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Abstracts

Waste water treatment

Optimization of the anaerobie waste water treatment plant in Lage sugar faetory *(H.-J. Jordening.* Teehnieal University Braunsehweig, W *Klosterhalfen, E. Kriesten,* Pfeifer & Langen GmbH & Co. KG, Germany)

The sugar faetory in Lage operates an anaerobie waste water treatment plant in eombination with ponds for beet soil storage. In re cent years sodium hydroxide was used for adjusting the pH value of the hydrolyzed water. In order to minimize the consumption of auxiliaries the whole system was analyzed and some changes in the conneetions between the parts of the plant we re introdueed. The result of these changes was a different spectrum of acids in the treated water, whieh was better sui te d for methanisation. The use of sodium hydroxide could be omitted in the last eampaign resulting in a eost reduetion of several ten thousands of Euros in eomparison to the previous eampaigns. The methane reaetor operated more smoothly than the years before, whieh is supported also by a reduetion of lime precipitations within the system.

Experienees with anaerobie digestion and green gas produetion *(A. van der Veen,* T. *van der Weg,* Suiker Unie, The Netherlands)

In 2011, Suiker Unie started with year-round fermentation of beet residues. Biogas from the anaerobie proeesses is not used in sugar proeessing, but is upgraded to a high methane eon tent whieh has to meet speeifie standards to deliver "green gas" to the Duteh regional grid. Proeess experienees from design phase to praetieal operation are eovering a wide field, starting with teehnieal issues, biological proeesses and gas upgrading, but moreover regulation of input materials and the use of digestate in agriculture to close the nutrient circle.j t

Sugar beet faetory performance improvement through anaerobie digestion (AD) *(L. Diego, F Martźn,* l. *Sagrista,* M. *Hernandez,* Azuearera, Spain)

Anaerobie digestion of sugary substrates is a well-known way of produeing energy but sometime it ean compete with the eonventional sugar proeess.

The aim of this paper is to demonstrate how the employment of certain sugar beet streams, currently recovered to process to increase the sugar production, for biogas production through AD can improve the overall performance of the sugar beet factory by reducing the energy consumption, reducing the thick juice color and increasing thick juice purity and then improve the factory extraction.

Several triais were carried out in the past to determine the decrease in juice quality (purity, color, ashes content ...) suffered by the recyding to proces s of same sugary streams but as same extra sugar was recovered from them, instead of treating them as a residue, they were kept in the process.

Studying the sugar process and the energy production through AD as an overall process, a big improvement opportunity is detected: instead of recovering some substrates to the sugar process which lead to a decrease in juice quality, and then in energy and extraction, they can be segregated to AD and lead to energy production, achieving a big overall benefit.

The results of pilot-scale and industrial triais will be shown with some streams tested to get the maximum factory performance through AD.

Approach to better beet-washing *(M. Spapens-Oerlemans,* J. *Struijs,* Cosun Pood Technology Centre, *A. Wittenberg,* Suiker Unie, The Netherlands)

Sugar beet from day soils are sometimes difficult to dean, especially when the soil is wet during growth and harvesting. This can result **in** high residual tares after beetwashing, leading to increased knife consumption, we ar to installations, filtration issues of 1st and 2nd carbonatatian juice and undesired levels of HCI-insoluble ash in pulp. During the last decade both the capacity of the Dinteloord factory increased as well as the relative amount of day beets to the factory. Therefore a more effective beetwashing is required in this factory.

To increase the knowledge of the technological design criteria for an effective beet-washing plant for day beets, a trial program was started in 2008. The effect of several input and process variabies on the was h result of drum-washing was examined on pilot scale. Variabies such as washing time, the amount of water to beets, water temperature and pre-deaning of beets we re examined. In the campaigns 2009-2012 further beet-washing triais were carried out on pilot scale drum-washing and jet-washing and on factory scale. The factory measurements we re executed in several West European factories. They consisted of residence time measurements and comparisons we re made between the wash results of different types of wash installations when washing similar Dutch day beet.

The jet-washing triais were carried out to examine the influence that the impact pressure of the jet and the chance that a beet is hit by a jet have on the wash result and on the sugar losses.

The results of the triais are analyzed and the condusions are transferred towards technological design criteria for a beet-washing installation suitable for beet from day soils.

