#786, S.I.T. Conference in New Orleans, May 2000

Recent Developments and New Applications of In-Line Colour Measurement on Crystalline Sugar

Abstract

Cost-effective operation of centrifugals requires frequent monitoring of the centrifugal performance. In order to optimise the separation process without sacrificing the quality many beet factories and refineries have installed Neltec ColourQ 800 in-line instruments for continuous colour measurement. The instruments are calibrated to ICUMSA colour in solution and have a good accuracy. Compared to the lab results, the instruments don't add any significant error. The range of colours measured at different installations is from below 10 up to 4000 ICU.

Author

Bjarne Chr. Nielsen Neltec, Bevtoft, Denmark

Introduction

Process optimisation is an important factor in keeping production costs and energy consumption as low as possible. Larger variations in the process are expensive to correct and may lead to a quality outside specifications.

For more than 10 years Neltec has supplied robust and accurate in-line colorimeters to the sugar industry. Frequent exchange of experiences and requests from existing or potential clients have led to continuous expansion of the application range, improvements in the instrument, and further development of the user interface.

The basic function and applications have been described in (1). The instrument has been tested by the Zuckerinstitut in Braunschweig (2), and by the Sugar Industry Research Institute in New Orleans (3,4). Sugar producers have reported about the use of the instrument in the production (5,6,7,8). Further reports by sugar producers are under publication. The instrument is considered an interesting emerging technology for the 21st century (9).

Recently, a sugar producer has experienced a Standard Error of Prediction (SEP) measured between laboratory colour determination and the in-line instrument with a value just below 1 ICUMSA unit. A beet sugar factory has used the instrument to measure – separately – the colour of two different qualities conveyed in the same scrolling conveyor. A refinery has installed the instrument on a conveyor with raw, washed, and dried cane sugar. (The results will be reported by the refinery). For instruments on belts and shaking conveyors the user interface has been developed further.

Good Accuracy

Just before the juice run in 1999, the Union SDA sugar factory in Bucy-le-Long, France installed an instrument on a shaking conveyor with moist sugar after the centrifugals. After the calibration of the instrument it was tested by comparing its results with laboratory measurements. See Figure 1.

