Arbeitsgemeinschaft Getreideforschung e. V.

in cooperation with

Max Rubner-Institut
Institute of Safety and Quality of Cereal

and the

University of Hohenheim
Institute of Food Science and Biotechnology

13th European Bioethanol and Bioconversion Technology Meeting

April 05th – 06th 2017 in Detmold

Program

Evening Program

Exhibition

Participants

Summaries

Wednesday, April 05th 2017

from 08^{00} on **Registration**

13^{30} **Opening Remarks** by the President of the Association of Cereal Research, **Götz Kröner**, Ibbenbüren (Germany)

1. Carbohydrates

13^{30} 1.1. **Tobias Thiele,** Potsdam (Germany)
Carbohydrate bioconversion - improving functional and nutritional properties

2. CO_2 Utilisation

14^{00} 2.1. **Heleen De Wever,** Mol (Belgium)
Valorization of CO_2-rich off-gases to polymers

14^{30} Communication Break

3. Fungal Strain

15^{00} 3.1. **Arthur Ram,** Leiden (The Netherlands)
Fungal strain development for complex hydrolytic enzyme cocktails

4. Second Generation

15^{30} 4.1. **Bernd-Peter Ernst,** Goettingen (Germany)
Low cost pretreatment process of straw using halophilic microorganisms

16^{00} Communication Break

5. Third Generation

16^{30} 5.1. **Christian Schweitzer,** Leipzig (Germany)
Synthesizing strengths of 1st and 3rd generation biorefineries. Update from EU side about the latest developments on Electric Biomethanol as a biorefinery product

Continued on the penultimate page

Lunch

Lunch will be served in the exhibition hall:

The menu:

Wednesday, April 05th 2017

Bean soup with sausages

Borschtsch (Ukrainian vegetable soup)

Vegetable sticks

Salmon Fresh Cheese Rolls

Chicken slices

Dessert: Mousse au Chocolat

Thursday, April 06th 2017

Cream of leek soup with cheese, mushrooms, mince

Carrot-ginger soup

Cheese Tortellini skewers

Meatballs with lime dip

Party wraps with fresh cheese and turkey breast

Mini baguette rolls

Dessert: Stracciatella mousse

Beverages:

Mineral water

Coca-Cola

Orange juice

Apple Spritzer

Bon appétit
and interesting conversations!

Evening Program

Wednesday, April 05th 2017

19:30 **Social gathering** at the restaurant "Waldhotel Baerenstein", Am Baerenstein 44, 32805 Horn-Bad Meinberg, near the "Externsteine" in the Teutoburg Forest

Buffet

Starters

Choices of green salad and raw food salads

Caprese tomato and mozzarella

Main course

Crispy braised leg of duck with cabbage in cream and potatoe gratin

Crusty roasts from pork, beans with bacon,with pepper sauce and small potatoes

Champignon-potatoes lasagne with chives

Dessert

Mousse au chocolat with fruit sauce

"Lippisches" wildberry stew with vanilla shank

Bus transfer

A bus transfer is organized for you.

17:45 h **Bus stop 1** **AGF e.V. – Schuetzenberg 10**

18:00 h **Bus stop 2** **Sparda Bank - Willi-Brandt-Platz/Paulinenstrasse**
(For the Hotels Lippischer Hof, Detmolder Hof and Best Western Residenz, Altstadt Hotel)

18:15 h Meeting at Parking Place at **„Waldhotel Baerenstein"**, Am Baerenstein 44, 32805 Horn-Bad Meinberg

