

August 12, 2016

United States Department of Energy

Sent by Email: [sugarandlignin@ee.doe.gov](mailto:sugarandlignin@ee.doe.gov)

Subject: Response to Request for Information DE-FOA-0001615 Cellulosic Sugar and Lignin Production Capabilities

Dear US DOE:

This letter is in response to your Request for Information under DE-FOA-0001615 Cellulosic Sugar and Lignin Production Capabilities. Here is the requested information for the start of the response:

Company/Institution Name:	ZeaChem Inc.
Company/Institution Contact:	Tim Eggeman
Contact address, phone, email:	215 Union Blvd., Suite 500 Lakewood, CO 80228 Office: (303) 248-7774 Cell: (303) 358-6390 Email: <a href="mailto:time@zeachem.com">time@zeachem.com</a>

ZeaChem operates a nominal 10 ton per day (dry weight) lignocellulosic pretreatment unit. Depending upon composition of the biomass (bulk density, size, ash content, etc.) the throughput can be greater or less. The pretreatment unit is an Andritz horizontal digester that can be operated using different approaches including auto-hydrolysis with or without steam explosion, dilute acid hydrolysis with or without steam explosion, dilute base with or without steam explosion, sulfite processing, organosolv processing, etc. The pretreatment unit can be run in a single stage configuration completing deacetylation or deacetylation and hydrolysis of hemicellulose to xylose rich hydrolysate, or in a dual stage configuration completing hydrolysis of cellulose in the second stage to glucose rich hydrolysate.

If the pretreatment unit is used in a single stage configuration then the hydrolysis of cellulose to glucose rich hydrolysate is performed using enzymatic hydrolysis in our 15,000-liter liquefaction unit and our 150,000 liter bioreactors. The throughput depends upon the enzyme performance generally occurring over 72-96 hours.

The rest of this response contains answers to the specific questions posed in the RFI. Please feel free to contact me directly with any questions.

Sincerely,

Tim Eggeman  
President & CEO

## Category 1: Lignocellulosic Sugars

Q1: ZeaChem is willing and able to sell our lignocellulosic sugars to any and all research entities that may request them.

Q2: ZeaChem is willing to provide small (1-10 kg) of lignocellulosic sugars when it has such sugars readily available from a production run. Larger quantities of sugars may require dedicated production runs. ZeaChem is willing to complete such production runs pending its facility's availability.

Q3: Sugar concentrations vary as a function of the type of feedstock and the method of hydrolysis used.

Q4: ZeaChem sugars are produced and sold in a liquid form. Currently ZeaChem is unable to refine sugars into a solid format, but would be willing to discuss sponsored capital upgrades if a customer desired such sugars.

Q5: ZeaChem sugars may be package in lab flasks, seal buckets, drums or totes.

Q6: ZeaChem can process any type of cellulosic biomass through its facility. Feedstocks processed to date include: hardwoods, softwoods, corn stover, wheat straw, sugarcane bagasse, energy cane, bana grass, and sugar beets.

Q7: ZeaChem has a variety of pretreatment and hydrolysis processes at its disposal. It has Andritz digester capable of steam explosion, auto hydrolysis, dilute acid hydrolysis, and sulfite processes. These processes may be combined with enzymatic saccharifications at various scales.

Q8: ZeaChem's pretreatment / hydrolysis unit is capable of processing up to 10 bone dry tons per day of a high density feedstock such as wood chips. Feedstocks of lower bulk densities may be processed at lower feed rates. Currently, ZeaChem's largest vessel for conducting enzymatic saccharifications is 3,000 gallons. It has plans to expand this production volume to 40,000 gallons.

Q9: Sugar stream compositions vary as a function of biomass input and hydrolysis process used.

Q10: ZeaChem conducts laboratory analysis of its sugars during all production runs. Consistency varies as a function of biomass input and hydrolysis process used.

Q11: Sugar stream impurities vary as a function of biomass input and hydrolysis process used.

Q12: ZeaChem has multiple solid liquid separation and membrane filtration units at its facility which may be utilized in a production run depending on the objects of the run.

Q13: ZeaChem does not presently have a large scale evaporator on its site. It does have a small rotovap for concentrating up small/lab scale quantities of sugars. Presently, additional

concentration can be achieved by using ZeaChem's existing filtration systems. Resulting concentrations depend on the concentration of the input which vary as a function of biomass input and hydrolysis process used.

Q14: Liquid sugar streams must have some type of stabilization step applied to them. The two main methods for stabilizing sugars are to concentrate them up to above 50% or drop the pH to ~2.

Q15: ZeaChem provides production runs at its facility based on its daily standard rate. ZeaChem works with third parties to define the scope, schedule and budget of their projects.

Q16: Markets and applications of products from ZeaChem's facility vary extremely widely given the feedstock and process flexibility of its plant.