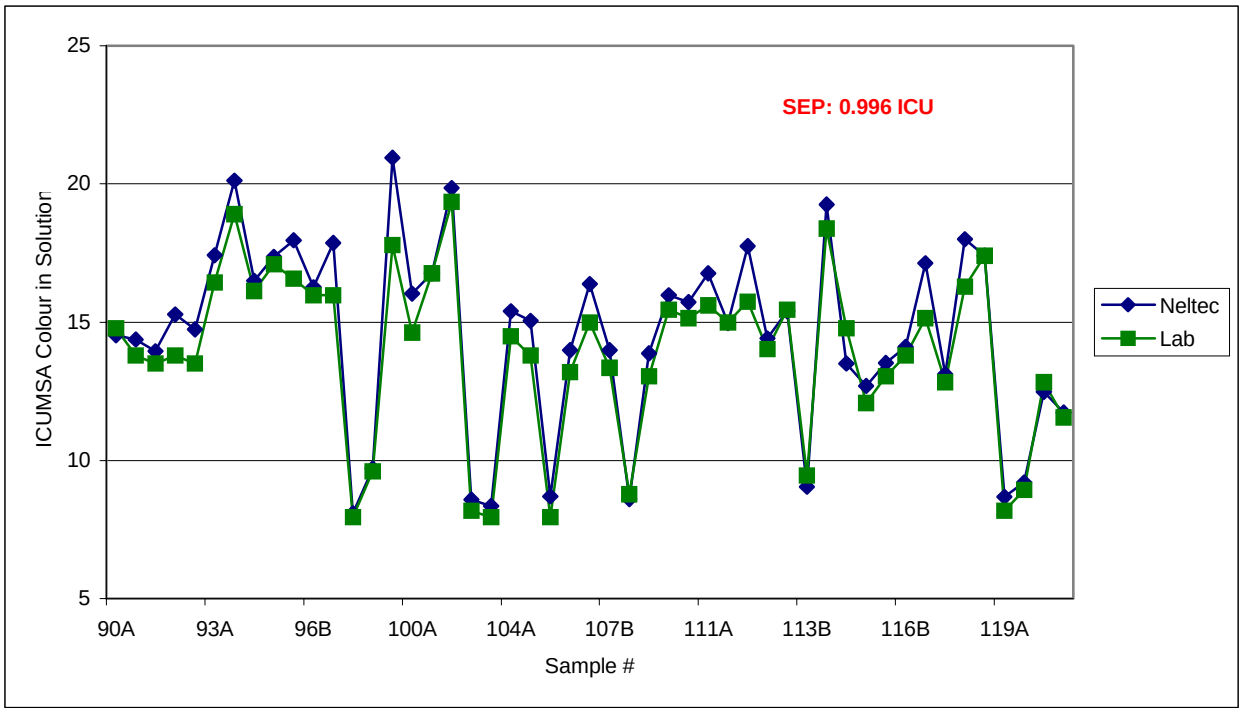

Figure 1

Two Different Qualities in One Conveyor

For the 1999 campaign the Nordzucker factory in Großmunzel, Germany, installed an instrument on a scrolling conveyor with moist sugar. The centrifugals discharging into the conveyor produced two different qualities. After the conveyor the two qualities were mixed into one product.

In order to monitor both original products, it was necessary to develop special software to keep the measurements on the two qualities separated, and to present the results separately. Figure 2 shows a photograph of the display.

The upper graph shows in light blue lines the colour of the sugar produced during the preceding 30 minutes. One of the two qualities has a colour in the 40 to 70 ICU range, while the other has in the 80 to 120 ICU range. The black curves are measurements on the bottom of the conveyor between the charges. These measurements are not included in the calculation of average colour.

