

Intensification of biobased chemicals manufacturing

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groundwater as well as the designation of protected areas. In order to implement these targets, intensive evaluation activities by experts (groundwater monitoring, elaboration of logistics concepts, dragnet inspections in the field of the preservation of clean air) will also be required.

General Sugar Technology

Studies on the storage stability of white beet sugar depending on its quality (*Ph. Bruhns, L.W. Kroh*, Technical University of Berlin, Germany; *Timo Koch*; Pfeifer & Langen GmbH & Co. KG, Germany)

Storage stability is an important element of sugar quality. Due to color formation during storage the sugar color can exceed the quality criteria for white sugar. It is not possible to predict the color formation tendency of a white sugar charge. Also the source and the mechanism of color formation are unknown.

Color formation is caused by several factors, which can be divided into the external influences such as humidity and temperature during storage and the internal causes such as contents of ash, polyphenols, nonsucrose-saccharides and amino nitrogen. Experiments under accelerated storage conditions have shown an influence of the temperature and the humidity on the color development. But the internal color sources are more important. This can be seen in the strong color formation tendency of the syrup layer in the surface film of white sugar crystals.

In the study investigations on the color distribution in sugar crystals were carried and the nonsugar compounds in the surface film were analyzed. The purpose of this study was to detect reactive monosaccharides and amino acids and to show correlations between the changes in contents of nonsugar compounds and color formation. Caramelization and *Maillard* reaction are possible color forming reactions. The saccharides were analyzed with a HPAEC-PAD, the amino acids were enriched with a solid-phase extraction and quantified with a GC-MS. 14 amino acids could be quantified in white sugar. The decrease in the amino acid and monosaccharide content during storage indicates that the *Maillard* reaction is responsible for color formation.

Exopolysaccharides in sugar manufacturing (*A. Antczak-Chrobot, M. Wojtczak*; Lodz University of Technology, Poland)

Deteriorated beet are an important topical problem in sugar processing. Deterioration of beet is mainly a result of storage of thawed beet. The most harmful result of deterioration of beet is the appearance of exopolysaccharides (EPSs), which are difficult to remove during the process.

The division of polysaccharides known from literature and the major polysaccharides causing technological problems at beet processing are presented.

The fact that exopolysaccharides consists of a family of molecules of different molecular masses and different branching structures makes it difficult to develop a specific analytical technique. The many analytical methods cited in the literature can be divided into "factory methods" that allow to determine the content of dextran in sugar beet and sugar juices and "spe-

cific advance analytical techniques" which are used to identify dextran and other exopolysaccharides and determine their chemical composition and structure.

A review of polysaccharide analysis used in routine analysis in sugar products is presented and a wide variety of modern analytical techniques of polymer analysis and identification is shown and an overview of the methods.

Linear pan growth control: a dual brix approach (*Ch. Mayhew, C. Parker, R. Howe, C. Haynes, Ch. Rhoten*; British Sugar, United Kingdom)

The fine control of the mother liquor saturation is key to efficient crystal production. Over many years the industry has developed several methods to approximate the mother liquor conditions across the total cycle of the batch pan. Both total massecuite rds and mother liquor rds have been used individually to control the degree of supersaturation indirectly, but neither method can accurately guarantee control of crystal growth in isolation. It is the interaction between both these rds measurements that can be used to portray the bigger picture of how the crystal is growing. This study, over the 2016/17 beet campaign at the Wisington sugar factory, will report on the investigation into how combining the output from a microwave meter and a refractometer can be used effectively to improve crystal growth within a batch pan.

Intensification of biobased chemicals manufacturing (*A.B. de Haan*; Delft University of Technology, The Netherlands)

In spite of the recently decreased oil price, the anticipated limitations in fossil fuel availability will continue to drive the transition to a future biobased economy. In this economy renewable resources will replace fossil resources to meet the demands of future generations. This transition to a biobased economy meets tremendous societal, logistic and technological challenges.

After growing and harvesting biobased resources, they must be separated into their constituents (fibers, sugars, proteins, lignin, etc.) to facilitate further valorisation by processing into biobased products such as feed, fuels and chemicals. In the applied processing schemes biobased raw materials typically undergo the opposite direction in molecular structure development compared to fossil based chemicals. Oxygen is being removed instead of added, making the products generally less instead of more polar. Furthermore most biobased raw materials, intermediates and products are more sensitive to the applied process conditions (temperature, pH value, solvents, etc) and also most characteristic biobased feedstock conversions concern equilibrium reactions. Extraction based technologies offer tremendous potential for the intensification of biobased product manufacturing processes. Important advantages of extraction compared to other separation technologies are the ability to process non-volatile components, operate at mild conditions, deal with complex mixtures including salts and solids and operate at high volumetric productivities.

