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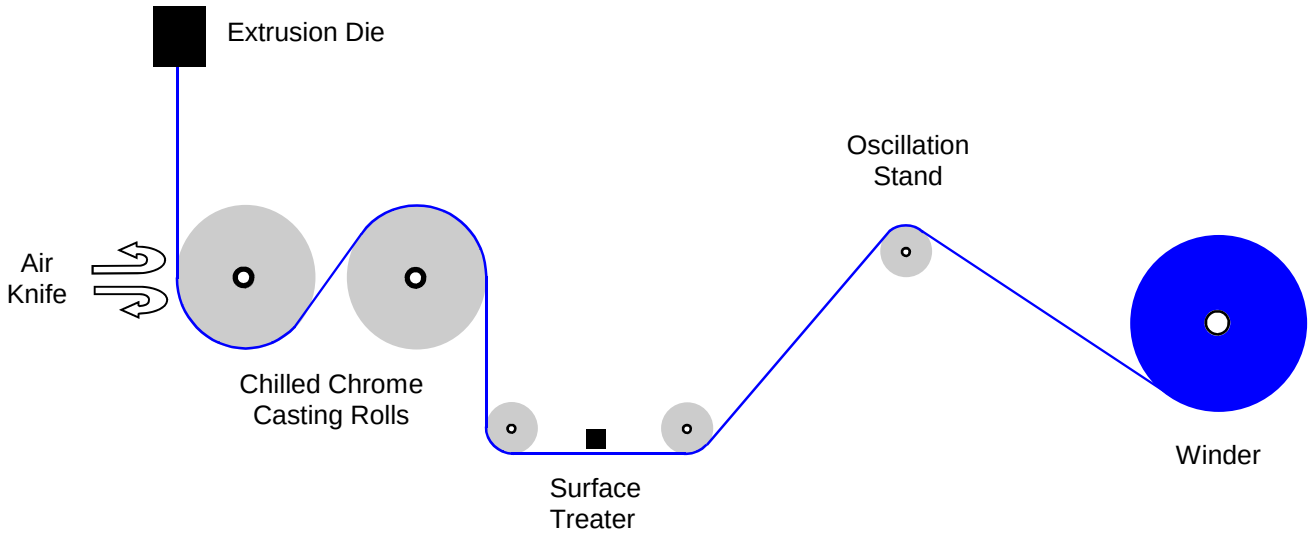
# Cast Film Inspection

Cast film inspection can be very useful for characterizing the resulting film and detecting problems with resins or dies as soon as they happen. A schematic of a typical cast film line is shown below:




Resin is melted and extruded typically through a T-slot or coat hanger die. The extruded plastic falls a brief distance through air, shrinking slightly longitudinally and then is pinned against a chilled chrome roll using an air knife or vacuum. The film moves across a pair of chilled rolls to ensure both sides are cooled rapidly. Next, the film is usually sent past some form of surface treater, and then through an oscillation stand to randomize any gauge bands which may be in the film. Finally, the film is trimmed and sent to a winder.

Inspection of this process can be very valuable to the manufacturer, as it provides nearly instantaneous feedback of many product properties. Like most processes, film quality depends upon many different variables, such as the resin used, the quality of its mixing, the melt process, die quality, temperatures and pressures. All of these processes need to be monitored, but inspection of the product can alert one quickly to problems in the process extremely quickly, resulting in cost savings and better quality control.

The best point of inspection of the film is as close to the winder as possible. One reason for this is to ensure that the inspection station is downstream of the oscillation stand, and that the observed web is the final product (i.e., after the trim has been cut away). Placing the inspection system as close to the winder as possible also ensures that the maximum length of the process is examined, including effects produced by rollers and equipment downstream of the casting station itself.

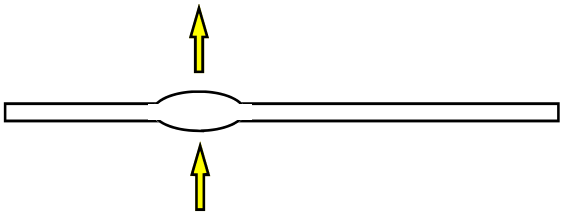
The types of defects that can be seen in cast films include carbon specks (die pickoff), air bubbles, striations due to poor crystallization, gels, certain thickness variations, opacity issues, holes and many others.

Typically, fast linescan cameras are used with transmitted light for this process. One or more cameras are positioned to observe the web with one or more bright linear light sources illuminating the web from the opposite side. In many cases, simply aligning the camera(s) to stare directly into the light source(s) provides excellent detection of defects.

