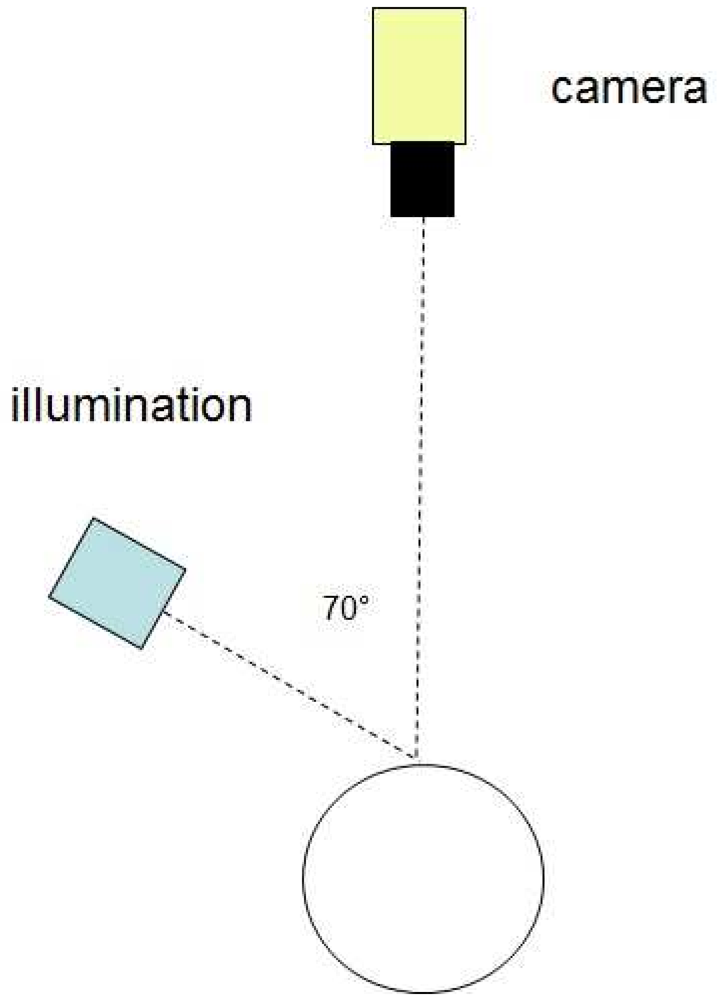
Learn how rollers and web handling affect your 100% inspection system's performance

sales@oneboxvision.com www.oneboxvision.com

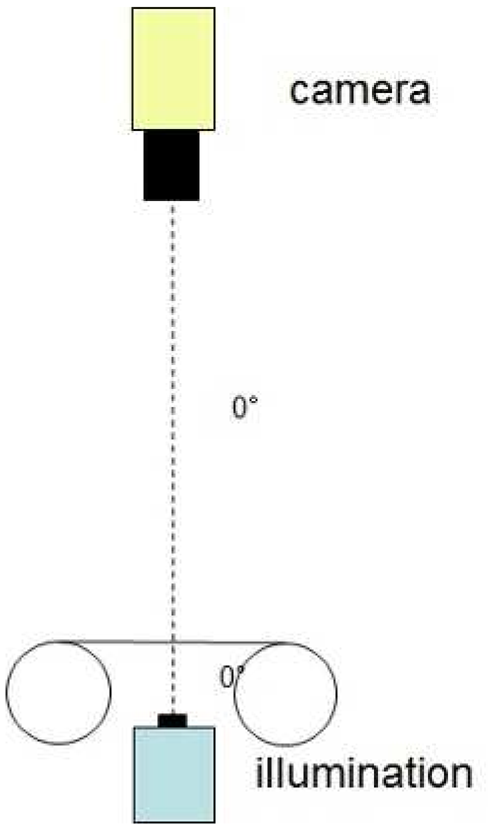
The following article explains the many reasons why rollers (idlers) and web material properties can adversely affect inspection performance especially for 100% print inspection. Let's understand exactly the effects of idlers and web paths on your vision system.

Why rollers are important parts of a 100% inspection system

Rollers are used to guide the web material along a predetermined path through a process line. Let's take a printing press as an example. The path will vary on most presses as different print jobs have varying print requirements (number of colours, cold seal, side of printing, drying time, etc.). The web path will also vary depending on the drying times and drying temperatures of the inks. Under the inspection head, rollers are used to present the web to the cameras in as stable a condition as possible. There are a couple of configurations often used for both surface inspection and print inspection.



The first approach is to use a large roller and to image the web on that roller. This works so long as no back lighting is required.



The second configuration uses two relatively small rollers that present the web in a flat orientation. This **“flat”** zone is usually between 150mm and 200mm depending on the exact configuration. In this case it is important to keep the flat zone as short as possible to minimise a phenomenon known as “**flutter**”. The magnitude of this phenomenon is directly related to the distance between rollers i.e. the more a web is unsupported the larger the magnitude. On a live image flutter can be seen as random variations in the brightness of the acquired image mainly along the edges.

Rollers or idlers are set in place in a precise procedure known as “**tramming**”. The tolerance is generally close to 0.01mm. If this “**tramming**” is not correct, flutter may be introduced into the system. This flutter does not necessarily have to occur at the inspection point but can in fact occur upstream. This can be the case as misalignment can stretch the material and cause bagginess on one side of the web. This is particularly true of materials that have little or no elasticity e.g. foils, whereas film is much more forgiving in this situation.