This presentation will provide an overview on how extraction based technologies can intensify biobased product manufacturing processes along the four main intensification directions:

materials, conditions, equipment and hybrid systems. For each direction the developments will be discussed and illustrated with several characteristic examples that illustrate how economic viability as well as sustainability can be improved. Special attention will be given to the application of ionic liquids as new materials in the recovery of biobased chemicals (organic acids, diols, alcohols) from aqueous product streams such as fermentation broths and chemical reaction media. It will be shown that these unique designer solvents have the capability to outperform current solvent systems by orders of magnitude and thereby significantly reduce energy consumption compared to classical evaporation/distillation process schemes. The integration of extraction with (bio)chemical conversions is an excellent example of hybrid systems that enable process intensification for biobased chemicals. Lactate ester production will serve as an example to illustrate the governing process design parameters, rate based modeling and design approach, achievable performance improvement and future challenges.

Factory trial Dorr versus BMA65 (*St. Royce, D. Simkiss, Ch. Rhoten, M. Blowers, R. Howe*; British Sugar, United Kingdom) British Sugar uses Dorr carbonatation as a method for beet raw juice purification. This purification technique has remained unchanged in British Sugar for many years whilst others have reviewed and installed classical purification processes. The classical purification process incorporates a 'hot liming stage' that results in juices of lower colour and increased thermostability however the downside is a loss of 'physical properties' namely settlement and filtration. British Sugar intend to carry out a trial that incorporates a 'hot liming' process using the BMA65 purification principles at their Bury St Edmunds factory during the 2016/17 Campaign with the objective to directly compare the two purification methods. The paper discusses the results and observations made during the trial.

The right approach how to design the conditioning system of a sugar silo (*N. Rösch*; Riedel Filtertechnik GmbH, Germany) The incorrect design of a conditioning system of a sugar silo could lead to incredible consequences. In these days sugar silos are designed for up to 80,000 t and the roadmap how to design the conditioning system is always a customized approach. The main target is to ensure the product quality of the sugar for the ongoing process as well as for the transport next to security aspects. The right treatment of the air, low air velocities, the air distribution within the silo are the main goals to achieve a good flow ability and the specified residual humidity of the sugar.

It will be explained which points needs to be considered and which worth case scenarios assumptions are the basics for the right design of the conditioning system because it is nothing that you can purchase off-the-shelf.

Isolation and identification of exopolysaccharides formed during degradation of frost damaged beet (*A. Antczak-Chrobot, N. Głowacka, A. Janiszewska, M. Wojtczak*; Lodz University of Technology, Poland)

Since sugar market regime results in longer campaigns, the problem of processing deteriorated beet is still an important topical problem. Deterioration of beets is mainly a result of storage of defrosted beets.

Frost damaged beet are very susceptible to microbiological infections which lead to several changes in the chemical composition of the beet. These changes concern mainly the hydrolysis of sucrose by microorganisms and the production of various metabolites. All this leads finally to the lowering of the technological value of the beet. The most harmful result of deterioration of beet is the appearance of exopolysaccharides (EPSs). EPSs is one of the most significant impurities negatively influencing sugar production mainly by slowing the filtration after carbonatation.

The aim of study is to develop methods of exo-polymers analysis and knowledge of the chemical composition and structure of EPSs formed during degradation of sugar beet. In the presentation the conditions of the beet's degradation and EPSs extraction and purification will be presented. Isolated EPSs were hydrolyzed by acid and various enzymes. In the presentation the results of the exopolysaccharides identification which were obtained by means of different methods such as anion exchange chromatography (HPAEC), sec chromatography (SEC), differential scanning calorimetry (DSC) and nuclear magnetic resonance (NMR) are shown.

Improved image analysis system for technical sugar crystal suspensions at Suiker Unie (*R. Daniels, D. Nouws, A. Wittenberg*; Suiker Unie, The Netherlands)

Since 2003 Suiker Unie used an off-line image analysis system to measure the size distribution of crystals in industrial massecurites. The practical range of the system was limited to suspensions with a mean particle size from 50 to 500 μm . Analyzing final A-product with a size of approximately 600 μm was not possible. This system was technically outdated and the opportunity was taken to extend the measuring range to include A-product with an updated system. The original light-microscope and automated XY-stage were extended with new components: an XY-stage controller, a high resolution camera and customized image analysis software. Combined hardware and software configuration now allow measurements in the crystal size range of 10 μm to 2000 μm . After image acquisition the individual images are merged into a large mosaic image which is then analyzed. The problem of edge-cut crystals is herewith avoided, providing a bigger size range and more accurate results with the same optical constellation. Detected crystals are particle sized and classified into four categories: fines, single crystals, and simple and complex conglomerates. Sample preparation procedure was modified to avoid false grain formation especially in suspensions of low purity. Samples are now directly fixated in sucrose-fructose solution. The updated system and procedure show less variance in mean aperture (MA) and coefficient of variation (CV) compared to the formerly used. Both seed crystals and the final A-product can now be analyzed, thus covering the complete sugar crystallization process.