Guided Tour to the "Externsteine" in the Teutoburg Forest

19:30 h Dinner at Waldhotel Baerenstein

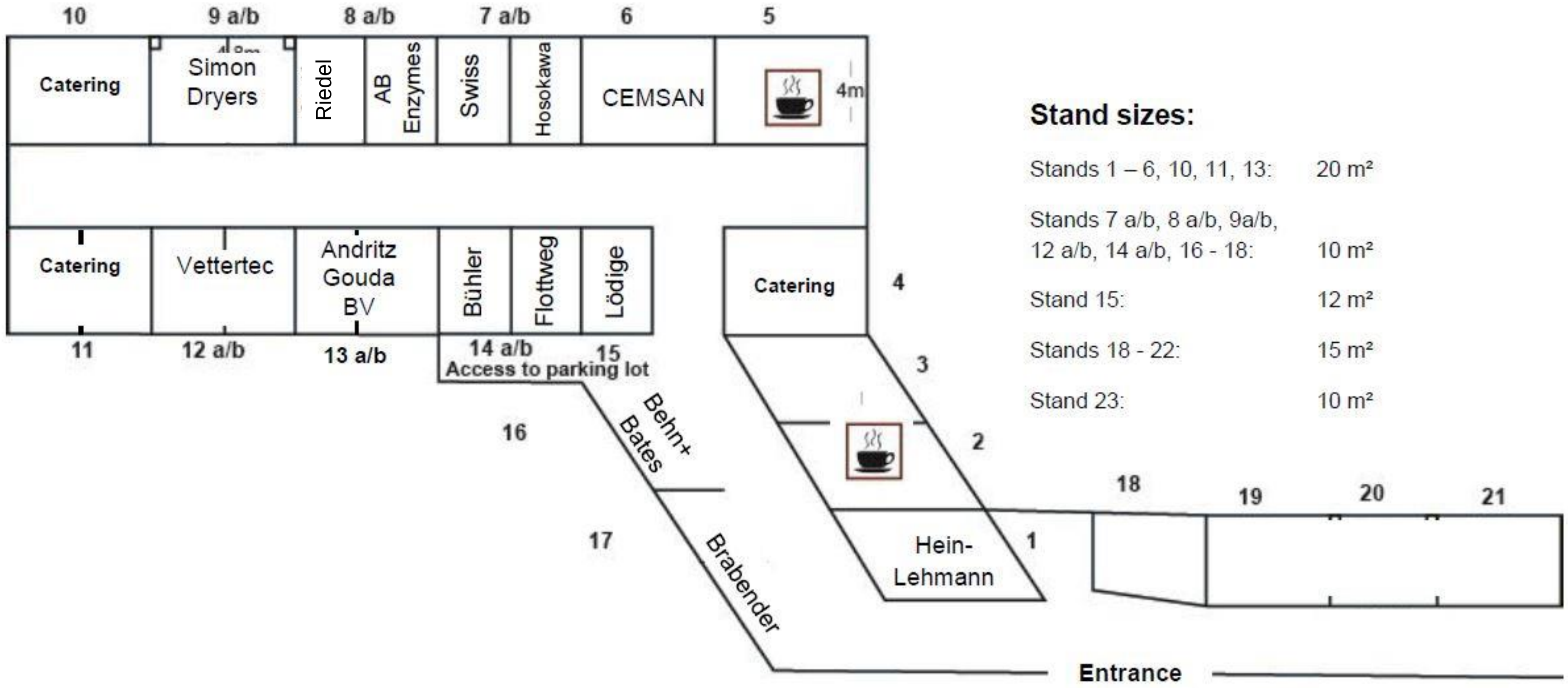
Departure: from 21:30 h

Thank you!

Exhibition Hall Association of Cereal Research

Stand allocation

68th Starch Convention and 13th Bioethanol and Bioconversion Technology Meeting from April 4th – 6th 2017



Stand sizes:

Stands 1 – 6, 10, 11, 13:	20 m²
Stands 7 a/b, 8 a/b, 9a/b, 12 a/b, 14 a/b, 16 - 18:	10 m²
Stand 15:	12 m²
Stands 18 - 22:	15 m²
Stand 23:	10 m²

Exhibition

AB Enzymes GmbH, Darmstadt (Germany)

Andritz Gouda BV, PD Waddinxveen (Netherland)

Behn & Bates Maschinenfabrik GmbH & Co. KG, Münster (Germany)

Brabender GmbH & Co. KG, Duisburg (Germany)

Bühler GmbH, Braunschweig (Germany)

Cemsan DIS TIC A.S., Arifiye Sakarya (Turkey)

Flottweg SE, Vilsbiburg (Germany)

Greif-Velox Maschinenfabrik GmbH, Lübeck (Germany)

Hein. Lehmann GmbH, Krefeld (Germany)

Hosokawa Alpine AG, Augsburg (Germany)

Gebr. Lödige Maschinenbau GmbH, Paderborn (Germany)

TUMMERS, Simon Dryers Technology, Nottingham (United Kingdom)

VetterTec GmbH, Kassel (Germany)

W. Kunz dryTec AG, SWISS COMBI, Dintikon (Switzerland)

Participants

Effective April 3rd 2017

Abeln, Dieter	Behn & Bates Maschinenfabrik GmbH & Co. KG, Münster
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Bergthaller, Wolfgang, Prof. Dr.	Lage
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Broeker, Timo	Hochschule Ostwestfalen-Lippe
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Wurm, Rainer	VetterTec GmbH, Kassel

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Schwake-Anduschus, Christine, Dr.
Stabenau, Gisbert
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Unbehend, Günter, Dipl.-Ing.
Vosmann, Klaus, Dr.
Weber, Lydia, Dipl.oec.troph.
Wiege, Berthold, Dr.
Wolf, Klaus

Summaries

1. Carbohydrates

1.1. **Tobias Thiele,** Potsdam (Germany)
Carbohydrate bioconversion - improving functional and nutritional properties

Even though that the low-carb trend is still present within the media, the solution for a balanced diet for everybody is not to avoid all forms of carbohydrates - but converting simple sugars or sugar containing foods into healthier alternatives. By the enzymatic conversion of mono- and disaccharides, alternative sugars with lower energy content and oligomers/polymers with additional functionality and health benefits can be produced.