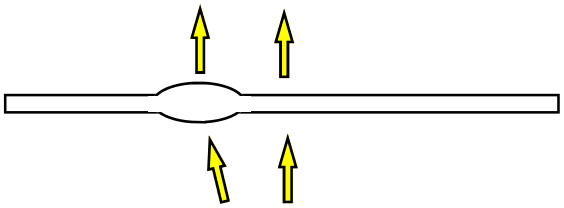
However, to see small gels and air bubbles, another technique works very well and can save considerable money and effort. This technique is known as “knife-edge alignment”.

Gels and air bubbles may cause differences in the film that are too small to be readily and easily detectable with an inspection system. We can take advantage of the fact that these defects usually cause the topography of the web to change, so refractive effects come into play.

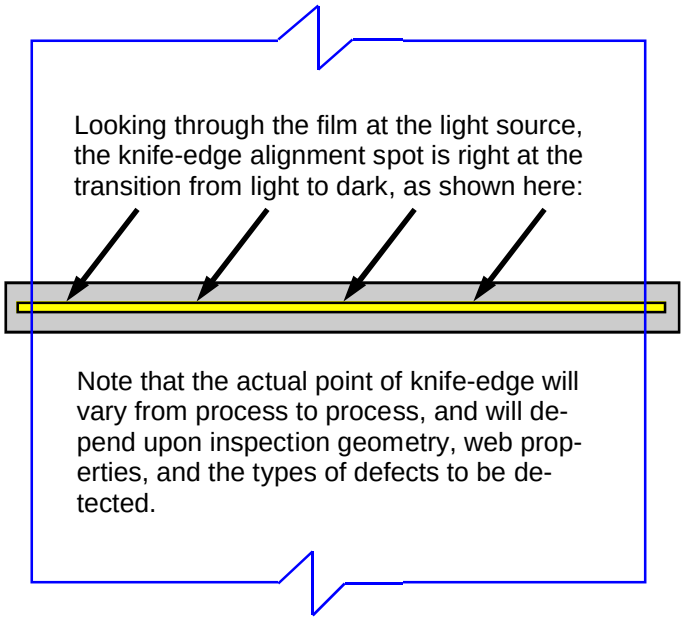
By aligning the camera(s) so that they stare directly into the “twilight” region of the light source(s) (in other words, the area where the light falls rapidly away to darkness), we can detect the refractions produced by these defect very easily, while still being able to observe other defects. A diagram illustrating the refractive effect and knife-edge alignment is shown below:



A “head-on” alignment, shown above, makes air bubbles and gels very difficult to detect as they cause almost no change in light received by the camera.



However, knife-edge takes advantage of the fact that the air bubbles and gels can refract some of the scattered light back to the camera, as shown above.



