

## **Sugarsweet campaign using the TOCN-4100**

### **Wastewater processing in the sugar industry**

“Campaign” – this is the way the sugar industry calls the time from September to January in which sugar beets are being harvested, transported and processed. Sugar fabs work round the clock during this time. Sugar beet cells contain approximately 78 percent water, which is eliminated into the wastewater during the production process. It is therefore of great interest to the sugar manufacturers to process and clean the considerable quantity of wastewater fast, economically and with validated parameters before it is discharged into the sewage effluent.

Shimadzu News visited the Union Zucker Süd-Hannover Ltd. plant in Nordstemmen, Germany, where the new Shimadzu on-line TOCN-4100 system has been used in a test run in order to optimally control the performance of the company-owned wastewater treatment plant with a capacity equivalent to approximately 1 million inhabitants. Dr. Manfred Brei explained the details to Dr. Heribert Hohmann (Shimadzu News).

*Shimadzu News: How much sugar is being produced in your plant and which production steps are required?*

Dr. Brei: Our main product is crystalline sugar for industrial applications. Approximately 20 percent of the sugar produced are for household use. In addition, we produce powdered sugar and gelling sugar. Fodder, fertiliser and molasses are obtained as by-products. During each campaign, approximately 800.000 tons of sugar beets are processed into 130,000 tons of crystalline sugar via extraction.

The sugar beets, which are pre-cleaned on the field, are first washed, cut and subsequently subjected to extraction. The sugary extracts are then subjected to a clean-up procedure and are then concentrated in an evaporation chamber by water evaporation. The sugar is obtained from the cleaned and concentrated fluids via multiple crystallisation in a vacuum crystalliser and yields the pure white crystal, which we know from our household shelves.

*Shimadzu News: Which types of wastewater accumulate during these production steps and where is the TOCN-4100 system put to use?*

Dr. Brei: During the clean-up of the sugar beets, highly polluted wash- and transport water with chemical oxygen demand values of up to 20,000 mg/ml are produced. In addition, we are dealing with a condensate resulting from the evaporation- and crystallisation process, which is severely polluted with ammonia-nitrogen. Nitrogen pollution can amount to 150 mg/l of ammonium nitrate.

Both types of wastewater are strictly separated. The highly polluted rinsing water is acidified and then anaerobically pre-cleaned whereby the COD is de-

creased by at least 95 percent. Subsequently, an aerobic purification step, consisting of nitrification and denitrification, is applied. In this step, the remaining COD will be further reduced. This way we manage to reduce the COD by more than 99 percent.

The condensate polluted with ammonia, which results from evaporation and crystallisation, is being treated in the same purification plant. The ammonia-nitrogen is oxidised via nitrification to nitrate and subsequently, in the denitrification step, irreversibly removed from the process as  $N_2$ .

A relevant parameter for the optimal control of the purification process is sludge pollution of the active biomass with respect to the added carbon and nitrogen. At this point, the TOCN-process analyser comes into play, which allows us to continuously measure the total organic carbon content as TOC parameter and the total nitrogen content as TN parameter. These parameters are used to optimise the wastewater treatment process.

*Shimadzu News: What does the correlation of COD to TOC look like?*

Dr. Brei: The instrument itself will supply NPOC data (non-volatile organic carbon) as well as total nitrogen values. The NPOC values are being used because, for wastewater from our plant, which is being treated biologically, the solutions are saturated with calcium carbonate and their carbonate content is not relevant for the capacity and control of the wastewater treatment plant.

All through the campaign data are being collected. Using identical samples, the data of wet-chemical analyses are continuously compared to the instrumental data and are correlated with respect to COD- and NPOC-values, as well as to the sum of N (nitrate, nitrite, ammonia) and TN in mg/l. We will certainly continue using these types of comparative measurements in our next campaign, because we expect that these values will fluctuate from year to year – for instance due to the growth conditions of the sugar beets and to the varying production conditions.

Based on our experience so far we expect, however, that the COD/NPOC correlation at the conclusion of these tests could surely be established with an acceptable tolerance limit. A preliminary evaluation is carried out using the graphic representation of COD and TOC. The data obtained represent the measuring values from one of the reaction step in the wastewater treatment plant which means, they represent one of the measuring channels of the TOCN-4100. The degree of wastewater clean-up in these sample streams is quite varied and reaches from non-treated raw sewage up to completely biologically purified wastewater, which may be discharged into the sewage effluent. This may explain the non-linear behaviour between COD- and NPOC-values.

*Shimadzu News: In your opinion, what are the advantages that are offered by the on-line TOC and TN system in wastewater process control?*

Dr. Brei: For instance, in order to optimally carry out the denitrification step, the ratio of C to N must be adjusted. The relevant amounts and the control parameters for the purification process, for instance volume streams, are continuously measured. In order to determine sludge and biomass, continuous concentration measurements can now also be included. This will indeed allow us to implement an on-line process control. In addition, the wastewater volume from production can be constantly monitored, in order to quickly recognise and stop possible undesirable emissions in the wastewater treatment plant. In addition to cutting costs, another advantage is that the laboratory capacity can be optimally used. In the laboratory it is not possible to carry out the complete analytical method needed for our purposes without the aid of process analysers. On the other hand, we cannot blindly rely on the process analytical system. We certainly have to test whether the system will stand up to validation. Laboratory and process analytical systems will have to work closely together.

*Shimadzu News: In the current campaign you have tested the on-line TOCN-4100 system and integrated it into your project. What is your experience?*

Dr. Brei: We did not know beforehand whether it would work for what we had in mind. Today, we know that it does and in addition, it functions without problems. I was convinced by the way of sample pretreatment and how sample homogenisation are handled by the system, because we have obtained data, which, in spite of the considerable content of solids, only show an extremely low degree of scattering. We actually did expect many problems caused by the solids content and the high degree of incrustation due to calcium carbonate saturation of the sample streams. We think that using additional automated acidification of the sample delivery units, the remaining problems are solved.

At present, we operate the on-line analyser using four sample streams. In the next phase, we plan to increase this to six streams. Integration of the on-line measurement using the TOCN-4100 for control and regulation of our process-analysis system is now being considered.

*Shimadzu News: Dr. Brei, thank you for this discussion.*

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