Improved control systems for surface inspection of strip

Stroboscopic lighting for strip surface inspection is a cost-effective quality control tool that has been further enhanced by use of improved control systems. These enable operators to use their experience and knowledge of the product and process to set inspection lighting for optimum viewing conditions, thereby increasing their ability to find defects, identify their causes and fix the problems.

Michael P. Simonis
Unilux Inc.

Modern coil processing places a premium on meeting quality specifications. With increased global competition, steel suppliers are under more pressure than ever to be as cost-effective as possible and to deliver only material they can verify to be in compliance with specifications. Delivering steel with surface flaws can be costly, not only in terms of reprocessing, but also with the intangible – and possibly higher – cost of the loss of customer confidence. Stroboscopic surface inspection lighting has proven to be a cost-effective tool for maintaining quality control for steel producers and coil processors, who can now increase their efficiency significantly by using various control systems to optimise viewing for specific product specifications.

In modern cold-strip mills and coil processing facilities, inspecting a variety of materials and finishes can cause difficulties unless plant operators have the means to fine-tune the surface inspection lighting system to fit the constant changes in the product being inspected. With more than 40 years of inspection experience in using stroboscopic lights, resulting in rejection rates below one percent, operators are now turning to better control systems to further increase their yield. High light pulse rates or intensity by themselves do not guarantee that an operator will be able to find surface flaws effectively. The type of material, its finish, patterns, varying speeds and environmental conditions such as ambient light – as well as an operator’s viewing preferences – all affect inspection procedures. Having the right control system enables an operator to use his experience and knowledge of the product and process to set inspection lighting for optimum viewing conditions, thereby increasing his ability to find defects, identify their causes and fix the problems.

Flexibility with remote control

Because of personnel cutbacks in many facilities, operators and inspectors often are required to do several tasks simultaneously. Modern control systems can help facilitate this. With fixed-mounted lights, for instance, typically found near the recoiler at the end of the processing lines, using remote controllers has two major advantages: first, they make it possible to set the light’s operating parameters at any time during a production run from an operators inspection station (see Figure 1), and, second, they allow the freedom to move during the inspection process. Both benefits can be useful when a variety of surface finishes are being inspected or where multitudes of defect combinations may require fine-tuning ‘on the fly’.
Control systems for today’s surface inspection lights can regulate the system either automatically through user-programmed settings or with manual adjustments. A more sophisticated unit, such as the Unilux Deluxe Controller, has features such as remote control of light intensity, hands-free automatic tracking of variable line speed and direct readout of flash rate, line speed and repeat distance. A control system with fewer capabilities, such as the Micro Remote, allows remote trigger selection, an on/off switch and manual control of the flash rate, all of which enable an operator to make changes dynamically. This can be useful in providing another perspective when analysing a defect or to fit more than one viewing comfort zone when several people need to examine a specific defect.

Automated controls allow the operator to perform a hands-free inspection even when the line speed changes during the process. This advantage is easily realised simply by synchronising the inspection light to the speed of the line being inspected. Using either a 4–20 milliamp or 0–10 volt signal, the light can be programmed through menu-guided instructions to follow changes in line speed. Once set up, the light pulse rate and line speed synchronise perfectly, enabling the operator only to glance at the line to ensure that the surface quality is good — there is no fine-tuning or compensating for changes in processing speed.

The capabilities of a unit such as the Deluxe Controller can be especially useful in situations such as emptying accumulators. When this is done at over-speed, the process takes 30–60 seconds, and the higher speed creates different operating characteristics that can introduce additional defects. More vibration in the bearings, for example, can increase chatter and drive roll slippage that, in turn, can cause scratches. At the same time, there is no way to stop the process for inspection purposes. With the automatic line-speed tracking capability, however, the flash rates can automatically adjust, enabling the operator to concentration fully on the steel as it passes by at an increased speed.

Automated controls also show line speed, the distance the strip moves between pulses and, in some cases, the ability to preset the inspection light to match certain product characteristics, such as finish and repeat patterns. The automatic control also allows the operator/inspector to regulate light intensity, change the pulse rate manually and turn the light on and off. These features are also available on basic remote systems, enabling the operator to manually change the system set-up as needed.

**Matching conditions**
The different processes in steel rolling and finishing all have their specific requirements, and remote controls allow the operators to match the conditions with each process or type of surface finish. For applications, such as continuous inspection on pickling lines, the operator can set the inspection pulse rate and intensity for his viewing comfort and either let the light run during the entire production session or turn it on and off manually as he inspects the material from his station.