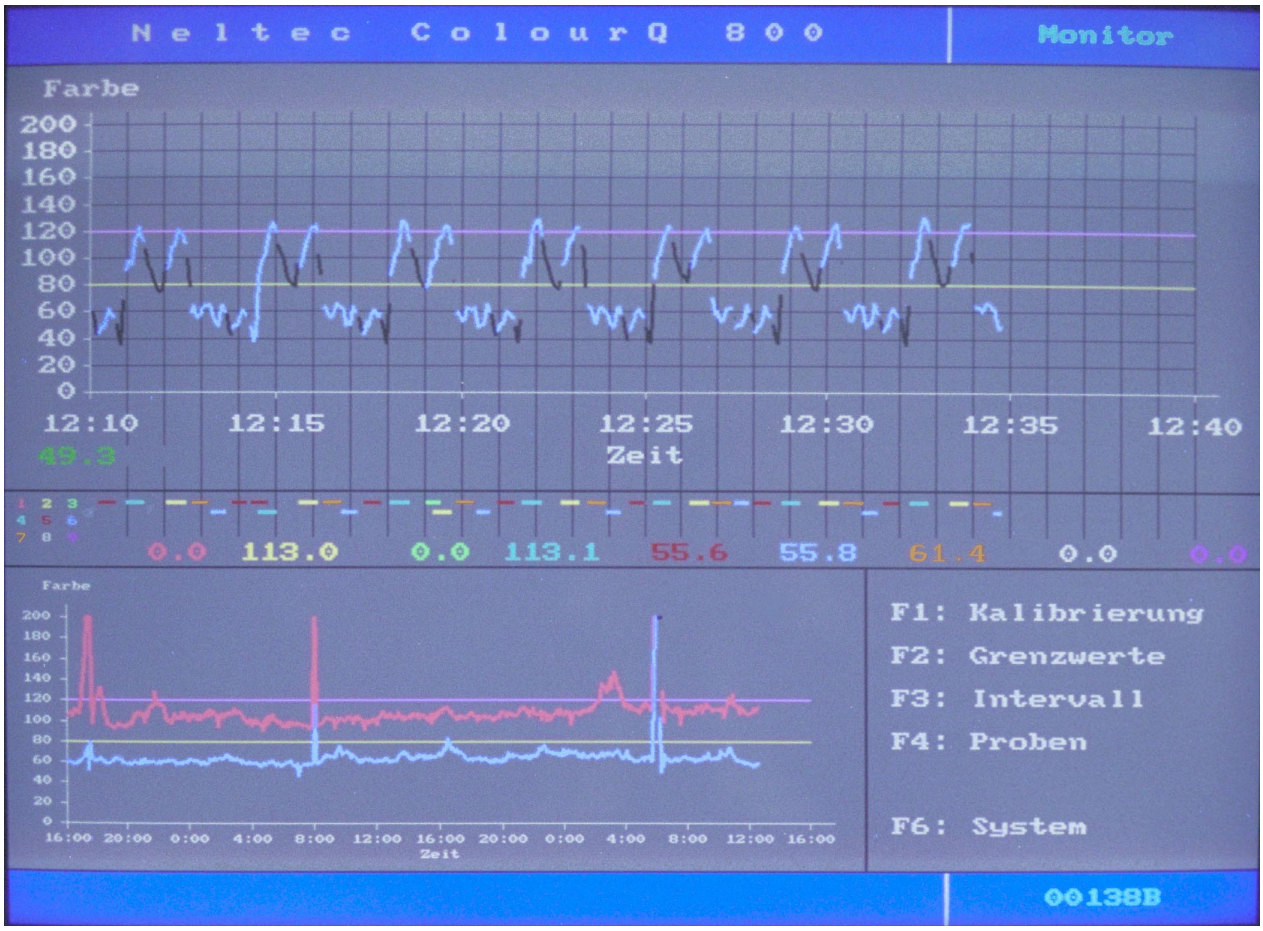

Figure 2

Below the upper graph is a field with a belt of horizontal coloured stripes. They indicate which centrifugal is being measured at any time. The stripes' colours correspond to the coloured numbers to the left. Here you see a red colour indicates centrifugal number 1, yellow number 2, green number 3, etc. If more than one centrifugal delivers sugar in the area of measurement at the same time, then the stripe for the second centrifugal is shifted down one line.

Just below the coloured stripes you see a row of numbers. They are the average colour over the last 15 minutes for each centrifugal. Centrifugal number 2 (yellow) and centrifugal number 4 (cyan) deliver sugar with almost exactly the same colour, 113.0 and 113.1 ICU respectively. This indicates they are both running without problems. The centrifugals 5, 6, and 7 deliver sugar with colour 55.6, 55.8, and 61.4 ICU.

The curves at the bottom of the display show the average for each of the two qualities over the preceding 48 hours. The curves show the fast reaction to any problem in the process. Shortly after the instrument detects a colour increase the problem is corrected and the colour gets back to the correct level.

New Design of User Interface

In the older version of the user interface it required some training to follow the colour variations within each charge. Trending for each centrifugal was not easy. Therefore a new version has been programmed. Figure 3 shows the display.

