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“Live” Quality Control

Integrated Inspection

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Film inspection systems are increasingly becoming an essential part of film production lines. This is because, firstly, the market demands 100% quality control for pharmaceutical, medical-grade or food-grade films and, secondly, all film manufacturers want to avoid an excessive reject rate and continuously optimize their entire production process. In view of the high investment costs for a film production line and the constantly rising material and energy costs, film manufacturers require objective information about actual film quality and the optimization potential of their process from the raw material to packaging.

**Teach-in Technology**

Many manufacturers of high-quality films monitor virtually 100% of their production with modern film inspection systems. These are able to detect the slightest defect, mark it, and trigger an alarm or inform the machine operator or person responsible for the process immediately. Here, the process itself, the raw material and the end product are monitored.

With the rapid advance in technology, modern inspection systems have a data rate of up to 320 MHz per camera. Depending on the application, CCD line-scan cameras with 2,048, 4,096, 6,144 or 8,192 pixels are used, as well as color line-scan cameras with CMOS sensors to detect low-contrast color defects. These achieve scan rates of up to 144 kHz. So even with very fast web speeds, high resolution can be obtained in the web travel direction (Fig. 1).

Today’s systems detect surface defects such as specks/gel particles, burn marks/black specks, fisheyes, coating cracks, streaks, flow lines, or insects. With the aid of defect images, the operator can teach in the defects and the system will then automatically specify the classification criteria for the defect categories.

Via different interfaces, data from external sensors or other measuring systems can be processed in the inspection systems. It is possible, for example, to read in laboratory color space values, degrees of gloss or thickness values. These are simply integrated with the established definition and visualization variant and then visualized as own data. Consequently, alarms can also be set for deviations from this external data.

**Fully Integrated Concept**

The road to achieving a fully integrated concept for inspection systems ("live" quality control) is a long one. In the steel, paper and polymer industries, different quality concepts have already been fully standardized internally but differ greatly from company to company.

Full integration means not only capturing inspection data from one or more measuring systems but also combining it with plant and process data (PLC), material data (SAP) and order data (BDE). Normally, this data is archived in higher-level, often independent, database systems and visualized on the plants with SPC analysis tools. Analysis of quality variations and their correlation with material and process data is only possible later or with other software packages.

The latest possibilities offered by inline inspection systems include not only the usual visualization of detected defects and
have been implemented to carry out data archiving, parallel data visualization, implementation of process and material data, extended data analysis, and SPC visualization (Fig. 2).

Because of the quantity of data captured and the need for long-term stor-
deleted on the line server. This database and software also make all roll data from all lines separately available via an internal ID and enable the data to be decompressed and its processing recorded (Fig. 3).

Through this data archiving, it is now possible to access and view the measured production quality characteristics of a roll that is currently being processed or is to be processed later on different machines and at different workplaces. The relevant operator can view individual areas or special defects and better analyze and define the position of these.

At a later stage, when specifying the further use of the roll (entering how many customer rolls (reels) are required or how much edge trimming is needed for this roll), further defect classification can be carried out and the prepared rolls/reels with defective areas can be completely segregated and separately checked. In this way, unnecessary cutting can be avoided and the customer roll preparation process optimized long-term.

For process technologists or personnel responsible for products, this facilitates the search for certain rolls or production periods, because they can track the pro-

Fig. 2. Inspection software system extension (figure: Klöckner Pentaplast)

Fig. 3. Software for the data logger (left) and roll visualization (right) (figures: OCS Optical Control Systems)
with each other afterwards as part of process analyses.

To provide the familiar operator interface and visualization during the production process, another tool is used here that can display specific process and inspection data curves in self-defined trend graphs. This tool is enhanced with SPC functionality so that operators at the machine and personnel responsible for the process and product can directly assess the current quality and process status at their workstations.

By integrating all available data into the existing inspection systems on all production lines, new tools are created, which open up a fully integrated concept for inspection systems. Through use or display of the required data combinations of the various tools independently of the machine or workplace, far more process steps can be supplied with data and more employees can be given the specific information they require.

**Integration into the Production Plant**

Klöckner Pentaplast is giving high priority to driving this process steadily forward and taking an integrated quality approach even further.

On the existing calenders and extruders (Fig. 4), films made from UPVC, PET and various combinations of other polymers are produced.

All production lines are equipped with inspection systems and for the most part also with labelers. Such systems have for many years been a firm part of quality assessment and process optimization. In recent years, much work has been done together with OCS on optimizing hardware and software and testing various illumination technologies. The level of inspection reached today is high so that in recent months it has been possible to concentrate on designing and developing further helpful program structures and procedures for dealing with the available inspection data.

The camera and defect detection systems installed on the calenders and extruders, which have been described in previous articles, are an important aid to monitoring the quality of the films produced, complying with customer specifications, and process monitoring and optimization [1, 2]. The systems facilitate rapid intervention in the event of material variations, help to optimize film quality on the calender through adjustment of the many influencing parameters, and are also used to assess different known materials or test new raw materials. At the same time, the systems are indispensable for checking compliance with customer specifications, triggering alarms in the event of any deviations and marking such deviations. If quality variations occur as a result of raw material problems or production faults, these areas must be visualized to the plant oper-
ator and the appropriate areas of film marked. The stored camera configurations form the customer specifications for the respective film types. Within the stored roll data, the taught-in defect classifications and specifications are retained. As well as the defect labels, alarm logs and if necessary roll photos are printed out and attached to the relevant roll. On the roll cutter, defective areas are assessed using the logs and labels and cut out individually or in grouped areas and documented.

The inspection data remains archived on the inspection system server for a defined time period and is stored in parallel on a data server.

The Quality Control department keeps its eye on all production lines via special software. Viewer software receives a screenshot of the measuring system’s defect spreadsheet on a computer in Quality Control. The software enables up to four defect spreadsheets to be displayed on a screen. In this way, Quality Control is always informed about the quality status of the films being produced and can react accordingly.

A central Measuring Technology department can connect to all machines and systems via remote software. This allows it at any time to adapt or copy all configurations at other sites worldwide. Because of the high integration density, once the inspection configurations have been set up, they are used worldwide. So the end customer benefits from the same guaranteed monitoring and required quality, no matter on which line the film has been produced (Fig. 5).

Conclusion

The new tools and functionalities described above permit further and better integration of inspection systems on production lines and downstream units. Step-by-step implementation and use of the data sets now available on roll cutters or sheeters, process and quality analysis at different workplaces and by different responsible personnel, and future SPC visualization directly on the machine via the inspection systems all open up great potential for handling quality and process information.

The new developments offer an opportunity to further improve standardization of quality assessment in global production. A processor can achieve the desired quality in any part of any production site in the world through the standardization of quality determination and increased integration of quality assessment.

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