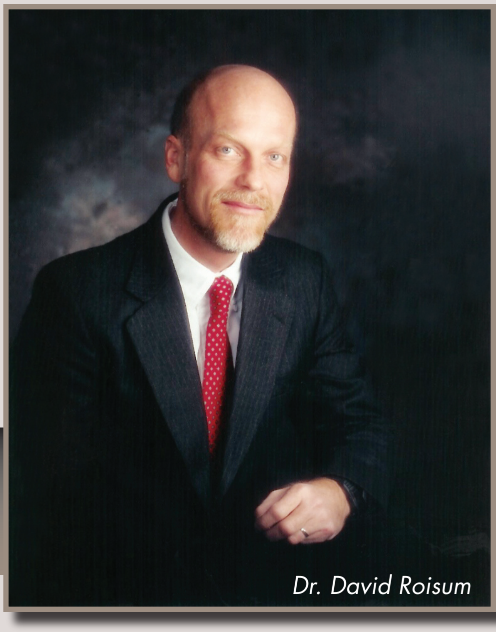
CRITICAL THINKING

by Dr. David Roisum


Dr. David Roisum

When Should Crowned Rollers Be Used?

A crowned roller is one whose diameter is intentionally larger in the middle than at the ends. The crowned, or barrel-shaped, roller is used for three primary purposes: nipped roller deflection compensation, spreading and guiding. The mechanical details and the mechanics of operation of each are distinctly different.

Nip load must be adjustable and controlled on many processes such as coating, laminating, printing, winding, etc. The problem is that when you push two rollers together at their ends, they bend apart in the middle. Left alone, this would make the nip pressure higher at the ends, and thus the product and process would be nonuniform. To compensate, the roller may be made bigger in the middle than at the ends to fill in the nip.

The diameter difference, or crown, can be precisely calculated by the physics of roller deflection. If the load is too low for the crown, the nip pressure will be higher in the middle, and vice versa if the load is too high. Nip pressure uniformity is easily checked with nip impression paper.

Because the deflection of a roller should not be excessive, we can quickly calculate the upper end of a reasonable crown. At a typical standard of no more than 0.00015 in. of roller deflection per inch of width, the bending, and thus crown, of a 50-in. wide roller would be less than 7 mils. This is the thickness of a human hair.

The second use of a crowned roller is somewhat more rare. It is a rotating version of a D-bar or bent pipe spreader. The principle of operation here is that the web wants to slide outward, away from the hump. The crowned roller has no better spreading than the bent pipe, nor does it usually induce less drag. The advantages are, however, that the relative velocity between web and spreader is less so that there is less spreader wear and web scratching.

The magnitude of the crown depends greatly on the application. Wide machines with extensible webs (e.g., nonwovens) could have crowns of more than several inches, while narrow machines with stiff webs (e.g., foil) may have crowns of less than a few mils. Large crowns make for floppy web edges in that span, but may induce permanent center bagginess due to stretching.

The third use of a crowned roller is as a passive centering guide. Here, the shape of the roller brings the web to the middle, IF the web is in traction with that roller. The principle here, though well understood, is too complex to describe briefly. The application is to keep thick heavy webs, such as belts or steel strip, on their rollers without the expense of active guides that have moving parts and controls. The most common place you would find the crowned roller is on flat belts, such as on vacuum cleaner bristle brush drives, some older web machine drives and conveyor belts. The magnitude of the crown is usually just a few mils.

This guide will NOT work on thin webs that most of us deal with—the web would bunch up in the middle of the roller. This principle also helps explain a couple of defects that you may have encountered. The first is the tendency to wrinkle on a roller that has a diametral bulge due to improper machining, wear, and tape or adhesive buildup. Some thin webs are so touchy that a hairs' thickness bulge will readily start a wrinkle. Similarly, this principle explains the "knot" defect of winding of thin materials such as film. Here, a caliper gage band starts a bulge in the winding roll, which tends to gather the web there. This makes the bulge even bigger, thus increasing the gathering power of the bulge in a snowballing cycle.

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David Roisum • Finishing Technologies™ • 1305 Orchard Ct. • Neenah, WI 54956 • P: 920.725.7671 • www.roisum.com