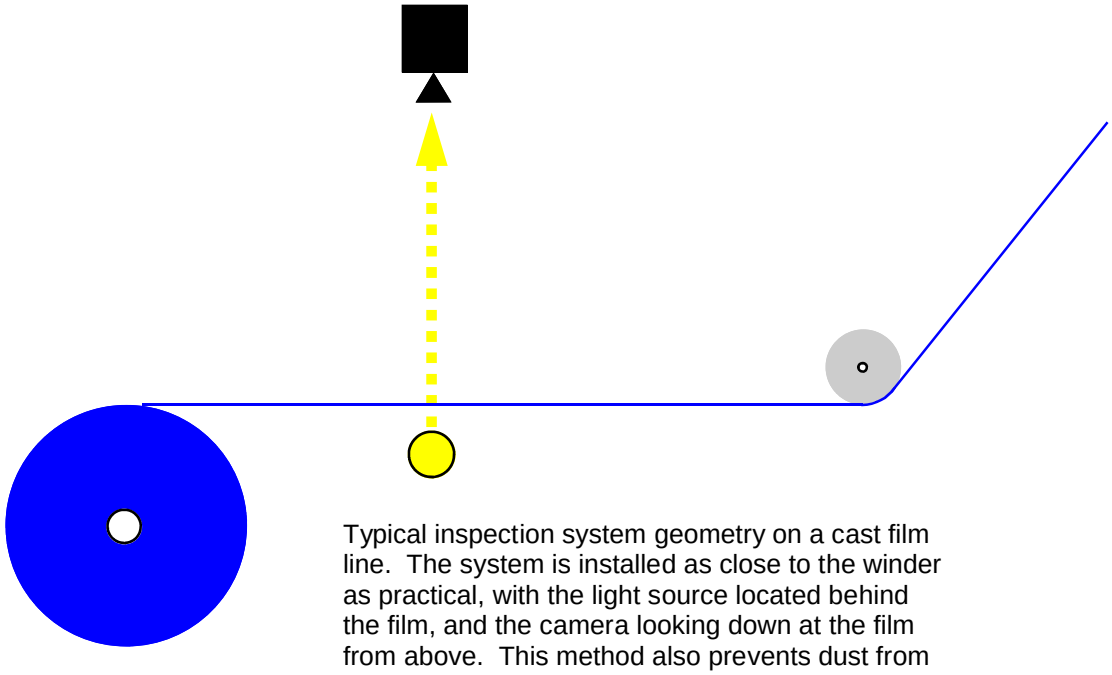

Proper setup of the inspection will allow best detection of the widest array of defects, as that is usually the requirement. Some inspection systems, such as those supplied by WEBVIEW, include video processing modules which can enhance certain types of defects and make them even easier to detect. WEBVIEW systems, even the low-cost Web-*i*, come with a special video mode called “Small Defect Channel”. Video is sent through a rate-of-change filter to enhance spots where brightness is changing rapidly from pixel to pixel. This video mode can be used to detect even defects which can get to be much smaller than the calibrated pixel size. This, in addition to knife-edge alignment, can allow resolution requirements to be relaxed and cost of a system to decrease significantly.

One must be aware of the fact that knife-edge alignment is a critical alignment, therefore, steps must be taken to ensure that both camera(s) and light source(s) are protected from vibration. Excess vibration in either the camera or light source will destroy the alignment and can cause good film to be incorrectly identified as defective. Fortunately, vibration is not generally a problem on most cast film lines.

For various reasons, it may be preferred to place the inspection system in a high-temperature area. Perhaps there is equipment in the way near the winder, or the inspection system might limit access to certain equipment. When mounting electronic equipment of any type, one must take into consideration ambient temperatures. As camera operating temperatures increase, noise generated within the camera increases due to the nature of CCD and CMOS devices. As this noise increases, the dynamic signal range of the camera is reduced. To prevent this, some sort of supplementary cooling is suggested when the camera(s) or light source(s) will be placed in areas where ambient air temperatures are at or above 100°F (38° C). This can be provided by plant air (dry air of instrument quality is a must to prevent condensation and other issues), external fans, or self-contained air conditioning units.

Positioning the light source isn't critical for films which are clear or transparent. The light source can be placed almost anywhere behind the film so that the camera can see it. For films which begin to become opaque, it is necessary for the light source to be positioned as closely behind the film as practicable, as the film begins to scatter light very effectively.

Cameras should usually be positioned on the opposite side of the film in the same plane of the light source. Some tolerance in the angle of attack is acceptable in most situations, and decent inspections can be performed even at significantly acute angles between the web and the camera. Perspective effects begin to become an issue as the angle between the camera and the web decreases, however.



Typical inspection system geometry on a cast film line. The system is installed as close to the winder as practical, with the light source located behind the film, and the camera looking down at the film from above. This method also prevents dust from settling on the camera objective.

Once installed on the cast film line, the inspection system collects data that can be used in two ways—immediately, or over time. Generally, manufacturers use data both ways to obtain the best value from the inspection system.

The inspection system can immediately notify the operator if gross defects begin appearing, usually via alarm. This can ensure rapid response to problems, and a corresponding decrease in scrap. Savings due to the immediate awareness of problems alone can be significant and can rapidly pay for the cost of an inspection system. Many systems, including those manufactured by WEBVIEW, can also quickly alert the operator to rising defect trends, allowing corrective action to be performed more rapidly than before. Repeating defects, which can be indication of die or roller troubles, can also be identified by WEBVIEW systems.

With all but the lowest cost inspection systems, defect characterization can be accomplished. This allows separation of defects by type, and from the data obtained by the inspection system, reports can be generated which can be invaluable in examining performance of the cast film line. WEBVIEW systems allow trending of data over long periods, providing an instant visual trend of whether or not defect densities are increasing, decreasing, or steady-state. Using long-term data can allow engineers a valuable tool in making adjustments to provide the best quality product.

As the cost of inspection systems has decreased, so have the payback times. Powerful inspection systems can now be purchased with discretionary budgets. With competitive pressures always increasing, no manufacturer today can afford to be without inspection.

We invite you to investigate WEBVIEW's complete line of inspection products at: www.webinspection.com