CHAPTER 24
Instrumentation

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24.1 Introduction

Confectionery production involves the measurement of a large number of parameters, and many instruments already exist on the market. These are continuing to be developed together with improved control and operator interface systems. To use these instruments correctly, however, it is very important for the production team and project technicians to have the knowledge and skills to understand the processes and also to interpret data to obtain meaningful solutions to production-related problems. In addition it is desirable to be able to work together with instrument manufacturers and system specialists to tailor machine/plant modifications according to need.

24.1.1 General measurement tasks

It is legally and economically important that all companies comply with ISO Standards, laws and regulations concerning food safety and HACCP, GMP/QA/SS+E and so on (Chapter 28) and measurements concerning these become part of daily life. Food safety standards must be continuously improved and implemented throughout the entire factory, not only in production areas. Appropriate hygiene standards must be applied by employees and suppliers prior to repairs, installation and commissioning and so on, and large-scale cleaning operations must be performed at regular intervals. This also provides information concerning the current hygiene situation. Long-term preventive measures, for example rodent or insect traps and other infrastructure monitoring, produce useful data regarding trends and critical point analysis.

24.1.2 Microbiological measurements

Measurements of the microbiological conditions are required to ensure product safety. Raw material must be checked for compliance with specification. In addition, the microbiological condition of intermediate products, for example cocoa mass after de-bacterisation, must be examined. The microbiological conditions in the surroundings (machinery, equipment, storage areas) as well as the environment

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around a production site are determined with the aid of smears collected on a systematic basis. The condition of finished products is the most important and must be determined in accordance with in-plant guidelines and food safety laws and regulations. This includes routinely determining the overall bacteria count and ensuring the absence of *Salmonella*. Very often these specialised analyses are carried out at a central laboratory or out-sourced and they are not described in this chapter.

24.1.3 Use of data analysis

The first step is to determine the reason for obtaining the data and the possible advantages arising from the analysis itself. Good experimental design provides the best insights into interactions within processes.

Instrumental results, called measured values, give a numerical value for each individual measurement together with a unit of measure. The overall error in the value obtained must be taken into account and depends upon the accuracy of the measurement, as well as such things as the bit width and scanning rate of the analogue to digital converter, where this is used.

After the measurements have been performed and the data recorded, the measured values should be subjected to statistical analysis in order, for instance, to assign the type of mathematical distribution characteristic of each series of measurement. Distribution functions, confidence intervals and standard deviations can be determined. It is important that the appropriate statistical evaluation procedure be correctly used, for example parametric hypothesis test for quantitative variables, proportion hypothesis test qualitative variables, Chi-squared fit test (test for type of distribution), Chi-squared test for independence, F-test for significant differences of location (means) or correlation test for linearity of a relationship in order to be able to interpret it correctly. It is then possible to explain the important parameters more certainly on the basis of graphic representations and also to distinguish between primary and secondary effects. In this way, misinterpretations can be largely excluded and improper handling of the data becomes detectable. Such an analysis is required when problem solving, or before plant optimisation, or new product/process development.

24.1.4 Use of data analysis to provide long-term production stability

The determination of measured values with a known distribution function and errors is the first step towards automated production using programmable logic controllers (PLC), as control circuits can then be designed, tested and engineered.

Costumers' trust in the manufacturer and his products is very important in developing a long-term relationship. Manual or mechanical (automatic) process