A final aspect of roller design is minimising ingress of air between the roller and the web. If a bed of air gets under the web it will cause it to aeroplane over the roller (known as “boundary layer effect”), which will result in lost encoder pulses if an encoder is used at that point. This is also known as slippage. The solution to this problem is the introduction of a “chevron” shaped groove designed to channel air away from the roller surface. A modified chevron design known as a “spreader” runs towards the edges of the roller as it rotates applying lateral forces to the web, which helps to maintain flatness of the web.

Let's look at the key items to consider when choosing an idler roller.

- Performance characteristics of idler rollers
- Materials used to build idler rollers
- Coating idler rollers
- Alignment of idler rollers

Performance Characteristics of Idler Rollers

The following are a list of characteristics that need to be considered as potential causes of defects, when adding rollers for an inspection system. This is especially true if it is the intention to use that roller to generate encoder pulses to drive the camera scanner.

Precision and Stiffness

Idler rollers must be precise so they run true and thus avoid undesirable fluctuations in web tension. Especially in cases of wide web widths, idler rollers must also be stiff to provide uniform tension across the web. Rollers, which lack adequate stiffness may cause deflections resulting in the centre of the web having less tension than the edges. This lowering of tension at the centre allows for the ingress of air between the web and roller creating centre line flutter. Sometimes a long roller can have undesirable deflection under its own weight. This phenomenon is known as “self-loaded deflection”.

Low Drag Bearings

If web tension is to be constant, the difference in web speed upstream and downstream of a set of roller must be minimized with low drag bearings. It is important that idlers impart minimal dynamic friction to the web. But more importantly, that the friction is uniform from one idler to the next. Any variation in friction causes undesirable variations in web tension, which can introduce real defects, or if it occurs at the encoder idler, this can introduce false defects due to variation in acquisition rate.

Rotational Inertia

Another important aspect of idler roller performance is rotational inertia. During web acceleration or deceleration, low rotational inertia is required to minimize the web tension variation upstream and downstream of a roller. Rotational inertia results in “dynamic drag” which resists acceleration. In addition to web tension variation, excessive rotational inertia can cause the accelerating web to slip on the roller, thus loosing encoder pulses and effecting the acquisition of the 100% inspection system.

Critical Speed

In some applications, the parameters of web speed, roller diameter, and roller length are such that roller vibration is a problem. To reduce roller vibration, and the associated web tension fluctuation, the roller’s natural frequency of vibration (critical speed) must be increased to well over the operational web speed.

Idler Roller Materials and their trade offs

Steel Idler Rollers

Steel idler rollers generally satisfy requirements for precision, stiffness, and low drag bearings. However, the high density of steel can lead to problems with rotational inertia, self-loaded deflection, and critical speed (speed at which natural frequency of idler occurs).

Aluminium Idler Rollers

Aluminum idler rollers generally have good precision and low drag bearings. Compared with steel rollers with similar dimensions, aluminum rollers have improved rotational inertia and bearing life. However, neither self-loaded deflection nor critical speed is improved, and stiffness is substantially reduced.

Carbon Fibre Idler Rollers

To simultaneously achieve high stiffness and low inertia, a material with a high stiffness to density ratio is required. This ratio, also known as specific modulus, must be maximized to achieve minimum self-loaded deflection and maximum critical speed. This important material property is also advantageous in bearing life. The commercial material with the highest stiffness to density ratio is a carbon fibre (graphite) composite, that the specific modulus is nearly triple that of steel or aluminium.

Coating Types for rollers

General Purpose

Polyurethane clear coat: This is the standard for the large majority of web handling equipment. Used mainly for its durability polyurethane clear coat is extremely tough.

Release

Teflon roll cover: For applications with sticky or adhesive coated webs, or for applications where rolls require frequent build-up removal. Depending on the orientation of the web, cold seal can run over the surface of the idlers close to inspection. If this cold seal is allowed to build up over time it will introduce both flutter and distortion of the web. It is also important to maintain a grip of the web material. This is achieved by etching the surface of the roller before it is Teflon coated. This configuration has the non-stick properties of Teflon but also has enough surface-dimpling to mechanically grip the material.

Traction/Elastomers

In other applications Elastomeric coatings are used to provide much higher grip on web materials with low friction coefficients.

Electro-Static Discharge

Some processes use solvents with extremely fast dry times. These solvents tend to be extremely explosive and any static discharge can ignite them. Raw carbon fibre offers excellent electro-static dissipation and is chemically inert to most industrial solvents.

Effect of Idler Misalignment on Wrinkle Formation

A prominent problem that arise as a result of misaligned idlers is wrinkling. These wrinkles can be detected by the system as defects and as such need to be removed from the process. It is important that the defective roller be identified quickly. The following information will help you identify the cause quickly.

Understand the forces acting at a misaligned idler

There are two **primary** forces imparted by a misaligned idler on a web:

- F_f - frictional force applied to the web by an idler where the idler direction and the webs direction of travel are not the same,
- F_s - steering force is a function of the idler alignment before and after the point being considered. A misaligned idler applies a turning moment on the web, which is transferred along the press.

Measurements conducted with a single misaligned idler have shown that the effect on web tracking and thus wrinkle introduction can be seen a significant distance downstream from the misaligned idler. It is noted that the point of largest tracking variation does not occur at the idler, which is misaligned but further downstream i.e. the wrinkling gets progressively worse for a distance downstream before the steering and frictional forces balance and the web stabilises.

Summary

OneBoxVision has learned over many years that to be successful at 100% inspection for web and sheet manufacturing process, that the transport of the product is a key element of a vision system. Contact us for more information and we can advise.

OneBoxVision Ltd.
Questum Business Centre,
Ballingarrane Science & Technology Park,
Clonmel, County Tipperary,
Ireland.
Phone: +353(0)52-614-6000

sales@oneboxvision.com www.oneboxvision.com