An Integrated System for Producing Advanced Wood Pellets and Biochemicals

A summary of why Arbaflame offers a technologically and economically superior solution to the shortcomings of white pellets.

FutureMetrics has completed a comprehensive independent study of the Arbaflame thermal treatment via steam explosion (SE) pellet technology and the biochemical reclaim process. The Arbaflame design results in a SE pellet plant and biochemical plant operating as an integrated unit.

Thermally Treated via Steam Explosion (SE) Pellets

SE pellets primary technical advantages over white pellets are:

- SE pellets can be stored in the open without degradation of their functionality. The SE pellet’s moisture resistance allows power stations to avoid the cost of building dry storage solutions (domes or silos). This also allows ship loading and unloading during rain and/or snow events, as well as uncovered truck and rail transport. This lowers the probability of demurrage costs and the cost of overland transport.

- They have a higher volumetric and gravimetric energy density than white pellets. Significantly more energy per cubic meter on board ships and railcars, and in the available storage area results in a lower transportation and storage cost per gigajoule of energy.

- They are harder and more durable than white pellets. They produce significantly fewer fines during handling, shipping and storage which lowers the probability of dust explosions. Fewer fines also lowers mass losses so that more tonnage is retained in the product as it passes through the supply chain.

- The properties of SE pellets permit a wider range of co-firing ratios than white pellets without major modification to a coal power station’s pulverizing systems, and, depending on the type of coal and the design of the power plant, without burner and fuel piping systems modifications.

Biochemical Production

Arbaflame has optimized the steam/pressure reaction to produce high quality biochemicals from the condensed reaction gases. For a 200,000 tonne per year SE pellet plant, the output of market grade biochemicals consists of furfural (270 kg/hour), methanol (90 kg/hour), and a few other less valuable chemicals. The actual outputs will vary slightly depending on the species of woods used as feedstock. The characteristics of the steam treatment can be adjusted to raise the yield of furfural and slightly lower the SE material that is densified into pellets. Additional value can be generated by converting the furfural into furfuryl alcohol.

1 The full report that contains a detailed analysis is available at the FutureMetrics website. www.FutureMetrics.com
Furfural and furfuryl alcohol are high value products that sell in the range of $1,500 – $2,200 per tonne in a global marketplace.

The furfural market is expected to reach nearly $1.1 billion by 2021 from $625.5 million in 2016, increasing at a compound annual growth rate of 11.7% from 2016 to 2021. Growing global demand for environmentally sustainable biomass-based chemicals and the growing application of furfural and its derivatives in the pharmaceutical industry is fueling the overall growth of the furfural market.

The process technology of stripping the chemicals from an aqueous phase (the condensate from the steam treatment) is widely deployed in the chemical and refining industry.

**Is the Arbaflame Integrated Pellet/Biochem Factory Cost Competitive?**

The reclamation of green biochemicals is a new and differentiating component of the integrated Arbaflame design. The mass loss due to steam treatment and the additional energy cost to run the reactor is more than offset by the value of the biochemical compounds.

Furthermore, the highly integrated process is optimally efficient in conserving energy. For example, under typical operating conditions, all of the pre-dryer energy is derived from recycled heat from the process.

*FutureMetrics believes that the Arbaflame SE pellet/biochem technology has overcome the shortcomings that have prevented the production of cost competitive SE pellets in the past.*

**Summary**

The ability to deliver hard, energy dense, and waterproof pellets at a price per gigajoule that is competitive with white pellets has been a highly desirable goal for many years. There have been many torrefaction and steam explosion technologies that have failed to deliver on the “price competitive” characteristic (including Arbaflame).

The Arbaflame integrated pellet and biochemical production design changes that.

On the SE pellet production side, Arbaflame’s evolution of design in the control, capture, and recycling of energy within the integrated process has optimized the energy needed to produce SE pellets.

The reaction gases produced from the thermal treatment of the woody feedstock, once a costly waste problem, are now converted into a significant revenue stream.

Using the typical price per GJ for white pellets as the price per GJ for SE pellets, the Arbaflame integrated pellet/biochem plant can produce a return on investment that should be attractive to most project developers.

[The following pages contain a photo of Arbaflame SE pellets and some charts and schematics showing some of the characteristics of the process.]
FutureMetrics can apply detailed modeling and analysis to any project-specific set of input variables, including specific capacities of plant components, ambient temperature profiles, feedstock moisture content, and transportation and labor costs, to provide custom analysis for project developers considering the Arbaflame thermal treatment pellet technology.

SE waterproof pellets after being stored outside over winter at the Thunder Bay station in Thunder Bay, Ontario
After 48 hours of immersion the water uptake is ~8%, and the change in durability is -0.7%, from an average of 98.9% to an average of 98.2%. If the pellets are then dried in the open air, they return to their original moisture content and durability.
The SE pellets do not lose their mechanical characteristics after the uptake of water.

**Durability of Arbaflame Pellets - Sample every 8 hours for 112 consecutive days**

Average = 98.8%; Standard Deviation = 0.31%

**Durability after 48 hours Immersed in Water - Tests approximately one week apart**

Testing by Ontario Power Generation, 2014 - One test in 2017 observed by FutureMetrics
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Biochemical reclaim

Bulk Density of Arbaflame Pellets - Sample every 8 hours for 112 consecutive days

Average = 790; Standard Deviation = 10.9

Typical Bulk Density of White Pellets

Sampled at the Arbaflame pellet mill in Norway, 2016

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Integrated Process Flow Schematic

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