With evoxx' proprietary alternansucrase platform sucrose can be converted to different products: An oligosaccharide called Fibermalt for slow energy release or the polymer alternan. Alternan has a high molecular mass of 40 x 106 g/mol and consists of alternating alpha 1,3-alpha-1,6 glycosidic linkages. Alternansucrase is originating from *Leuconostoc mesenteroides* and was expressed in *E. coli*. To broaden the range of potential applications alternan can be modified enzymatically and chemically. Despite the high molar mass the viscosities of alternan solutions are quite low at concentrations below 10 %. By carboxymethylation the viscosity was increased up to a factor of 10.000. After introduction of hydrophobic groups to the alternan backbone, the resulting alternan-esters show emulsifying properties.

The second product from the alternansucrase platform is the oligomer Fibermalt. Fibermalt shows unique properties in terms of pH-stability and can be used for slow energy release in Food.

The production of both products, Fibermalt and alternan, was established on technical scale and can be scaled-up easily for industrial applications.

***Dr. Tobias Thiele**, born July 8th 1976, 1996-1998 Food Technology University of Applied Sciences Lippe Lemgo (Germany), 1998-2002 Food Technology Bonn University (Germany), 2000-2001 Food Technology Manchester Metropolitan University (Great Britain), 2002-2005 Doctoral Studies food technology at Bonn University, 2005-2007 Research coordinator, Institute of Nutrition and Food Science Depart. Bonn University, 2007-2008 Research work membrane separation Bayer BioScience GmbH Potsdam, 2008 Head of Segment Management, Multivac Sepp Haggenmueller GmbH & Co. KG Wolfertschwenden, 2008-2010 Director of Application Center, Multivac Sepp Haggenmueller GmbH & Co. KG Wolfertschwenden, 2010-2016 Head of Process Technology, aevotis GmbH Potsdam, since 8/2016 Group Leader Processing, evoxx technologies GmbH Potsdam*

2. CO_2 Utilisation

2.1. **Heleen De Wever,** Mol (Belgium)
Valorization of CO_2-rich off-gases to polymers

Carbon dioxide or CO_2 is considered to be the major cause of climate change by its accumulation in the atmosphere and its greenhouse properties. Nowadays it is recognized that CO_2 can be a valuable source of carbon for the production of commercially valuable products. Clearly, CO_2 is the ultimate sustainable resource, available everywhere, in unlimited quantities, and forever.

This presentation focuses on the use of CO_2 as feedstock for the synthesis of (bio)polymers using biotechnology as core process. Two utilization forms will be discussed. VITO's activities in this area will be presented with results of selected projects and activities.

First, CO_2 can be utilized as renewable carbon source for the direct production of biopolymers via fermentation. As a case study, the use of *Cupriavidus necator* for the sustainable production of the biopolymer polyhydroxyalkanoate from CO_2 will be discussed. Test work encompassed optimizations with mock-up gas mixtures and real CO_2-containing off-gas. Biopolymers can also be produced in an indirect manner from CO_2 through the synthesis of chemical building blocks from CO_2. The conversion of CO_2 to different organic acids (such as acetic acid and succinic acid) was evaluated. We will end the presentation with an outlook on the potential and challenges of bioconversion processes for CO_2 valorization to biopolymers.

***Heleen De Wever** obtained a PhD in Applied Biological Sciences in 1995. In 2001, she joined the Business Unit of Separation and Conversion Technology at VITO, the Flemish Institute of Technological Research in Belgium. She is currently leading VITO's biotechnology team which focusses on two main research lines. The first one is bioprocess intensification, typically through integration of bioprocesses with separation technology. Technological approaches include high cell density fermentations, in-situ product recovery, enzyme immobilization and/or selective product separation, and tailoring of biomass towards defined oligomer fractions. The second one is the valorization of organic streams and CO2-rich off-gases through biotechnological approaches.*

3. Fungal Strain

3.1. **Arthur Ram,** Leiden (The Netherlands)
Fungal strain development for complex hydrolytic enzyme cocktails

Aspergillus niger is an important industrial fungus expressing a broad spectrum of plant polymer degrading enzymes such as amylases, xylanases and pectinases. The expression of genes encoding these enzymes is tightly controlled by substrate specific transcription factors. Well known examples of such transcription factors include AmyR[1], XlnR[2], and GaaR[3] which control the expression of amylolytic, xylanolytic, pectinolytic enzyme networks respectively.