Posters

Azucarera Carbocal (carbonation mud) utilization for mushroom culture optimization *(lA. Jimenez Hernandez,* Centro Tecnológico de Investigación deI Champifión de La Rioja (CTICH), Spain; *A. Garda Zamarreiio,* G. *Mate Araus,* Azucarera (AB Sugar), Spain) The target of the project was to find a more cost-effective alternative to the expensive imported casings which have traditionaUy been used to cultivate mushrooms in Spain, through systematic study and application of mixtures of national materials. The studied materials we re black turfs, blonde turfs, brown turfs, Carbocal Plus and day. Carbocal Plus is the final result of the stabilization of the organic matter from the sugar factory lime. In the casing, it is used as pH corrector and to give structure, to replace part of the turf, and to make it cheaper. After 20 cultivation triais in experimental cultivation rooms, the results conduded that the best alternative for the casing is a mixture made up of 20% of Carbocal Plus, 40% of Spanish blonde turf and 40% of black imported turf. This study highlighted the strength of Carbocal Plus as a pH regulator and the benefits it offers in terms of improving the structure and adding important elements such as Ca, Fe, Zn, Mg and Cu to the casing.

Update on beet juice softening by ion-exchange *(F Rousset,* Novasep, France)
Beet juice softening using ion-exchange technology has become current good practice for some sugar producers, but is still not used extensively by others.
Limits to larger utilization of the technology indude lack of knowledge about this critical process step and associated benefits, and also capital and operating costs in some countries. Several processes are used for ion-exchange softening of thin juice before evaporation. They differ by the type of ion-exchange resin used, and by the nature of the regenerant solution. AU current processes are effiuent-free, as regeneration effiuents can be recyded in the sugar production process.

Sugar beet thick juice in lactic acid fermentation *(Timo Johannes Koch, Martin Bruhns,* Pfeifer & Langen GmbH & *Co.* KG, *Joachim Venus, Leibniz-lnstitute for Agricultural Engineering,* Germany)
Biotechnological production of lactic acid has been studied in various ways, e.g. micro-organisms, fermentation processes, down-stream processes, fermentation substrates, and fermentation nutrients. A variety of different substrates converted by different biological systems has previously been studied. The problems of all processes still are high costs for feedstock and fermentation nutrients. This study evaluates in general the use of sugar beet thick juice as a substrate for lactic acid production.

Microbiological purity of raw and refined white cane sugar *(M. Wojtczak, A. Papiewska,* Łódź University of Technology, Poland)

The increasing role of cane sugar on the European sugar market calls for investigations connected with the control of its quality and microbiological purity in order to guarantee the interests and safety of the consumers. Such investigations should embrace different kinds of commercial cane sugar and raw cane sugar, as well as the problem of the impact of the re fin ing process upon the quality of the final product.

The legislation of the European Union lacks mierobiological criteria for raw cane sugar. This is probably due to the fact that it is treated as an intermediate product that undergoes a refining process to obtain the final product, Le. refined white sugar. The microbiological evaluation of white sugar obtained both by refining raw cane sugar and by beet processing is commonly based on the requirements of the standards developed by the U.S. National Sof t Drink Association (NSDA).

The study material consisted of samples of raw cane sugar and sarnples of refined white cane sugar. In the investigated sugars the analysis concerned the total number of mesophilic aerobie bacteria, anaerobie bacteria, thermophilic bacteria, thermophilic anaerobic bacteria, thermophilic spore-forming bacteria, mucus-forming bacteria, Enterobacteriaceae bacteria, and the total number of yeasts and molds.

Raw cane sugar samples we re characterized by varying degrees of mierobiological eon-tamination. Among the examined microorganisms, the largest share was recorded for mesophilic bacteria and thermophilic bacteria. Assuring proper refining proces s and lowering sugar losses require a control of the microbiological purity of the raw sugar. High degree of mierobiological contamination of raw sugar may eliminate the possibility of using it for direct consumption. It was shown that white sugar obtained by refining various purity raw cane sugars meets the standards developed by the U.S. National Sof t Drink Association.

New developments in decolourisation using activated carbon that reduce operating costs and improve efficiency *(P. Blundell,* J *Warner,* C. *Bryant,* Jord International Pty Ltd, Australia)

Coloured components in sugar are commonly removed by adsorption on activated carbon or ion exchange resin. Each alternative has features that attract advocates all of whom strive to maximise the difference between the benefits gained by removing coloured components from sugar and the cost to operate and install the required process. In this paper re cent developments in the design of decolourising systems that use activated carbon are reviewed. These include improvements in the manufacture of the carbon itself; improvements in regeneration that have reduced energy consumption and emissions to atmosphere. The relative advantages of pulse bed and fixed bed systems are discussed, together with the impact on plant design and operating cost with particular reference to the low colour sugars now available to most refineries. Traditional fuel sources for the regeneration of carbon are reviewed against biogas as

an alternative/supplementary fuel source. Furthermore heat recovery techniques are also reviewed that improve operating costs ensuring carbon remains technically and economically attractive. Operating and capital cost estimates are discussed.

