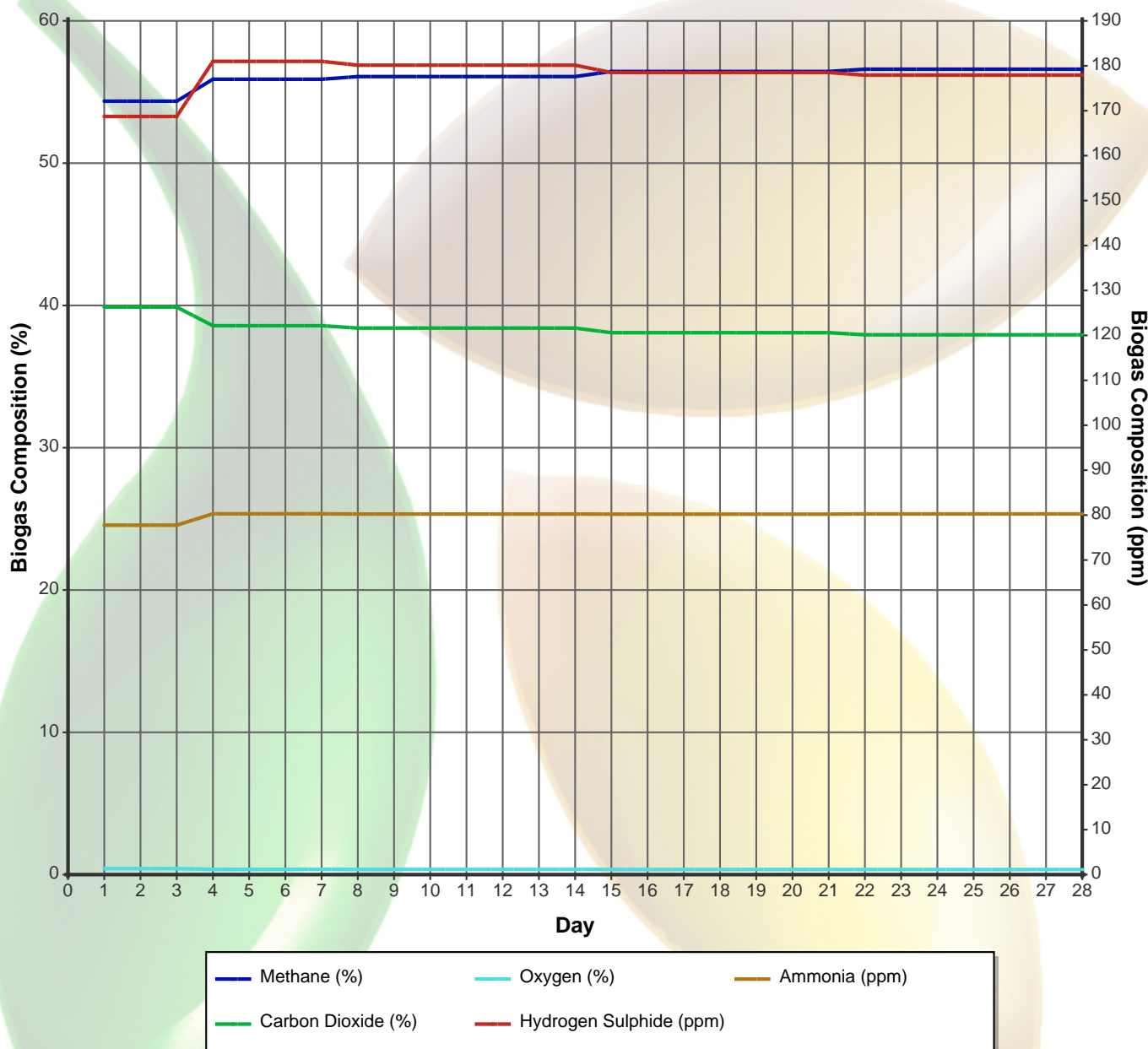
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Sample Name - Dairy Sludge
Plot of Weighted Biogas Composition - Inoculum Subtracted


Lab Manager Signature:


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Sample Name - Dairy Sludge

Ultimate Analysis - Replicate Data

Test	Method Reference	Average	Replicate 1	Replicate 2	Standard Deviation
Dry Matter Basis (% Dry Mass)					
Carbon	EN 15104:2011	32.23	31.96	32.50	0.38
Hydrogen	EN 15104:2011	4.62	4.64	4.61	0.02
Nitrogen	EN 15104:2011	5.81	5.75	5.87	0.08
Sulphur	EN 15104:2011	0.36	0.40	0.33	0.05
Oxygen	Calculated	14.50	14.78	14.22	0.39
As-Received Basis (% Wet Mass)					
Carbon	Calculated	25.26	25.05	25.47	0.30
Hydrogen	Calculated	3.62	3.64	3.61	0.02
Nitrogen	Calculated	4.55	4.51	4.60	0.06
Sulphur	Calculated	0.28	0.31	0.26	0.04
Oxygen	Calculated	11.36	11.58	11.15	0.31
Dry Ash-Free Basis (% DAF)					
Carbon	Calculated	56.03	55.56	56.50	0.66
Hydrogen	Calculated	8.04	8.06	8.01	0.04
Nitrogen	Calculated	10.10	10.00	10.20	0.14
Sulphur	Calculated	0.63	0.69	0.57	0.08
Oxygen	Calculated	25.20	25.68	24.72	0.68

- Data at www.celignis.com/output/analytical_customer_view.php?editid1=21608

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Sample Name - Dairy Sludge

Stoichiometric Methane Potential (SMP)

Volatile Solids Basis (L per kg VS)

	Biogas	Methane	Carbon Dioxide	% Methane
Calculated from Buswell Equation	1,045	596	449	57.0
Actual Values at Day 28	634	359	240	56.6
Biodegradability Index (%)	60.7	60.2		

Dry Mass Basis (L per kg Dry Matter)

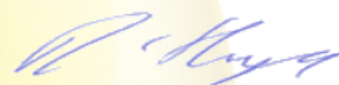
	Biogas	Methane	Carbon Dioxide	% Volatile Solids
Calculated from Buswell Equation	601	343	258	
Actual Values at Day 28	364	206	138	57.53

As-Received Basis (L per kg Fresh Matter)

	Biogas	Methane	Carbon Dioxide	% Total Solids
Calculated from Buswell Equation	471	269	202	
Actual Values at Day 28	286	162	108	78.38

- Results after 28 days of digestion (test complete).
- Data at www.celignis.com/output/biogas_view.php?editid1=6
- For Buswell Equation see www.celignis.com/anaerobic-digestion.php#buswell

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