In Nature, the full expression of the enzymes involved in the degradation of particular plant polymers (e.g. starch, xylan or pectin) only occurs when the substrate is present in the environment. So-called scouting enzymes (lowly expressed enzymes able to degrade a certain substrate) will liberate small amounts of inducer molecules from the substrate, which will activate a specific transcription factor. Activation of such a transcription factor is required for the full induction of an entire enzyme network.

The requirement of specific substrate-derived inducer molecules to fully induce particular enzyme networks limits the choice of feedstock used to produce enzymes or enzyme cocktails. Moreover, the enzyme cocktail obtained is largely determined by the type of feed stock used and therefore variable feedstocks are not suited for reproducible production of enzyme cocktails. We have therefore considered molecular genetic approaches to obtain *A. niger* mutants which produce high levels of substrate-specific enzymes independent of the feedstock source.

To isolate mutants that constitutively express pectinases or xylanases, forward genetic mutant screens have been set up. Analysis of mutants displaying constitutive expression of pectinases resulted in the identification of a repressor protein which specifically controls expression of the genes encoding enzymes related to the pectin degradation pathway[4]. Mutations in this repressor gene lead to inducer independent expression of pectinases. We have also successfully used the screen to isolate mutants with constitute expression of xylanases. Analysis of these mutants is ongoing and will be presented. Mutations leading to constitutive expression of different enzymes networks can be combined in a single strain to generate *A. niger* strains suitable for the rapid and complete degradation of complex substrates.

***Dr. Arthur Ram** obtained his MSc. with honors in Biology from the University in Amsterdam, the Netherlands, in 1991 and obtained his PhD in the Yeast Cell Wall Biology Group at the University of Amsterdam in 1996 under supervision of prof. H. van den Ende and Dr. F.M. Klis. After a one year post-doc in the same research group, he has worked two years as post-doc at TNO in the department of Applied Microbiology and Gene Technology under supervision of Prof. Kees van den Hondel. In 1999, he moved to Leiden University to start, together with Prof. van den Hondel, a research group on Fungal Genetics and Gene Technology. In 2002, he got a tenure track position within the Institute of Biology at Leiden University and in 2006 he was appointed as assistant professor. Since 2010 he is associate professor and head of the research group Molecular Microbiology and Biotechnology (MMB) within the Institute of Biology at Leiden University. Since 2016, he is also educational director and responsible for the Biology bachelor education program within the Institute of Biology at Leiden University.*

4. Second Generation

4.1. **Bernd-Peter Ernst,** Goettingen (Germany)
Low cost pretreatment process of straw using halophilic microorganisms

Mobility is one of the key features of our time and an essential aspect of our daily life, it influences everything we do and our surroundings, respectively the environment. To keep this world alive in times of expected dramatic climate changes mainly driven by misuse of fossil energy we have to establish sustainable alternatives to crude oil. Plant biomass that does not compete with food can fulfill this need in case that it will be economically possible to hydrolyze cellulose and hemicelluloses out of the stable developed matrix established by evolution.

The most promising method for hydrolysis of hemicelluloses and cellulose to monomer sugars is the use of enzymes or enzyme complexes. However it is not possible to make the raw material accessible to enzymes without some kind of pretreatment. In the last decades a lot of pretreatments have been worked out on physical, chemical and physicochemical basis. (i. e. incubating the biomass with inorganic acids at high temperatures, defined pH values, steam pretreatment and hydrothermolysis or alkaline methods like ammonia fiber explosion) All these pretreatment processes have in common that they are expensive, making the overall process of transforming plant biomass to biofuel economically not competitive.

We reestablished a process that was originally built up in 1638 in Bad-Sooden-Allendorf. An impressive graduation house was used to be filled with straw, through which the brine trickles to be concentrated. Due to the evaporation of the water the concentration of the brine was increased from 12 % to 25 %. This was very helpful in the process of salt production in salt pans, because it was much cheaper to heat 25 % of brine in contrast to 12 %. The straw was later replaced by bundles of blackthorn brushwood because the straw degraded during the process. In the last three years we examined this degradation process in deep. In a small research graduation house 500 kg wheat straw (first year), 500 kg rye straw (second year) and 500 kg oat straw (third year) were treated with brine in a cycle-process to detect and characterize the microorganisms involved. We could confirm that a small 40 W pump that was driven in intervals over a period of 12 to 16 weeks was sufficient to realize the circulation of brine. This “biological pretreatment” changes the physical and chemical properties of straw dramatically, without consuming appreciable amounts of hemicelluloses and cellulose or Lignin. After this incubation period the straw could be simply washed out with pure water to be almost sterile for 24 to 48 hours because the strong halophilic microorganisms died from osmotic effects. After this biological pretreatment process the straw is accessible for commercial cellulases and glucanases tested by Biogazyme 2x, ASA Spezialenzyme GmbH, Wolfenbüttel.