Operators may want to adjust the light intensity to match the environment and surface finish of the material being inspected. The absorption of a duller finish will require a higher intensity, while a more reflective finish will require a lower intensity to minimise the glare reflected from the surface. Ambient light in the area also affects the light’s intensity settings so that the inspection light should overpower the ambient level by a 4:1 ratio for best results. This is done simply by using the intensity settings for light brightness. A digital readout on the control system provides flash rate and line speed information for an operator/inspector (see Figure 2). For some units the controller is also located inside the system’s power supply (see Figure 3).

The Unilux Sentry 850 D shown in Figure 4, for example, has an internal control system that can regulate two light heads, and its brightness control enables an operator to find optimum viewing settings to match paint colour and ambient light. An inspector in a pulpit overlooking the production line can use the controller to turn the light on and off and adjust the flash rate by pushing one of two buttons and adjust intensity to 35, 50, 75 or 100%. The controller can also be synchronised with an external trigger that automatically turns the inspection lights on and off when the production line reaches a specified speed. This level of control works well for
processes where, once set up, line speed changes are minimal.

The ability to adjust lighting intensity and use some masking techniques can help eliminate ‘hot spots’ or areas of excessive glare. This is a variation on dark field inspection of a very shiny surface, such as hot-dipped galvanised steel, stainless steel or aluminium. When using an inspection light, a bright surface will reflect glare back at the inspector. In addition to being visually uncomfortable, the glare can prevent an inspector from seeing low-contrast surface flaws in galvanised steel.

By varying the intensity, using colour filters or masking the light head, operators can vary the light’s action, resulting in increased inspection capability on these surfaces. Masking involves placing a piece of opaque material over the inspection light’s lens with the shiny side facing the lamp. The mask will keep the light from falling directly on the centre of the viewing area, where the reflection would be strongest. Operators can then adjust intensity to match the material. Combining these techniques aids inspection flexibility and effectiveness.

Finding the defect source
Once the operator has spotted a defect, it is increasingly important to determine the cause quickly. With long combination lines, which can involve pickling, annealing and coating over several kilometres of processing operations, finding and correcting the defects can be a difficult task. When an operator sees a specific defect, such as a scratch or a roll mark on the strip, the digital readout will show the distance the strip travels between pulses. By determining the multiple of this dimension that matches a roll diameter and knowing where the rolls of each size are located, the operator can take a portable stroboscopic light, such as a battery-powered Unilux Miti-Lite (see Figure 5), and sectionalise the line. Within a few minutes, he should be able to locate the origin of the defect and determine the steps needed to correct the problem.

Filling in the inspection process
Remote controllers also can be used to regulate lights and video cameras in locations that are inaccessible to operators. Using images generated by cameras, operators can adjust light intensity and flash rates to match the viewing conditions for the material at each camera location. If the cameras are arrayed in a cluster of four, operators in a control room can look at random samples of the strip in a quad view that shows the entire strip or any part of the strip through a single camera. This is especially useful in looking for edge cracks produced during rolling.

Cost reduction
As well as generating cost reductions through improved delivered quality, use of better control systems can also reduce the operating costs of stroboscopic systems. For instance, with the automatic line speed tracking capability, because the flash rates can automatically adjust, this has the additional advantage of prolonging lamp life by turning the light on once the line reaches a specified speed (that is, 50m/min) and shutting it off when the speed drops below that rate. Because mills need their inspection lights only when product is actually
Furthermore, the ability to link an inspection light to the line speed can offer significant cost savings simply by tripling the life of a stroboscopic lamp. At a typical cost of nearly $300 per lamp, enough could be saved in replacement costs for a two-headed inspection unit to cover the cost of the inspection system in 10 years. Additional savings can be realised by reducing the wear and tear in other parts of the inspection system.

**Concluding remarks**

Even the most sophisticated control systems are intuitive in their use. In mills where stroboscopic inspection lights are being introduced to the workforce for the first time, they can be operated on a very basic level such as on/off, flash rate and intensity. Then, as operators gain experience with their inspection systems, they can make more use of the controllers’ features to improve their inspection capabilities – and quality control will truly be in their hands.

Michael P. Simonis is Company President – Unilux Inc., Saddle Brook, New Jersey, USA.