Cross Light Illumination for surface inspection

Surface inspection has been greatly enhanced with the latest developments in LED technology utilised in stroboscopic inspection. The ability to precisely control the flash duration time of LEDs now enables inspectors to have sharper and crisper images of the strip surface, allowing them to detect finer anomalies. This control over light timing also makes it possible to deploy the simultaneous use of Bright Field and Dark Field lighting such that surface imperfections are dramatically enhanced, making it easier for operators to see both common defects in surface quality as well as extremely subtle defects on coated and reflective surfaces.

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HOW STROBOSCOPIC INSPECTION WORKS

A flash from a strobe light acts to freeze motion seen by the eye just as the camera shutter does for a photographer. A flash with a duration of 10-20 microseconds triggers a motion-freezing retinal response. An object moving at 600m/min moves only 0.1mm during this time – a distance so negligible it appears absolutely stationary to the eye. Thus, motion blur is eliminated and contrast, critical to defect definition and detection, is enhanced.

Xenon-based strobe lights, although rated at 10-20 microsecond durations, are measured at 90% peak and, in reality these strobes had very long tail of discharge times that could easily extend over 100-200 microseconds. LED-based strobe lights enable precise timing of on- and off-time, so the exact flash duration (or on-time) of the light can be controlled (see Figure 1). It is this characteristic of...
Fig 3 Simple Bright Field illumination with strobe lights opposite the inspection platform and shining towards the operator.

Fig 4 Simple Bright Field illumination with strobe lights at a flat angle to strip from bottom.

Fig 5 Simple Dark Field illumination shines the light across the strip and parallel to the inspector.

BRIGHT FIELD AND DARK FIELD LIGHTING

To understand the application of Cross Light Illumination one must first understand how incoming light will interact with a metal surface. With Bright Field lighting, the various rays of light on the steel surface will be specular, meaning the angle of incidence will equal the angle of reflection. With proper positioning of the light source, the reflective angle of the light is directed back to the inspector as a disperse light and displays defects as dark on a bright background. Defects such as scratches, dents, slivers, scale and holes are easily recognisable in this light.

Bright Field lighting is generally used on dull or matte finished surfaces. If the surface is smooth and shiny, a very high percentage of the light will be reflected back at the operator, creating ‘hot spots’ that can make inspection difficult. In these cases Dark Field lighting is applied. In Dark Field lighting, reflected light shines towards the strip at a steep angle and away from the inspector. The image of the surface that the inspector sees will tend to be dark since the majority of the light will not be reflected back to the inspector. If there is a defect on the surface that causes light to be scattered leading to a change in the angle of the light, then the LED stroboscopic light that allows sharper and crisper images as well as the capability to apply Cross Light Illumination via strobe placement and algorithmic timing.
inspector will observe this defect as a light area on a dark background. On highly reflective surfaces, this angle of light will highlight scratches, build-up and dross. Examples are shown in Figure 2.

CONFIGURING STROBOSCOPIC INSPECTION SYSTEMS
Proper placement of the light source is critical to achieving maximum performance. The following examples in Figures 3-6 show various configurations of Bright Field and Dark Field lighting techniques in order, from simple to complex.

CROSS LIGHT ILLUMINATION
Depending on the material and rolling process, either Bright Field or Dark Field techniques would be selected. Since every rolling process can produce multiple anomalies that would be enhanced visually by both lighting techniques, surface imperfections become more apparent when lit from multiple angles. The use of both techniques simultaneously, or Cross Light Illumination, can now be achieved for the first time with stroboscopic inspection systems using LED diodes instead of xenon bulbs. These are illustrated in Figures 7 and 8.

With the long burn time of xenon bulbs, it was impossible to use Bright Field and Dark Field lighting techniques at the same time because the flash durations would overlap images to the eye, thus cancelling each other out. With LED
strobes, we can now deploy an algorithm to control flash duration so that different light sources can be triggered simultaneously, creating a single perfect image.

PLANT APPLICATION
- This system works at any strip speed, but the advantages are maximised for any speed above 50m/min.
- Retrofitting is very easy and does not necessarily need factory support, although it tends to be welcomed by users.
- It is suitable for both as-rolled, i.e., scaled surfaces, and bright rolled steel. These require different illumination setups and we work on site with the customer to achieve best results.
- We are currently commissioning this system at two mills in Europe.

SUMMARY
To detect defects on steel strips, good lighting contrast has always been essential. Until recently, mills have had to choose between Bright Field or Dark Field illumination. LED technology for stroboscopic inspection now allows inspectors to gain the same technological advantages previously only available using cameras. The ability to synchronise multiple lights has led to the development of algorithms that, when paired with stroboscopic inspection light positioning, provides optimum visual inspection at far less cost than camera-based systems. Cross Light Illumination affords metal producers better inspection capability. Operators have greater insight into the quality of the steel they are producing, in order to increase yield and reduce customer rejections.

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Efficient Surface Inspection & Improved Safety

- Eliminate bulb replacement and downtime associated with bulb burnout
- LEDs eliminate light spillover, a safety issue on the plant floor
- Extremely bright and even light distribution
- Reduced maintenance and 60% less energy consumption than xenon strobos

Call 201-712-1266 today for an on-site demonstration.
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