Without any further mechanical treatment this straw could be used in biogas plants with a 20 % higher ratio in building methane over untreated straw. We carried out metagenom analysis and characterized all involved bacteria, archaea and fungi in pure culture. Several hundreds of cellulases genes have been characterized cloned and activity tested. The process described is robust and can easily be upgraded to industrial amounts. We could not detect any inhibitory effect for following fermentation processes. Halophilic organism involved in this process turned out to be the ideal candidates for a biological pretreatment process, because they initiate the accessibility of plant biomass within reasonable time schedules, but they are not fast enough to consume the target molecules used for biofuel.

Dr. Bernd-Peter Ernst *has studied Organic Chemistry at the Georg August University of Göttingen and graduated in 1991 with a doctoral thesis on "Synthesis of cytotoxic Lignane – Search for chemical lead structures derived from Podophyllotoxin". He was a postdoctoral fellow for 4 years at the Department of Pediatrics and Neuropaediatrics at the Georg August University. In 1996 he founded the DNA- Sequencing Company Seqlab GmbH, were he provided the CEO position from june 1996 to December 2016. The Seqlab GmbH is one of the three leading Custom sequencing companies in Europe for Sanger sequencing and NGS Sequencing. In 2007 Seqlab started a research project with focus on decentral production of Bioethanol from lignocellular biomass in small independent production units. In 2013 the company started to work out pretreatment processes for lignocellullar biomass. In 2016 it was decided to separate custom service from the realization of bioethanol production. Custom service in Sanger-sequencing will be provided by Seqlab GmbH now belonging to Microsynth (Swiss), bioethanol research, NGS Sequencing projects and patents will be embodied in the startup of dna-planet GmbH i. G.*

5. Third Generation

5.1. **Christian Schweitzer,** Leipzig (Germany)
Synthesizing strengths of 1st and 3rd generation biorefineries. Update from EU side about the latest developments on Electric Biomethanol as a biorefinery product

The ethanol industry is in the transition from a pure biomass-to-fuel industry towards a system relevant implementer of the energy transition in all respects. The presenter shows a way how to secure made investments and how to realise a branch security for the next 30 years.

Electric fuels have been identified to increase the value of Bioethanol with utilization of the biomass emission streams and to achieve the EU target of approx. 2.5 Mill. tons/y of advanced fuels within 3 years. CO2-to-Methanol will be there the major pathway. 2016 was the year that set the legal trail of this new industry and 2017 will be the year of the legal implementation by discussion of LCA methodologies (amended certification systems), adoption of national legislation and kick-offs of realisation projects.

The lecture deepens the economic aspects in the use of carbon dioxide for the production of electrical biomethanol as an additional product with a lower heating value, that were presented in the previous year including now with the impacts by the outcome of the Renewable Energy Directive II and ETS Phase IV discussion (normative-economic impact). Beside the technical explanation of the individual process units the normative classification of electrical biomethanol will be updated in each other's context (technical-normative impact).

The Realisation of CO2-to-Methanol Small scale methanol-plants is performed by a world leading team with existing references of the individual process units and operation model.

Christian Schweitzer *was born in July 1964 in Aachen. There he completed his engineering studies at the Fachhochschule Aachen. He also received his Bachelor of Business Administration from the St. Gallen Management Institute, Switzerland in 1999. Since 1995, Mr. Schweitzer is managing director of bse Engineering Leipzig GmbH (bse). The bse works across whole Europe and is an independent, consultative and customer-oriented engineering company in the field of liquid and solid biomass. The trendsetting company is the initiator of a full service package consortium for execution and operating of small scale Methanol plants. The Partners are Aker Solutions, BASF, InfraServ Knapsack, Nordic Green and WEMAG. The targeted beneficiaries for the innovative methanol plants are from different industrial sectors like waste incineration, pulp & paper and bioethanol.*

6. Fermentation

6.1. **Heleen De Wever,** Mol (Belgium)
Membrane technology for bioprocess intensification (Membrane bioreactors in fermentation)

A growing predilection towards utilization of sustainable resources and an ambition to reduce import of oil are the impetus for the implementation of biotechnological production processes. Despite the progress made, several bio-based processes can benefit from integration of membrane separation technology to increase product titers and/or volumetric productivities. In this presentation, we will discuss the potential gains for selected organic acid and solvent fermentation processes.