The use and advantages of air cooled vacuum steam condensers in sugar refining applications *(P Blundell, T. Gourinath,* D. *Reeves,* Jord International Pty Ltd, Australia) Air cooled heat exchangers provide a viable alternative to water cooled condensers for condensing evaporating crystallizer and evaporator steam, especially when water is scarce or expensive or cooling tower blow-down disposal present a problem.

For vacuum steam condensing, air has been used as the cooling medium for many years in the power industry. The use of air cooled vacuum steam condensers in the sugar industry however is only a re cent event.

Although a condensing condition of about 0.18 bar (absolute) is common in both industries, those condensers employed in the sugar industry experience different criteria and require significant design modifications to those condensers used by the power industry. Air co ole d condensers consist of heat exchanger tubes which are finned ex ternally, usually with aluminium fins, made into fiat bundles, with air fiow forced or drawn over them by axial fiow fans. These bundles can be assembled in horizontal or A-frame configurations and the relative merits are discussed. Jord has recently installed such air co ole d condensing systems in new sugar refineries in Egypt, Algeria and Israel and more are currently under construction. The operating experience, capital cost, power consumption and important design considerations of these installations are discussed.

Fluidised bed and steam drying news (G. *Caspers, K. Nammert,* H. *Fersterra,* H. *Hatemann, A. Lehnberger,* BMA Braunschweigische Maschinenbauanstalt *AG,* Germany) The drying of pressed sugar beet pulp in a pressurised fiuidised bed with superheated water vapour is widely used in the sugar industry and can be considered to be state of the art for energy-efficient drying concepts in combined plant systems. The process has been used on a large scale in the sugar industry for more than 20 years.

In the past campaign, BMA subjected existing drying systems at various locations to a number of refinements. These systematic process engineering modifications allow the dryers to work more efficiently and reliably. The principles of fiuidisation and of drying in superheated water vapour have been carefully studied, and scientific testing on a laboratory and pilot-plant scale allows the process to be adeąuately described. So far it has not been possible to also fully determine essential operating data in industrialscale plants to provide a sound basis for extensive process optimisation.

Feeding pressed pulp into a fiuidised-bed dryer is a critical phase in the drying process and can lead to malfunctions. The ability to determine the fiuidisation conditions in the first dryer cells provides more detailed insights into the process so that critical situations can be detected at an early stage and therefore malfunctions can be avoided.

Further investigations have shown that the height of the fiuidised bed has a considerable effect on the degree to which steam superheating is utilised and, consequently, on water evaporation. The drying efficiency can be enhanced by changing the height of the fiuidised bed, due consideration given to adequate product transport. Further efficiency improvements have been achieved by improving the fiow conditions in the vapour circulation system.

Grape sugars production - Description of a new industrial plant installed in Sicily (Italy) *(Fabrizio Bartocci,* Sadam Engineering, Italy)

On January 2012, in Mazara del Vallo - Sicily the installation of a new industrial plant for the production of crystalline sugars from grap e was completed.

Crystalline grape sugar is a mixture of glucose and fructose extracted from grap es and crystallized. The production capa city of the plant is about 25 t/day.

The plant was designed by Sadam Engineering (a aompany part of Maccaferri Group Ltd.), which has folIowed the construction, startup and project management. The plant used BMA technologies for crystallisation and separation.

The raw material for the production of grap e sugar crystals is the MCR (RectiEied Concentrated Must), a produet normally used for the correction of sugar centent in wine musts. MCR is a water solution at about 65% of dry substance composed of over 98% glucose and fructose. MCR produced from grap e must through the processes of clarification, demineralization and concentration.

The start up of the plant took place in February 2012 and the purpose of this paper is to describe the main technical issues of the plant and production.

The plant is composed of different stations. The mains are:

- Chromatographic separation, where the raw material is separated in glucose and fructose water solution;
- Concentration, where glucose and fructose solutions are concentrated until crystalisation of dry substance
- Cooling crystalisation, where the crystals grow
- Centrifugation, where the crystals are separated from mother liquor
- Conditioning, where the sugars are dried, cooled and sieved
- Storing and packaging, where the final products are stored in silos and packed in 25 kgbags.

The paper describes also the main production Eigures , included energy consumption.

