

Black Pellets

When will they become Mainstream?

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FutureMetrics LLC™



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There are two fundamental types of black pellets made with two very different technological pathways:

- **Torrefaction**
- **Steam cracking (also known as steam explosion)**



Both thermal treatments can yield pellets that have many desirable characteristics versus plain vanilla white pellets.

- **Higher energy and bulk density**
- **Water resistance**
- **Closer substitute for coal**

Material properties

SE = Steam Exploded (Steam Cracked)

			Pellets 1.0	Pellets 2.0		
		Wood chips	White pellets	SE pellets	Torr. Pellets	Thermal Coal
Moisture content	% w.b.	30-55	4-8	4-8	3-6	10-35
Volatile matter	% d.b.	70-75	70-75	57-67	55-65	15-30
Fixed carbon	% d.b.	15-25	15-25	20-28	23-35	50-55
C-H ratio		1.51	1.51	1.31	1.25	0.76
C-O ratio		0.76	0.76	0.58	0.55	0.07
Mass loss	%	N/A	0	12	25	N/A
Biochemical production (primarily furfural) from mass loss				Yes	Potential, but not currently done	
Energy loss	%	N/A	0	5	12	N/A
Process temperature	°C	N/A	N/A	240	270	N/A
Gravimetric bulk density	kg/m3	200-250	550-700	720-850	650-800	800-850
Gravimetric energy density (LHV)	GJ/mt	8-12	16-18.5	18-21	19-22.5	18-26
Volumetric energy density	GJ/m3	1.6-3.0	8.25-12.6	13.0-17.9	12.4-18.0	14.4-22.1
Dust	%	N/A	2-4%	1-3%	2-4%	N/A
Durability	%	N/A	96-97	97-98	96-97	N/A
Water resistant properties		Hydrophilic - but maintain mechanical characteristics if wet	Hydrophilic - do not maintain mechanical characteristics if wet	Hydrophobic - maintain mechanical characteristics if wet	Hydrophobic - if sufficiently torrefied	Hydrophobic
Biodegradation		yes	some	negligible	negligible	none
Grindability		poor	poor	very good	very good	excellent
Handling and Storage		special	special, dry	similar to coal	similar to coal	
Quality variability		high	low	low	low	low

- Typical value ranges for a soft wood/ hard wood mix.
- Hydrophobicity for torrefied pellets will vary with degree of torrefaction.
- Lignin coated micro-fibers after SE disruption results in lower densification energy demand and hydrophobicity.
- Biodegradation – Aerobic microorganism activity is one of the causes of self heating. The other is oxidation. There is no self-heating and CO offgassing with SE pellets*.

*Based on research for EdB that is confidential.

Challenges have been economic and technical

Economic

Mass and energy losses in the thermal treatment process automatically raises input wood costs per gigajoule (GJ) of energy in the pellets and thus the price per GJ will be higher than for white pellets.

- Solutions

- **Torrefaction** – Use the mass/energy losses (syngas) as fuel for the reaction.
 - Challenge – Higher degrees of torrefaction produce more syngas that is needed for the reactor, so a heat customer is needed.
 - Challenge – Using the by-products as fuel for heat equates the value of the syngas per GJ to low grade wood used in pellet factory heat plants.
 - Results – A higher price per GJ is still necessary.
- **Steam Cracking** – Use the mass/energy losses from the wet process to produce biochemicals (primarily furfural currently selling for \$2,000 to \$3,000 per tonne). Revenue from biochemical sales allows pellet price to be competitive with white pellets.
 - Challenge – Need two offtake agreements.
 - Results – Price per GJ can be competitive with white pellets.

Technical

There are many torrefaction solutions that have been presented over many years.

A few have achieved continuous and safe operations.

Airex Energy is one and is part of the WPAC post-conference tour!

There are two major suppliers of steam cracking solutions:

Valmet (continuous) and Arbaflame (batch).

The Valmet process is operating reliably at the EdB plant.

The Arbaflame process, with furfural recovery, is nearing full output levels.

Issues

Consistent and safe operation. Robust processes.

Durability (torrefied).

Water resistance (torrefied).

Potential for high COD (chemical oxygen demand) from fuel pile leachate

Lack of multiple suppliers.

A long list of promises not met!

Markets of the Future?

- Heat and power generation
 - Probably steam cracked due to:
 - Better durability/low dust,
 - Good grindability,
 - Better cost per GJ than torrefied (assuming biochem recovery)
 - Could be torrefied if higher energy density is required and the boiler operator is willing to pay the higher cost.
- Steel refining
 - Definitely torrefied due to:
 - Ability to produce a high carbon content product.
- Other?
 - Torrefied
 - Any demand for high carbon content feedstock where the net carbon benefits to the environment translate into an ability to pay for the higher cost.

Steam cracked pellets produced using the Valmet continuous process.

These pellets produced by Européenne de Biomasse (EdB) in Reims, France are sent to the Paris district heating system to replace coal.



Thank you

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Bill and Fezziwig about to go for a mountain bike ride in western Maine.