As a first example, productivity of lactate fermentations was pushed through operation at increased cell densities in a set-up with integrated microfiltration membranes. Though membrane fouling proved to be the major bottleneck in the process, the system could be operated under constant operating conditions for extended periods of time. Significant improvements were obtained in comparison with batch and (regular) continuous conditions: maximal productivities were 30.5 $g.kg^{-1}.h^{-1}$ combined with high average lactate concentrations and complete consumption of C5 and C6 carbohydrates.

A second example is conventional acetone-butanol-ethanol fermentation which suffers from end-product inhibition leading to low solvent titers and productivities. Combination with an *in-situ* product recovery (ISPR) technology can alleviate such inhibition effects. Salient results of tests with an integrated organophilic pervaporation unit will be presented covering tests at lab- and pilot-scale. These include increased productivity, enrichment of solvents in the condensate, co-utilization of glucose and xylose, and improved water balances.

Heleen De Wever *obtained a PhD in Applied Biological Sciences in 1995. In 2001, she joined the Business Unit of Separation and Conversion Technology at VITO, the Flemish Institute of Technological Research in Belgium. She is currently leading VITO's biotechnology team which focusses on two main research lines. The first one is bioprocess intensification, typically through integration of bioprocesses with separation technology. Technological approaches include high cell density fermentations, in-situ product recovery, enzyme immobilization and/or selective product separation, and tailoring of biomass towards defined oligomer fractions. The second one is the valorization of organic streams and* CO_2*-rich off-gases through biotechnological approaches.*

6.2. **Johan van Groenestijn,** Zeist (The Netherlands)
Removal or preventation of fermentation inhibitors in biomass hydrolysates

In the process of producing fermentable sugars from lignocellulosic biomass by-products can be produced that inhibit fermentation. Worldwide research is focused on identifying the inhibiting compounds, detoxification, selecting more resistant micro-organisms and preventing the production of compounds responsible. We studied sensitivity differences in a list a microbial species. Bacteria seem to be relatively sensitive.

Exometabolomics was used to identify inhibitors and a list was produced. This list was used in a study in which adsorption was used to detoxify hydrolysates from thermal/acid pretreated wheat straw, corn stover and bagasse. It was demonstrated that detoxification can solve the problem, but against costs. However, the study also revealed that if pretreatment is carried out under certain conditions the ratio between inhibitors and fermentable sugars can be low as well. The importance of the type of pretreatment process was further studied.

Four different pretreatment processes were used to make wheat straw, beech chips and spruce chips accessible to hydrolytic enzymes. The processes were acid catalyzed steam explosion, ethanol/water organosolv, alkaline oxidation and superheated steam with catalysts. After enzymatic hydrolysis under standard conditions the hydrolysates were tested using five microbial species with different sensitivity. The wheat straw/ superheated steam hydrolysate did not inhibit any of the five strains.

The hydrolysates produced by alkaline oxidation inhibited the most sensitive of the microorganisms (*Bacillus coagulans*), none of the others. The organosolv hydrolysates severely inhibited the most sensitive of the microorganisms (*Bacillus coagulans*). The hydrolysates produced using steam explosion were the most toxic. Membrane fractionation reduced toxicity. However, detoxification is not always required if the pretreatment process is chosen well.

Dr. Johan W. van Groenestijn *is a bioprocess technologist with a MSc degree in environmental technology and a PhD degree in microbiology from Wageningen University (The Netherlands). From 1988 to 1992 he worked at Gist Brocades (now DSM) R&D in the Fermentation Process Development Group, the last year as head of the Department Bioconversion and Bacterial Fermentation. His task was the development and transfer of laboratory scale fermentation processes to full scale. In 1992 he joined TNO at which he develops production processes for the biobased economy. He knows how to convert (residue) plant materials into chemicals, biofuels, paper and cattle feed. He is senior scientist and TNO's leading expert in lignocellulosic biomass pretreatment technology.*

7. Technology

7.1. **Arno van de Kant,** Delft (The Netherlands)
Research on pilot scale

Situated at the Biotech Campus Delft, the Netherlands, the Bioprocess Pilot Facility B.V. (BPF) is a unique open access facility where companies and knowledge institutions can develop new sustainable production processes by converting bio-based residues into useful chemicals or fuels and production processes for Chemical, Food and Pharma industries.