Revival of the low ternperature belt dryer for sugar beet pulp (5. *Staufer,* W. Kunz dryTec AG SWISS COMBI, Switzerland)

1983 Swiss Combi has installed two low temperature belt dryers (LTD) for sugar beet pulp, each with an active surface of 600 m? and a water evaporation of 30t/h. Whilst one of them has been dismantled with the sugar factory Zeil in 2004, the other is still in

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operation at the Sudzucker plant in OJ.fstein. Pre-drying the beet pulp with was te heat from the sugar plant it has saved more than a Terawatthour of fuel since its start-up. Now, 30 years later the low temperature drying technology has got its revival and 3 Swiss Combi LTD plants have been installed. Since the campaign 2012/13 a LTD with 580 m? pre-dries the sugar beet pulp at the Sudzucker plant in ~ with a capacity of 30 t/h water evaporation, utilizing waste heat from the sugar factory. Besides the natural gas savings it allows to run the drum dryers with lower drum inlet temperature which reduces significantly the emissions.

At Agrana's beet sugar plants in Tulln and Leopoldsdo.rf, LTDs with 870 m? and 45 t/h water evaporation pre-dry the beet pulp, utilizing also waste heat from the sugar plant, additionally fiue gas from the boiler and heat recovered from the drum dryers. Co n-densing the drum dryer exhaust gases allows to heat a part of the LTD at a temperature equal to the wet bulb temperature of the drum dryer exhaust gas. As a side effect it is scrubbed in the condenser, which reduces the dust load significantly and condenses some of the VOC and odour emissions.

With the LTDs the two Agrana plants achieve natural gas savings of 60% for the pulp drying.

The SWISS COMBI belt dryer can dry a wide range of wet biomass to the required mois-ture eontent by using waste heat from other processes. The guaranteed dust concentrations are the lowest in the market .

Extraction of juices using puIsed electric field technology at industrial pilot (O. *Vźdal,* H. *Mhemdi,* Maguin, France)

The pulsed electric field technology (PEF) is promising to extract juice from sugar beet tissues and other biomass tissues. MAGUIN with partners, HAZEMEYER and UTC French University have operated a new industrial pilot at 10 t/h using PEF to extract juices. The purpose was to demonstrate feasibility of the new and patented extraction concept applying PEF technology directly to the tissue without addition of any liquid or any pretreatment or any heating.

After electroporation of the sugar beet tissue the juice quality has been analyzed showing as expected from laboratory research a higher purity and lower color but also much lower pectin and colloid eontent in solution. Taking advantage of that PEF juice is of higher quality, ultrafiltration test have been made with 8 K Dalton up to 300 K Dalton UF membranes. The Ultra Filtered PEF juice showed much lower color traditional elear juice with almost all colorants removed. Other tests demonstrated the good pressability of the cossettes with about 80% of the cell juice at high d.s. eontent and purity extracted directly by the twin screw press smoothly operated. Those results introduce new paths to extract juice from beet tissue and to develop an alternative to the traditional calco-carbonic purification scheme. The last trial was to test with twin press screw the pressability of PEF pulp after imbibition and measuring sugar eontent in the pulp. Results showed that an alternative extraction scheme is possible with low

sucrose eon tent in pressed pulp. Laboratory research showed that the pressability of PEF beet pulp treated at ambient temperature is much higher compared to the wet pulp from extractors. Other important trials in progres s are to tak e advantage of the high er PEF pulp pressability to raise considerably the pressed pulp d.s. eontent after sucrose extraction. The technology is also opening a path toward higher pressed pulp dry matter. Parameters and corresponding data and results are depicted.

A presentation on the integration of all-welded, one-piece Johnson Screerrs'" Vee-Wi re " **screen baskets for continuous centrifugal operation in the sugar industry** (M. *Pierotti,* Johnson Screens, USA)

An important step in sugar production is the centrifugal operation. Selecting quality screens with the optimal slot size is critical to the performance of the continuous centrifugal operation. Low grad e continuous centrifuges are one of the main areas of sugar loss in the manufacturing process.

In the past, Chrome-Nickel screens were state of the art, but required continuous replacement. The lack of tensile strength of the sof t nickel caused the slots to widen, resulting in a loss of sugar crystals. The service life of the screens was also inadequate and resistance to damage was minimal, particularly in larg e centrifuges. As a result, the plant had to continually monitor each centrifuge to determine when it was starting to fail, or had failed. This was not always immediately determined. Often the plant had been losing sugar for days before purity increases were determined to be at a point where change was necessary. Once the failure was determined (usually 30 to 90 days), the plant incurred downtime to change the screen. The downtime to replace the screen was approximately 2 hours per change. When this is multiplied by the number of tons per hour that modern centrifuges produce and then multiplied with the market price of sugar - the results is a very large number.

