

UMaine Response to Request for Information Categories and Questions

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Category 1: Lignocellulosic Sugars

If you are a producer of lignocellulosic sugars and are willing and able to sell or otherwise make them available to the research community, please provide information in your response to the following questions. You may respond to as many or as few questions as you wish. The questions are intended to provide the research community with useful information when looking for a supplier of lignocellulosic sugars. **BETO is requesting NON-PROPRIETARY information only:**

Question 1: To which types of research entities are you willing and able to sell your lignocellulosic sugar (e.g., university researchers, national laboratories, industry/private sector)? Are there any types of research entities to whom you are not willing and able to sell your lignocellulosic sugar?

Answer: We would sell to all customers with proper non-disclosure agreements and material transfer agreements.

Question 2: What are the maximum and minimum quantities of lignocellulosic sugar you are willing and able to sell (kg)?

Answer: We have two modes of sugar production. For the pulp mill scale, the smallest batch size is 6,340 kg of sugar. This batch should be sold prior to production. A maximum long-term contract is approximately 10,000 kg/month at 350 g/l sugar concentration. Larger contracts are possible with addition of a second shift, lower sugar concentrations, or less clean sugars.

For the pilot plant mode, the sugar production rate is between one and two weeks per batch, depending on the final purity and concentration desired. A minimum production batch would be 6.5 kg of sugar. A maximum production rate of approximately 10kg/week of purified and concentrated sugar could be achieved with application of double shifts. These batches should be sold prior to production.

Question 3: What is the sugar concentration in your product?

Answer: Our preferred sugar concentration is 350 g/l. However, we can provide between 100 g/l and 600 g/l concentrations. Expected shelf-life at 100 g/l is seven days at 25°C and lower. At 350 g/l and above, the expected shelf-life is several months at 25°C and lower. Higher storage temperature may decrease shelf-life.

Question 4: What physical form do you sell your sugars (e.g., solid or liquid)?

Answer: Liquid solution. We have not tried solid, but are willing to explore.

Question 5: How do you package your lignocellulosic sugar for shipping? Do you ship in bulk?

Answer: 1000 kg plastic IBC tote is the largest size. We also ship 200 kg, 19 kg, and 1 kg plastic jugs.

Question 6: What type(s) of biomass do you use to produce lignocellulosic sugar?

Answer: Softwood and Hardwood Trees. At the pulp mill scale we process unbleached kraft pulp produced on-site, or a similar pre-treated biomass feed supplied by other entity.

For the pilot plant mode, we can process woodchips, sawdust, or other biomass ground to woodchip size or smaller using a variety of pre-treatments in 14 dry kg batches.

Question 7: What process do you use to produce lignocellulosic sugar?

The Kraft (or similar) pulping process followed by enzymatic hydrolysis.

Question 8: What details of the scale of your process are you willing to share (e.g. batch and/or continuous/ volumetric productivity)?

Answer: Please see answer to question 2. For the mill scale and a 10,000 kg per month production rate of our cleanest sugars, one 50,000 gallon batch of hydrolyzate is produced and then processed monthly.

Question 9: What is the typical composition of your sugar stream (e.g., glucose, galactose, mannose, xylose, arabinose) and what is the purity?

Answer: Typically 74 – 80% glucose and 20 – 26% xylose. The ratio of glucose to xylose depends on the softwood to hardwood ratio.

Question 10: Do you routinely test your cellulosic sugar for consistency within and between lots and between feedstocks (if applicable)?

Answer: Yes. We test for key quality indicators including suspected fermentation indicators, sugars, organic acids, lignin, solids, pH, and conductivity.

Question 11: What impurities are present in your lignocellulosic sugar process and what testing do you perform to determine the presence of impurities?

Answer: We test total suspended solids to monitor and control our separation processes. Suspended solids are unhydrolyzed wood particles collected on a 1 micron filter. We have two levels of solids reduction depending on customer requirements: medium is < 3000 mg/l and high is < 300 mg/L at 300 g/l sugar concentration. We use conductivity to monitor and control dissolved impurities. The pH control chemicals, sodium hydroxide and sulfuric acid, may be considered impurities, and the denatured enzymes may be considered impurities. Residual lignin may be considered an impurity, and we monitor and control lignin concentration. We have two levels of impurity removal depending on customer requirements: medium is < 3000 uS/cm and high is < 600 uS/cm at 300 g/l sugar concentration. We also use HPLC to determine sugar and organic acid content. We have the ability to control organic acid content depending on customer requirements. We can control glucuronic, lactic, formic, and acetic acid concentrations.

Question 12: Does your process include a purification step?

Answer: Yes. We can produce a range of purification depending on customer needs. See answer to question 11.

Question 13: What is the highest concentration in grams/Liter you can provide?

Answer: 600 g/l is the highest.

Question 14: Have you examined the impacts of transport and storage on sugar degradation? If so, can you please provide any relevant (non-proprietary) details of these impacts?

Answer: Yes. We have conducted degradation studies and have resolved sugar degradation problems both in our plant and post-shipping. Please see our answer to question #3. We apply practices similar to maple syrup sugar manufacture to prevent sugar degradation. Handling instructions are included on the shipping container label and include recommendations to refrigerate after opening. We do not add preservative, but rely on pasteurization practices and a clean plant.

Question 15: What additional information are you willing and able to provide to the research community about your lignocellulosic sugar? Please provide any non-proprietary cost information you are willing to share.

Answer: Traditional wood pulp mills contain most of the equipment, processes, and people required for large scale biomass enzymatic hydrolysis and first stage mechanical sugar cleaning. The sugars produced from only slightly modified pulp mill equipment are good enough for some sugar applications. Additional equipment is required for other cleaner sugar applications. Secondary products, such as organic acids can also be sold to reduce sugar pricing.

Sugar production costs are largely influenced by some of the same cost factors as pulp manufacture including the raw material (biomass or wood chips), and sugar production has the additional cost of enzyme and evaporation for sugar concentrations above 150 g/l. Sugar concentrations of 150 g/l or lower do not require evaporation.

Question 16: Into what markets do you typically sell your lignocellulosic sugar? What is a typical application for your lignocellulosic sugar?

Answer: Customers primarily use our sugar to make products traditionally produced from fossil materials extracted from the ground. Fuels and plastics are produced from our sugars.

| **Category 2: Lignin**