Scale up is a key part of the process of bringing great ideas from lab to commercial scale. At the BPF we are helping companies from all over the world to scale up their processes. Companies like DSM, Corbion, Verdezyne and many more are using the expertise and the facilities of the BPF to scale up their process and gather information for the industrial scale in a commercial viable way. BPF is a service provider with very flexible facilities to help startup's and large enterprises to scale up their process. BPF has experience with many different chemicals, food and pharma ingredients.

Because of its high quality standards, the BPF can also be used to produce kg-quantities of material for pre-marketing and application tests at customers and/or trials. The BPF has a long standing historical track record in bioprocess piloting with an experienced crew of more than 40 years.

The facility has been specifically designed to enable the transition from laboratory to industrial scale. The facility has a modular setup. BPF has about 33 people, mainly experienced process operators. With an asset value of 75 Million of which 37 Million Euro have been invested in the last 2 years, we are able to construct complex operations by linking the separate process modules: Pretreatment, Hydrolysis, Fermentation and/or Downstream Processing.

Based at the Biotech campus Delft all infrastructure and networks are available to perform chemical/biotechnology scaling processes. Topics to be addressed are the challenges in scale up and how to address them.

Arno van de Kant*, with more than 25 years experience, Arno is an experienced business development director, working for the Bioprocess pilot facility in Delft. He worked for several companies in marketing, sales and business development; NewBrunswick Scientific, Akzo Nobel, NIZO food research, bioMerieux, and TNO. He also worked as CEO of ARKI and MicroDish, a startup company, discovering and detecting novel organisms.*

7.2. **Jakob Skjold-Jørgensen,** Copenhagen (Denmark)
Unlocking the Potential of Your Plant's Data and Staff for Profitability

“You can have data without information, but you cannot have information without data.” Daniel Keys Moran, computer programmer and science fiction author. In a dynamic market, where prices on oil, ethanol and other fuels fluctuate, consistent profitability is a genuine challenge. At Novozymes, we believe that data holds the key to unlock a plant’s full potential and maximize its profitability. We do not believe that data itself provides the needed value, rather what *lies beyond* data.

For this reason, we have developed a platform which enables plants to identify key areas of improvement and make swift data-driven decisions which will drive results through optimized plant conditions for greater profitability. As part of our commitment for partnering for impact, we also provide access to the Novozymes Bioenergy University as part of our service offerings. The Bioenergy University is an industry-leading online-based instructional platform which makes education and training of plant personnel easy and effective. We believe that well educated staff is crucial for enduring success in the fuel ethanol industry. Applying our advanced data services and educational offerings we seek to sharpen your competitive edge, ensure plant consistency and provide you with the ability to maximize profitability.

Jakob S. Jørgensen*, B.Sc. & M.Sc. in Biotechnology from the University of Copenhagen, DK. Ph.D. in Biophysical and Bioinorganic Chemistry from University of Copenhagen, DK. Working at Novozymes as Industry Technology Specialist within Biofuels in EMA. Pro-active with an eye for improving processes and motivating people through promotion of best practices. Entrepreneurial spirit with a passion for customer-oriented solutions. Enjoys playing the classical guitar and a BIG fan of basketball.*

7.3. **Vijay Singh,** Urbana, Illinois (USA)
Reducing Operating Cost and Improving Efficiency of Bioethanol Production Process

Conventional corn dry-grind ethanol production process requires exogenous alpha and glucoamylases enzymes to breakdown starch into glucose, which is fermented to ethanol by yeast. This study evaluates the potential use of new genetically engineered corn and yeast, which can eliminate or minimize the use of these external enzymes, improve the economics and process efficiencies, and simplify the process.

An approach of in situ ethanol removal during fermentation was also investigated for its potential to improve the efficiency of high-solid fermentation, which can significantly reduce the downstream ethanol and co-product recovery cost. The fermentation of amylase corn (producing endogenous α-amylase) using conventional yeast and no addition of exogenous α-amylase resulted in ethanol concentration of 4.1 % higher compared to control treatment (conventional corn using exogenous α-amylase).

Conventional corn processed with exogenous α-amylase and superior yeast (producing glucoamylase or GA) with no exogenous glucoamylase addition resulted in ethanol concentration similar to control treatment (conventional yeast with exogenous glucoamylase addition). Combination of amylase corn and superior yeast required only 25 % of recommended glucoamylase dose to complete fermentation and achieve ethanol concentration and yield similar to control treatment (conventional corn with exogenous α-amylase, conventional yeast with exogenous glucoamylase).

Use of superior yeast with 50 % GA addition resulted in similar increases in yield for conventional or amylase corn of approximately 7 % compared to that of control treatment. Combination of amylase corn, superior yeast, and in situ ethanol removal resulted in a process that allowed complete fermentation of 40 % slurry solids with only 50 % of exogenous GA enzyme requirements and 64.6 % higher ethanol yield compared to that of conventional process. Use of amylase corn and superior yeast in the dry-grind processing industry can reduce the total external enzyme usage by more than 80 %.