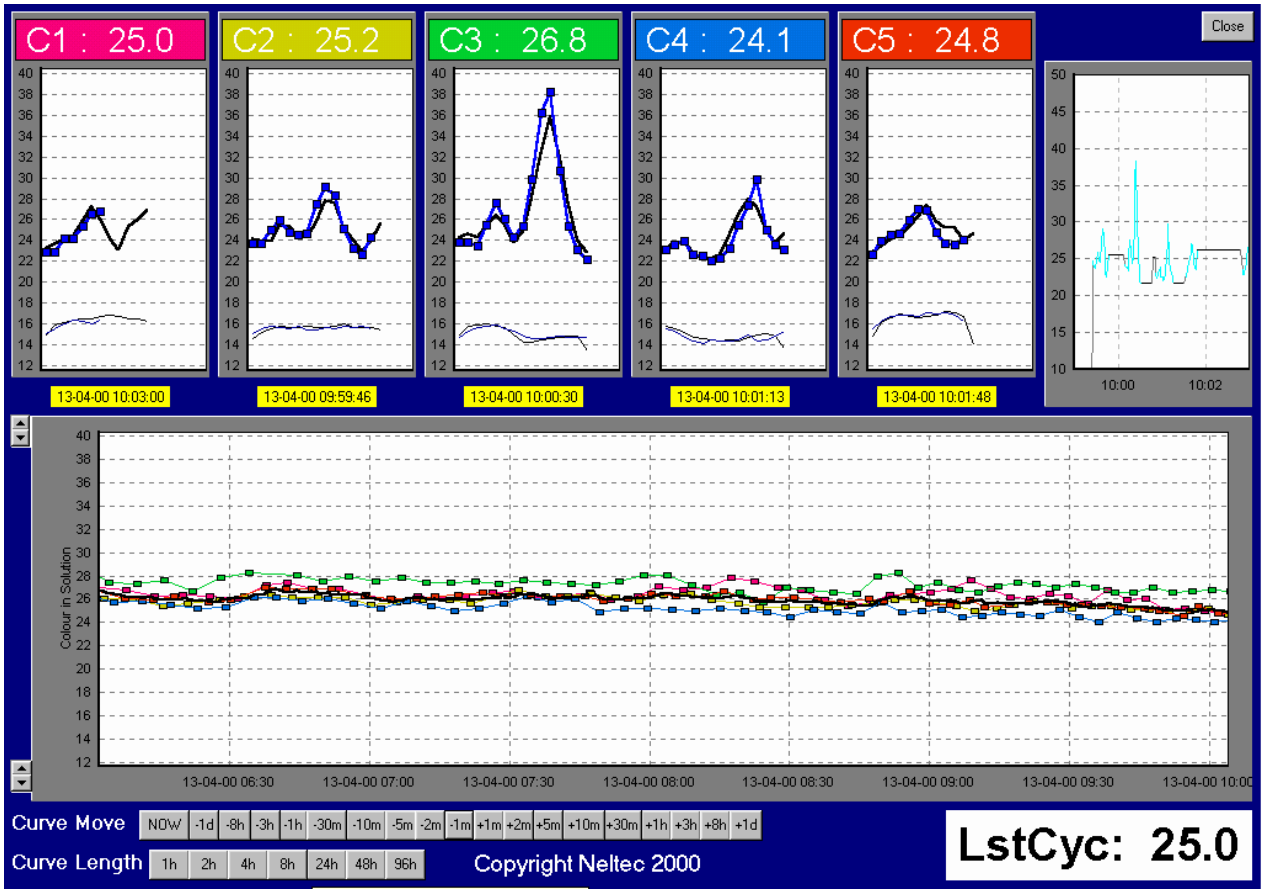

Figure 3

The five fields in the upper half of the display each represent the actual state of one centrifugal. (The number of fields can be adjusted to the actual number of centrifugals.) The centrifugal number is written in the top of the field, followed by the mean colour of the most recent discharge from this centrifugal. Comparing the five numbers you see the relative performance of centrifugals.

The curves with blue square markings show the colour variation from the start to the end of the most recent charge for each centrifugal. The curve with a solid black line is the average colour over the preceding two charges at corresponding points during the discharge. The two thin lines show the amount of sugar on the conveyor. The blue line is the most recent discharge. The black is the average over the two preceding charges.

The yellow field below shows the time of the last measurement made on sugar from this centrifugal.

The coloured background behind the centrifugal numbers is a code to the curves in the lower half of the display. Points for each centrifugal are coded with this colour.

In the large graph one point represents one charge from one centrifugal. All points for one centrifugal are connected with lines to make trending very easy. The black curve is the average colour for all centrifugals over the last cycle. This graph shows historic values. It can be adjusted by the user to show the history from one hour to four days back in time. If you want to see history further back, you can shift the curves backward as long as you wish.

When you shift the curve back in time, the small curves with centrifugal details follow. In this way it is possible to analyse the performance of a centrifugal weeks back, second-by-second.

In figure 4 the curves show the influence of increased washing. All centrifugals deliver sugar of almost the same quality, and the colour variation within each charge is very small. The resulting sugar quality is very good, but at a cost.