Today, Johnson Screens" new patented fine Vee-Wire" continuous centrifuge basket is guaranteed to provide a high mechanical strength, a precise slot opening and a larger percentage of open area, increasing the amount of sugar erystal recovery. In addition, this basket provides: long lasting, decreased purity, consistent process characteristics, simple installation (minimized risk of damage during installation and at start up), minimal maintenance requirements (reduced labor cost and downtime) and slot widths to suit individual mill requirements (optimize process benefits). With over 100 screens in operation worldwide, and a normal wear life of 3 years, plants have seen, in some cases, as much as $300,000/centrifuge in increased sugar captured per season.

Scale formation

A new test method to investigate and predict the scale potential of juices (5. *Frenzel, T. MicheZberger,* Sudzucker AG Mannheim/Ochsenfurt, Germany)

A speciallaboratory evaporator has been developed to study the scale potential of thin juice while concentrating it in evaporation. The design, test procedure and functionality of the equipment is described.

Evaporation trials with thin juice, without addition of antiscaling agents, were carried out to determine the scaling behavior of thin juices from different factories. The initial experiments have demonstrated that a relatively long time span is required for a substantial and reproducible build-up of scale deposit on the heat-exchange surface in the lab evaporator. In addition, the results of scaling tests of juices with high scale potential are reported.

An artificial thin juice has been used in order to test the effectiveness of different anti-scaling agents. The new scaling test enables to distinguish the juice scaling behavior when different antiscalants are applied at increasing dosage rates. These experiments are ongoing. The aim is to develop a reliable comparative method to test the effectiveness of available antiscaling agents.

Composition, formation, removal and avoidance of scales in evaporators and heat exchangers of sugar factories (D. *Grossmann, J Gryc, F 5tanjek,* Keller & Bohacek GmbH & *Co.* KG, Germany)

The intention of this paper is to give an overview about scaling in sugar factories, with the foeus set on beet sugar factories but also including aspects which are specific for cane sugar production.

Based on the analyses of some thousand scale samples collected during the last 40 years from sugar factories all over the world typical scale compositions and their abundance depending on factors like region, operation conditions of the factory, effect and type of evaporator are shown. Long time trends in scale composition and their relation to changing conditions in the sugar production are extracted from these data, e.g. the influence of longer campaigns (up to 140 days) on the scale composition in beet sugar factories in Central Europe. Based on its composition and the conditions during factory operation the formation of a specific scale is explained. This includes scale compounds like e.g.

- Ca-oxalate, being found in sugar factories worldwide,
- Silicates, including Al-Silicates, resulting from limestone or sugar cane,
- Ca-aconitate, being specific for South America,
- Ca-sulfite and -sulfate, resulting from sulfitation,
- Ca-phosphate, often found in the first effects of cane sugar factories,
- Ca-carbonate, sometimes found in the first effects of factories with carbonatation,
- Sugar coal and caramelized sugar, found e.g. in falling film evaporators,

- Ca-saccharate, as part of specific scales found in the first effect of some beet sugar factories.

For each type of scale a method for the removal, proven by laboratory studies and experience gained in the factories, is presented and recommendations are given to reduce or avoid the formation of a specific scale.

Physico-chernical **characterization of** particie s **that cause turbidity of beet sugar solutions** *(E.-S. Abdel-Rahman, E. Floeter,* Technical University Berlin, Germany)

The quality of white sugar is a concern for international markets, consumers and food processors such as drink manufacturers. The level of non-sugar particles whether components of turbidity or insoluble residual in process streams is a quality parameter for the clarifier and filter performance in sugar factories. Their performance is directly linked to sugar quality.

Knowingly the turbidity is related to calcium salts. Larger insolubly particles (» 1 urn) we re found to be predominantly calcium carbonate while smaller particles were identified to be calcium oxalate (CaCPJ In this contribution different methods to address the issue of turbidity will be discussed. Stepwise filtration and analysis of the composition of solid residue confirm the composition size correlation. Aspects such as the dependence of turbidity to hardness (Ca-ion content) and level of oxalic acid and means to reduce the levels of key components for turbidity development will get attention.

Deteriorated beet

Experiences with the invert determination in the beet lab (D. *Vermeulen,* Cosun Food Technology Centre; *P Gulden, A. Wittenberg,* Suiker Unie, The Netherlands)

During the campaigns of 2010, 2011 and 2012 trials have been conducted in the beet lab of Suiker Unie to determine the invert sugar eontent in the brei of the beet samples. Suiker Unie has started to study the invert determination in the beets for several re asons. Beet campaigns are longer now than in the past, which is in part due to the consolidation of the sugar production in the Netherlands. As a result of these longer campaigns, more beets are stored for longer periods. Furthermore, new harvest rnethods are shifting from topped beets to defoliated beets.