Dr. Vijay Singh is a distinguished Professor of Bioprocessing in the Department of Agricultural and Biological Engineering and Director of Integrated Bioprocessing Research Laboratory at the University of Illinois at Urbana-Champaign. His research is on development of bioprocessing technologies for corn/biomass to ethanol, advanced biofuels, food and industrial products. Dr. Singh has directed more than $9.5 million research, has authored 150 peer-reviewed journal articles, 70 other publications and holds ten patents related to corn processing and biofuels production. He has received numerous excellence in research awards from professional societies, academic institutions and trade organizations. Professor Singh has also received “Excellence in Teaching” and “Innovation in Research” recognition several times. In 2015, Dr. Singh was selected as University Scholar, highest honor given to a faculty member at the University of Illinois-system wide. He received his M.S. and Ph.D. in Food and Bioprocess Engineering from the University of Illinois at Urbana-Champaign.

7.4. **Kent Rausch**, Urbana, Illinois (USA)
Effects of Process Conditions within a multiple effect evaporator on heat transfer fouling

In the fuel ethanol industry, evaporator fouling occurs when thin stillage or steepwater are concentrated during wet milling or dry grind processes. Fouling of heat transfer surfaces affects the efficiency and environmental footprint of more than 200 biorefineries in the US. Various studies have estimated costs of heat transfer fouling to industrialized countries to be 0.5% of their gross domestic production.

During starch and bioethanol production, process fluids concentrated by evaporators have complex compositions that are dynamic, biological and complex. Research has focused on effects of corn oil, pH, Reynolds number, solids concentration and carbohydrates. However, temperature and heat treatment effects on thin stillage fouling have not been studied. Experiments were conducted using model thin stillage (1% starch solution) and commercial thin stillage with varied temperature conditions.

Methodology included use of an annular fouling probe to simulate evaporator conditions. We found that temperature conditions had effects on fouling characteristics. Increased initial probe temperatures increased fouling rates and maximum fouling resistance for commercial thin stillage and model thin stillage.

At an initial probe temperature of 120°C, higher bulk temperature (80°C) increased fouling rates and reduced induction periods. Effects of exposure to evaporator heat treatment were studied by examining fouling behavior among samples from various locations within an evaporator. Effects of heat treatment were not detected.

Samples before and after plant cleaning were collected to study effects of plant cleaning. Fouling tendencies were reduced after plant cleaning.

Kent Rausch *is an associate professor of Agricultural and Biological Engineering in the area of corn processing at the University of Illinois. He is author or coauthor of more than 90 peer reviewed publications and more than 155 published abstracts on bioprocessing, corn coproducts and membrane separations. Prior to joining the University of Illinois in 1997, he was a product development engineer at the American Maize Products Company (now Cargill) in Hammond, Indiana and served on the faculty at Kansas State University. His research interests include corn coproduct processing, process stream characterization, evaporator performance and membrane filtration. His current research is focused on methods to increase the rate of water recycle during the corn to ethanol production process as well as determining factors that influence thin stillage evaporation efficiency. He also has studied nutrient flows and concentrations in the corn wet milling process. Dr. Rausch recently served as an associate editor for the journal Cereal Chemistry. He is a member of AACC International, American Institute of Chemical Engineers and American Society of Agricultural and Biological Engineers.*

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Thursday, April 06th 2017

6. Fermentation

08^{30} 6.1. **Heleen De Wever,** Mol (Belgium)
Membrane technology for bioprocess intensification (Membrane bioreactors in fermentation)

09^{00} 6.2. **Johan van Groenestijn,** Zeist (The Netherlands)
Removal or preventation of fermentation inhibitors in biomass hydrolysates

09^{30} Communication Break

7. Technology

10^{00} 7.1. **Arno van de Kant,** Delft (The Netherlands)
Research on pilot scale

10^{30} 7.2. **Jakob Skjold-Jørgensen,** Copenhagen (Denmark)
Unlocking the Potential of Your Plant's Data and Staff for Profitability

11^{00} 7.3. **Vijay Singh,** Urbana, Illinois (USA)
Reducing Operating Cost and Improving Efficiency of Bioethanol Production Process

11^{30} 7.4. **Kent Rausch**, Urbana, Illinois (USA)
Effects of Process Conditions within a multiple effect evaporator on heat transfer fouling

12^{00} **Closing remarks**
by the Chairman of the Starch Experts Group of the Association of Cereal Research, **Willi Witt**, Oelde (Germany)

12^{30} Lunch Break