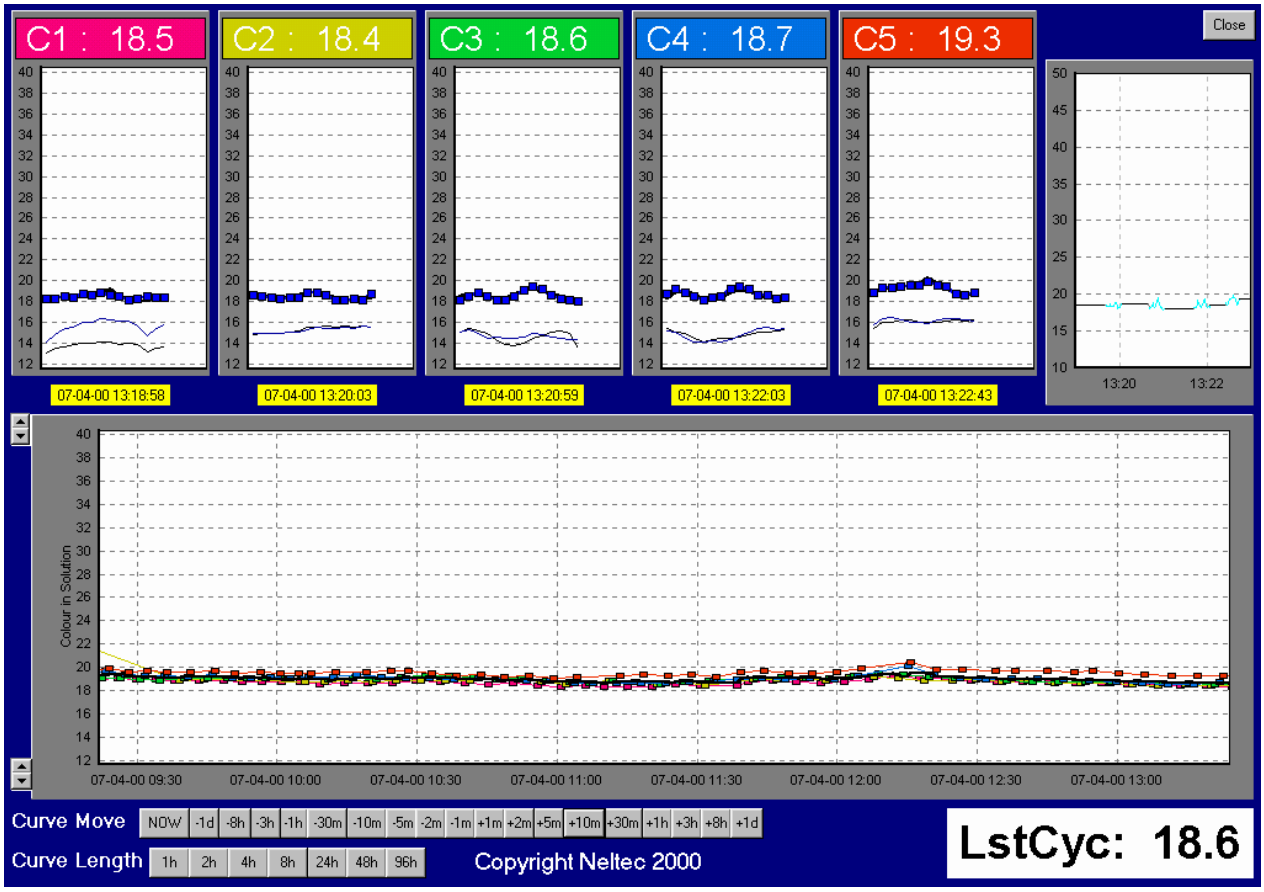

Figure 4

Summary

This paper has presented some recent developments in process monitoring and control for sugar manufacture by use of in-line colour measurement. Different applications of a robust and accurate instrument have been described.

Acknowledgements

The author is most grateful to Mrs. K. Fauter, Nordzucker, Mr. Laurent Bienaimé, Groupe SDA, Mr. Franz Führer, Agrana, Mr. Michel Mabillot, Eridania Béghin-Say, Mr. Ronan Malgoyre, Saint Louis Sucre, Mr. Per Nielsen, Danisco, and Mr. Günther Witte, Südzucker for many helpful discussions and suggestions.

References

1. Nielsen, B. C. (1996). In-line colour measurement of sugar in ICUMSA units. Proc. Sugar Proc. Res. Inst. Workshop on Separation Processes, pp. 215-227.
2. Buchholz, K. and H. Puke. (1995). Report of the investigation of the NELTEC-instrument for measurement of white sugar colour in solution at the Nordstemmen factory of Union-Zucker Südhannover GmbH. (In German).
3. Edye, L. A., Clarke, M. A., and Nielsen, B. C., (1997). On-line Measurement of Colour in Raw and Refined Sugars. Proc. Sugar Ind. Tech. Inc. Conf., pp 57-68.
4. Nielsen, B. C., Blanco, R. S., and Clarke, M. A., (1998). On-line Color Measurement of Raw and Washed Raw Cane Sugars. Proc. Conf. Sugar Proc. Res. pp 506-518.
5. Buchholz, K. and M. Bruhns. (1995). The 1994/95 campaign in Germany and new technological developments. (In German) Zuckerindustrie 120: 357-358.
6. Bienaimé, L. and Nielsen, B. C., (1999). White sugar colour in solution, Comparison of Laboratory and In-Line Methods. Proc. C.I.T.S. Conference, Antwerp, Belgium, pp. 465-469.
7. Malgoyre, R., Nielsen, B. C., Verhaeghe, F., (1999). Centrifugal Washing Optimisation by Real-Time Colour Measurement. Proc. Sugar Ind. Tech. Inc. Conf.
8. Nielsen, P K. and Nielsen, B. C., (2000). 10 Years ColourQ Experience. News from Neltec, 1-2000.
9. Mathlouthi, M., (2000). Highlights of the twentieth century progress in sugar technology and prospects for the 21st century. Proc. Conf. Sugar Proc. Res.