Less optimal storage conditions or beets that are damaged by frost or are delivered with more crown lead to elevated levels of invert sugar in the beet. In the sugar factory, invert sugar leads to loss of alkalinity and may result in additional sugar losses in the molasses. Monitoring of invert sugar in the beets delivered may help the growers to maintain optimal beet quality, which is also a benefit to Suiker Unie.

The triais of 2010 and 2011 were carried during part of the beet campaign with equipment from different suppliers. The invert sugar detection based on the benzamid

method had some restrictions such as the maximum limit that can be measured and the reproducibility. Also the costs and the workload are high. The alternative method that has been tested is a glucose measurement with immobilised enzyme. Based on the results of these tri als it was decided that for the campaign of 2012 all beet samples were to be analyzed. Both analysis lines in the beet lab were equipped with a glucose meter based on a method employing an immobilized enzyme. From the analyzed glucose concentration, the invert sugar content is calculated.

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Experiences with the objective detection of deteriorated beet (W *Hein, F Emerstorter.* T. *Neururer,* Zuckerforschung Tulln, Austria)

With increasing sugar beet campaign lengths over the las t years, a range of measures were implemented in Austria in order to improve the processing of deteriorated beet. Consequently, possibilities for the objective detection and evaluation of beet quality we re tested. This included an image analyzer, which detects the share of dark-coloured beets on the belt conveyor, determination of volatile organic compounds (VOC) above the cossette belt conveyor by means of a flarne ionization etector as well as the determination of glucose in raw juice and an automated determination of the optimum end-point of the 1st carbonatlOn and effective alkalinity juices in juice purification. Apart from discussing the technical set-up of the measurement systems also the possibilities how to use the information for operating the process, e.g. for optimizing the application of dextranase or the amount of milk of lime in juiee purification are presented. These systems, which were originally developed and tested in Austria in the factory Tulln, are now being implemented bit by bit also in other factories of the Agrana Sugar Division.

Determination of the micrrobiological activity during the procesing of damaged sugar beets *(M. Wojtczak; A. Papiewska; E. Chmal-Fudali; A. Antczak,* Łódź University of Technology, Poland)

Mannitol is now known to be a major degradation produet of sugar beet by *Leuconostoc* infection and can be considered as a marker of mierobiological contamination of beet and beet juiees. Mannitol is a more sensitive indieator of sugar beet deterioration than lactic acid or dextran. Thus, the mannitol eontent can be used to predict sucrose losses and dextran-related problems in the factory. The mannitol eontent in beet brei or beet juices is suitable for determining the degree of deterioration by microorganisms, mostly by *Leuconostoc,* during long periods of beet storage. The content of mannitol can be also used to evaluate the activity of bacterial species during beet sugar processing. In the present study, high performance anion exchange chromatography (HPAEC) with electrochemical detection was used for determining mannitol eontent of thin juiee subjected to spontaneous fermentation at 30 "C. At the same time, glucose and fructose content was determined. The eontent of lactic and acetic acids was also determined by HPACE with conductometric detection. Chromatographic analysis was performed

with an ion chromatograph DIONEX ICS-3000 with an electrochemical detector and conductivity detector with suppressor ASRS-ULTRA II.
The obtained results show that the high performance anion exchange chromatography with electrochemical detection makes it possible to determine the mannitol eontent in juices during sugar processing, and thus it allows for on-line monitoring of micro-biological contamination of juices and syrups. Consequently, it could be a sensitive indicator of sugarcane and sugarbeet deterioration as well as a sensitive indicator of microbiological infection. AdditionalIy, the simplicity of the method, the small volume of sarnples and short time of analysis to obtain information about the ion composition of the material studied, makes the HPAEC technique particularly suitable for periodic control of mannitol in intermediate products during sugar processing.

