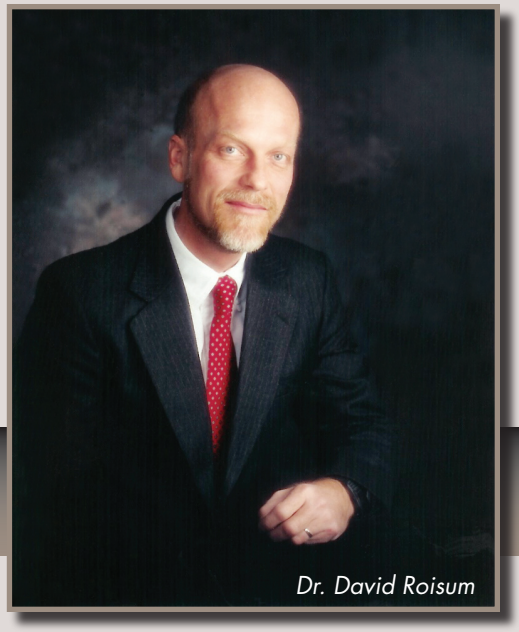
CRITICAL THINKING

by Dr. David Roisum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How Big Should My Rollers Be?

Sizing rollers should be a science based on certain standards. Standards, in turn, are based not on good experience, but rather on avoiding known cases of bad experience. Any standard that does not border on, and even occasionally cross over into, failure, is too conservative.

The concept of "zero defects" is economic nonsense here, as well as in any other industry. For example, airplane wings will very occasionally break (<<1% of all accidents) if the pilot is careless enough to fly into a big enough thunderstorm. To make the wings strong enough so as to never fail would mean the plane would be so beefy and so heavy as to have no extra payload capacity to carry passengers. Zero defects may mean zero profit.

What failures are we trying to avoid when sizing rollers? Excessive deflection determines roller size more than all other criteria combined. If the deflection is too much, thin materials tend to wrinkle, nips become uneven and vibration may limit speed. Many in the industry have more or less settled on a Class B deflection for most applications. Here, the bend of the rollers due to the combined loads of roller weight, web tension and nip will not exceed 0.00015 times roller width.

Thus, a 100-in. wide roller could bend in the middle as much as 2 thicknesses of a human hair. Some applications, such as with flexible or bulky materials, can tolerate more. A few, such as very precise calenders or coaters, may tolerate less. Some applications, such as cores and spreaders, are a compromise: we really would like it to be tighter, but we can't afford it.

Science and Skill

Once you determine deflection criteria, your roller size is determined. The width is slightly greater than the width of the web, and the diameter is calculated to keep deflection within spec. Even though they do affect deflection, roller wall thickness and material are not significant factors compared with diameter. Perhaps surprisingly, journal stickout makes a big difference. You can judge the skill of a machine designer standing 30 ft from his machine by merely noting how long the journals are. They should be so short as to have the roller heads almost rubbing on the bearing housing.

While deflection determines roller diameter in most cases, there are other criteria that sometimes require even larger diameters. On very high-speed machines, you may want to avoid critical speed or resonance of rollers and this may up the size a notch. On extremely highly loaded rollers, you may exceed a fatigue stress of the roller unless you increase diameter. On heated and cooled rollers, you need a very large circumference to get the dwell time for heat transfer. These rollers are much bigger; usually several or many feet in diameter.

One last area of sizing would be for the inside of wound rolls. Consider the core or mandrel which supports a wound roll as a "roller." The diameter of a core-supported unwind or winder must be big enough to distribute the wound roll's weight and shaft torque without overloading the web material at the bottom of the roll. Using a core that is too small is like running a pickup truck on golf-cart wheels: Expect the rubber to walk (telescope) or shred. We have learned similar lessons on layon rollers and especially winder drums. The paper industry now sizes winder drums to be 2-3 ft in diameter, even on narrow pilot machinery. Larger idler rollers are similarly more tolerant of wrinkling than smaller idler rollers.

Well, then, why not just make the rollers really big? Two reasons: Cost of equipment and cost of control. Large rollers cost more money and require larger components such as frames and motors. Also, driving a large inertia is quite tricky, especially during speed changes. Simplistically, large rollers (or many rollers) tend toward poorer tension control.

Thus, rollers are baby-bear sized: Not too big and not too small. In other words—just big enough to avoid most troubles and no more. My book The Mechanics of Rollers has several chapters that put the science to the story.

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