Ensuring tube quality

On-line inspection systems have been the primary way to ensure the quality of glass tubes for many years. As Henrik Hegelund explains, these systems are typically installed a few metres from the rough cut mechanism. Depending on its dimensions, the tube can travel up to 20m/sec and still be inspected with precision.

For the last decade, the standard equipment for defect inspection of drawn glass tubes has been the SK-3000 system. Available in different versions, this system operates at line speeds up to 1200m/min, detecting stones/knots down to 50 microns and airlines down to 20 microns on tubes with diameters between 1mm and 80mm. Traditionally, they have been used primarily to inspect backlighting and pharmaceutical tubing, in response to these sectors' focus on fault-free products. Today, however, they are also used on standard production lines, especially for medical tubing applications, where the attainment of better quality is increasingly important.

In response to industry requests for detection equipment to find very thin airlines on borosilicate lines, JLI vision has developed a system capable of detecting airlines down to five microns, while maintaining the flexibility of the SK-3000 system.

At the heart of the SK-3000 is a powerful light source, based on a standard sodium street light bulb. This is a rugged, highly efficient lamp with a long service life, illustrated by the fact that the first systems installed in 2001 still use their original lamps. The high intensity of light from this bulb makes is possible to use an almost closed aperture (down to f 22) and a short camera shutter speed.

The shortest shutter times are down to 1/55.000 second or 18 micro seconds. The 'closed' aperture gives a fairly large field of depth, making it possible for the cameras to focus on both the front and back of the tube, even on large diameters. The fast exposure time is necessary to detect small defects as they fly through the inspection machine.

In order to increase the ability to detect thin airlines, the resolution of the cameras has to be increased. This can be achieved by replacing the standard macro lenses in the SK-3000 with special lenses with a much higher magnification. However, the problem with this solution is that higher magnification requires much more light, especially if the same field of depth is to be maintained. Because it is impossible to boost the amount of light, this problem must be solved in other ways. The solution is to accept a reduced field of depth and double the number of cameras, so each camera no longer needs to focus on both sides of the tube but can concentrate on either the tube's front or back.

NEXT GENERATION

The recently developed SK-4000D incorporates this principle. While the SK-3000 used three cameras, the SK-4000D has four camera positions, where each position employs two cameras, bringing the number of high speed line scan cameras to a total of eight.

Because the field of depth of each camera in the SK-4000D is reduced considerably, the focal point has to be realigned when the diameter of the tube changes. This is achieved by moving the cameras back or forward by servo actuators to predefined positions. Everything is controlled by the system computer, based on diameter information.

Close up of the quadruple optical system.

With this setup, the SK-4000D is able to operate with the following specifications:

- OD: Maximum 30mm.
- Wall thickness: Maximum 18% of OD and maximum 3mm.
- Stone/knot: >50 microns.
- Airlines width: >5 microns.
- Airline length: >1mm.
- Line speed: Maximum 8m/sec.

The system is designed for use in the production of pharmaceutical glass but with its high capacity and large range of sizes, this versatile unit can be used to inspect glass tubes for many different market sectors. The latest inspection software has several features, including sorting the glass tube in different qualities. To set up this feature, the operator can select how many defects below a certain size are acceptable within one rough cut tube length, while defects above a certain size always results in rejection.

Production records are maintained and faults seen since last reset are listed. These production records and other statistical information can be transferred to the factory network and setup information can be received from the line control system, making it possible to run the system fully automatically.

REMOTE CONTROL

For support and service, all systems can be connected to the internet. This makes it possible to observe if the parameters are set correctly and to guide operators to optimise sorting in good and bad product.

The whole system can be operated remotely, a useful option where the glass lines are placed in different locations. And if the system needs service, JLI can operate and modify the software from the company's Copenhagen offices. ■

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