Nitrite

Overview of activities and preliminary results of the ESST Nitrite Study Group *(S. Frenzel,* Sudzucker AG Mannheim/Ochsenfurt, Germany)
The presentation intends to give an overview about the activities of the ESST study gro up "Nitrite in Feed". At the las t ESST conference in Bratislava this study group was commissioned for investigating the origin of nitrite and its development all along the sugar process. The study gro up is guided by the Scientific Committee of the ESSI.
The complex matter of nitrite formation, distribution and degradation in the sugar proces s is ruled by numerous parameter, some to be considered already at an early stage like the soil and the growth conditions for the beet. The weather and other environmental conditions influence the uptake of nitrate by the beet. By this way nitrate is introduced into the process and serves at several process steps as acceptor for reducing equivalents by nitrate-reducing bacteria thus forming nitrite. A lot of efforts we re put in investigating the prevention of forming of nitrite at the extraction process (preventing the formation of nitrite matters more than elimination of once formed nitrite). For this purpose different diffusion systems (tower diffusion, RT-drum and DDS-trough) of several European factories were selected for a detailed monitoring. "Hot spots" indicating locations with elevated nitrite formation were identified. The location of these hot spots and the nitrite forming potential seem to vary from year to year and from factory to factory. The presentation gives also a review on the nitrite contents in different intermediate and final product. According to these preliminary results of measuremen ts applying not validated analytical methods it seems that elevated or low nitrite levels appear simultaneously in many factories during the same campaign. External factors like the beet quality influence significantly the nitrite level in the process of the respective factories.
Some activities dealt with the control of the microbiological activities in the diffusion systems. Aeration of the diffusion systems for suppressing the nitrate respiration and

application of biocides were investigated. Among other results it turned out that the elevation of the redoxpotential in the diffusion tower by dosing air to the tower did not influence the nitrite formation.

Most of important was the development of an analytical working method which enabled the involved researchers to observe the proces s behaviour. Currently there does not exist a validated method for the determination of nitrite in the complex matrix of the sugar juices and feed products. Therefore the study gro up first had to develop a provisionally working method. This working method is only suitable to observe the trend of the nitrite level at different process steps and serves the ESST study gro up to evaluate the results of technological trials/investigations. It is not a validated method and does not meet the requirements of an official control method for feed. Due to this uncertainty all presented nitrite values have to be regarded as preliminary.

It is obvious from this presentation that many difficulties in understanding the compl ex behavior of nitrite in the sugar process still remain.

Precision of the determination of nitrite in feed and status of the CEFS monitoring

CD. *Martin,* Sudzucker AG Mannheim/Ochsenfurt, Germany)

Different analytical methods for the determination of nitrite in molasses and beet pulp are compared. An ion chromatographic method has been developed and checked for precision data such as recovery, limit of quantification, and linearity in a single lab validation procedure. Repeatability, reproducibility and ruggedness against variation of chro-matographic conditions have been tested in a collaborative study. Furthermore results of a 3rd European monitoring program conducted by CEFS are presented in comparison with previous investigations.

Nitrite formation and degradation - New knowledge collected during 2012 campaign in Nordzucker CF *Emerstorfer,* W *Hein,* Zuckerforschung Tulln, Austria; C. *Bergwall,* M. *Bengtsson, JP Jensen Name,* Nordzucker Innovation & Technology, Denmark) During the 2012 campaign the work to clarify the microbiological pathways for nitrite in sugar beet extraction have been continued within the ESST working group. Main activities have been conducted within Nordzucker and Agrana in many areas such as factory monitoring, test of control strategy including test of biocides, laboratory reactor characterization of microbiological pathways, influence of nutrients, inhibitors and nitrate etc. The contribution will focus on new findings from these investigations and include also other observations from participants in the ESST working group.

General sugar technology

Operating a be et **yard without antifoam agents** *(T.] Koch,* Pfeifer & Langen GmbH & Co. KG, Germany)

In the sugar industry various auxiliaries are used for solving minor and major problems in processing beets, juices and different side streams. Part of these are antifoam agents which are employed to minimize trouble with foam formation in water and juice cycles starting from the beet yard and ending in the sugar house or waste water treatment. Beside their positive aspects these substances are connected to costs and also impact on humans and environment which always leads to the necessity of reduction. Typically the use of these agents is primarily related to technical problem s and the solution thereof. By an extended study over three campaigns the use of these antifoam agents in water circles on the beet yard was investigated by a socio-technological perspective. In detail it is described what employees expect from the use or non-use of the auxiliaries and according to which principles the antifoam agents are dosed. Parts of the study are experiments which show how the employees and the process react to situations where the dosage of antifoam agent to the water cycle on the beet yard is partly reduced or fully stopped.

Evaluation of energy cane and sweet sorghum as feedstocks for conversion into fuels and chernicals *(Vadim Kochergin.* Audubon Sugar Institute, now Amalgamated Research Ine., USA)

A regional multidisciplinary consortium of agricultural scientists, biotechnologists, technology and engineering providers, economists and educators has been created to facilitate conversion of energy cane and sweet sorghum crops in to aportfolio of bio-based fuels and chemicais. The project was funded by National Institute of Food and Agriculture of USDA. Selected crops and improvement in their production are being evaluated through utilization of low-input, sustainable systems to ensure an uninterrupted supply of carbohydrates and fiber to biofuel production facilities. A training and demonstration facility is being expanded to support research, education and extension goals for the emerging biorefining industry. The facility that simulates the front end of a proposed biorefinery, includes equipment to extract convertible sugars and proces s selected feedstocks into storabie syrups. Raw and purified syrups obtained from both liquid and lignocellulosic portions of the plants will be evaluated by conversion partners to demonstrate production of butanol, additives for gasoline, diesel, jet fuel and bio-isoprene. Pathways have been generated linking regional agricultural production scenarios with different processing pathway. Regionally appropriate business-marketing models that integrate biobased fuels and products into existing logistics and supply chain infrastructures are being developed based on inputs from agricultural research and techno-economic

analyses. Results of first year progress will be discussed, produetion cost of various feedstoek and its yields and processing effieieneies through various scenarios are ealculated.

The eontent of organie acids in eane and beet white sugars *(A. Antczak, K. Lisik;* M. *Wojtczak,* Łódź University of Teehnology, Poland)

The increasing entranee of white eane sugar to the European market requires proper reaetion of both sugar produeers and industrial users of sugar. It is thus quite justified to earry on analysis of eane sugars coneerning their quality as well as funetional properties.

One of the speeifie eriteria in the proeess of evaluating the quality of sugar may be the content of organie acids. Organie aeids present in sugar manufaeturing may be divided into two groups: Acids forming insoluble ealcium salts *(eg.* oxalie, tartarie, citric) and aeids forming soluble ealcium salts (eg. aeetie, laetie, formie, galaeturonie and malic). The formation of insoluble ealcium salts of lime allows for the removal of acid from the juiee during the produetion process, while soluble ealcium salts ean be passed on through all stages of the produetion proeess and finally they may pass to the final produet.

The study presents information about the usefulness of high-performance anion exehange ehromatography HPEAC method for the determination of some organie acids in beet white sugars and refined white eane sugars.

The study found no statistieally signifieant differenees in the eon tent of the analyzed organie aeids in beet and refined eane sugars. In the ease of plantation white eane sugars the content of aeetie acid and citrie ae id was signifieantly higher. The analyses show the usefulness of the applied method for the evaluation of the content of organie acids in white sugars of different origins. Determining organie acids in white sugars ean result in a more precise evaluation of sugar quality and the effeetiveness of the technological process.

Possible improvements of lime utilization efficiency *(P Wawro,* Nordzueker Polska S.A., Poland)

Primary strueture of suerose - lime sediments reeeived in the reaetion between lime and suerose solution at the temperature close to the room temperature was investigated.

The experiments of double ion exehange showed that suerose -lime sediment eontains CaO at least in two forms. About 80% of the sediment takes the form of oecluded CaO and the 20% forms sable compound (-s). This eompound is stable in water solutians. The solubility at *roam* temperature is low, ea. $6{,}6 \cdot 10^{-4}$ mol/dm". Passible teehnalogieal applieatians has been discussed.

Managing change in ABSugar's Chinese beet sugar factories *(F. Hinson,* AB Sugar, United Kingdom)

The Chinese Beet Sugar Industry has undergone significant reforms since the turn of the 21st century, a move which prompted the expansion of ABSugar's footprint from the south of China into the North.

Socio-economic and political challenge s notwithstanding, the technological challenges that the factories face are considerable, with under-sized assets and extreme environmental conditions. Change management in the business has been through much iteration in re cent years. The business currently embraces a bottom-up approach to innovation whilst retaining decisions on capital spending at a centralievel, a process that has seen a rapid increase in the uptake of new technology and ideas.

With the glob al sugar industry entering a period of significant change, there is certainly the potential to leverage lessons from ABSugar's last 6 years in China to improve the position of some smaller, less efficient industrie s in the world.

This paper aims to present a roadmap of the process that the North China business has been through in order to reach this point. Specific examples will be used to highlight the successes and pitfalls along the journey, and hopefully provide some lessons on how to effectively manage change and successfully embed new technologie s into a long established industry.

Theoretical and practical experiences with molasses exhaustion in Nordzucker

(M. *Carter,* S. *Heppner, T. Bech Andersen,* Nordzucker)

The cooling erystallizer stations at many factories have be en modernized over the past 15 years as part of factory upgrades. This has been done either by installing new equipment or by transferring equipment from closed factories. As part of investment decisions theoretical predictions we re made to estimate the benefits in sugar recovery. This required the development and validation of a computer model to simulate the cooling crystallization process. The presentation will review both theoretical and practical experiences in molasses exhaustion measured at seven different factories all using different cooling erystallizer and sugarhouse set-ups.