Pneumatic expandable winding shafts: A key to today’s high-speed tissue machines

Winding and unwinding of reels, and the methods of handling those reels, play an important part in the total operational efficiency and safety on today’s modern tissue machines.

Progress towards higher quality, speeds, and efficiencies in the tissue industry is continuously made in a series of steps. Some are fairly big, like TAD, NTT, the steel Yankee dryer and the shoe press. Others are fairly small, and don’t always get that much attention. This is not because they’re not important but because they are playing an auxiliary or “supporting actor” role in the efficiency-improvement process.

One such example of a “supporting actor” is the expandable shaft that is used for handling reels on almost all modern tissue machines and converting lines. As tissue machine speeds went up remarkably over the past few decades, a bottleneck to the increasing tonnage became the handling of the reels coming off the end of the machine. And more specifically the shafts and cores on which the reels were wound.

Winding critical for product quality

Winding and unwinding of the tissue sheet plays a critical role in the final quality of the tissue paper product. Softness and bulk are two of the most important properties of tissue, and winding has a very sizable impact on both of those characteristics. Although the science of winding is beyond the scope of this present article, it is important to note that it plays an important role in the final paper quality.

Winding and unwinding on the paper reel has always been done on some sort of shaft. In much earlier days, the paper was taped or glued onto the shaft for winding of the paper reel. Over the years, paperboard or even plastic cores have been used for winding tissue reels, with a rotating shaft inserted into the core and then the tissue taped or glued to the core on the outside to start the reel building.

This helped speed up the process quite a bit, but there was still the shaft that needed to be extracted from the inside of the core. So paper machines would be sold with 20 or 30 shafts which would be moved around from the paper machine to the converting or rewinding operations of the mill.

Expanding shafts get launched

Going the next step in efficiency improvement, expanding shafts were developed which included rubber ledges which would extend the diameter of the shaft to grip the core securely to block it from slipping or moving sideways during the winding-unwinding process. Extension of the ledges at that time was done via bolts on the end of the roll journal which were turned, in one direction to extend them, and in the opposite direction to retract them. When retracted, the shaft could be pulled out to be used for the next reel.

Starting in the 1980s Svecom PE in Italy began working on a pneumatic expandable shaft in which a single pneumatic valve fed air into a series of bladders that extended the rubber ledges for gripping. And for retracting, the air was let out of the valve to deflate the bladders. This sped up the process of gripping and releasing the core considerably.

Single valve presents risks
However, it was soon realized that being dependent on a single valve for holding the large reel in place was risky. If a leak developed anywhere in the bladders, tubing or valve system, all of the ledges would retract. This meant that the giant, heavy, fast-turning reel could start bouncing on the shaft or moving left or right on the shaft. This presents a fire risk, and the danger that it eventually could get out of control, thus jumping out to the Machine.

Safety concerns about out-of-control reels, and possible dangers concerning fire and worker protection, led to further thinking about the shafts. Taking the pneumatic expanding shaft a step further, Svecom developed and patented an independent multiple-valve pneumatic expanding shaft in which all of the valves operate independently with internal check valves. Thus, if there is a failure at one section of the pneumatic system, all the other ledges remain in place and the core is still securely held, even at very high peripheral speeds.

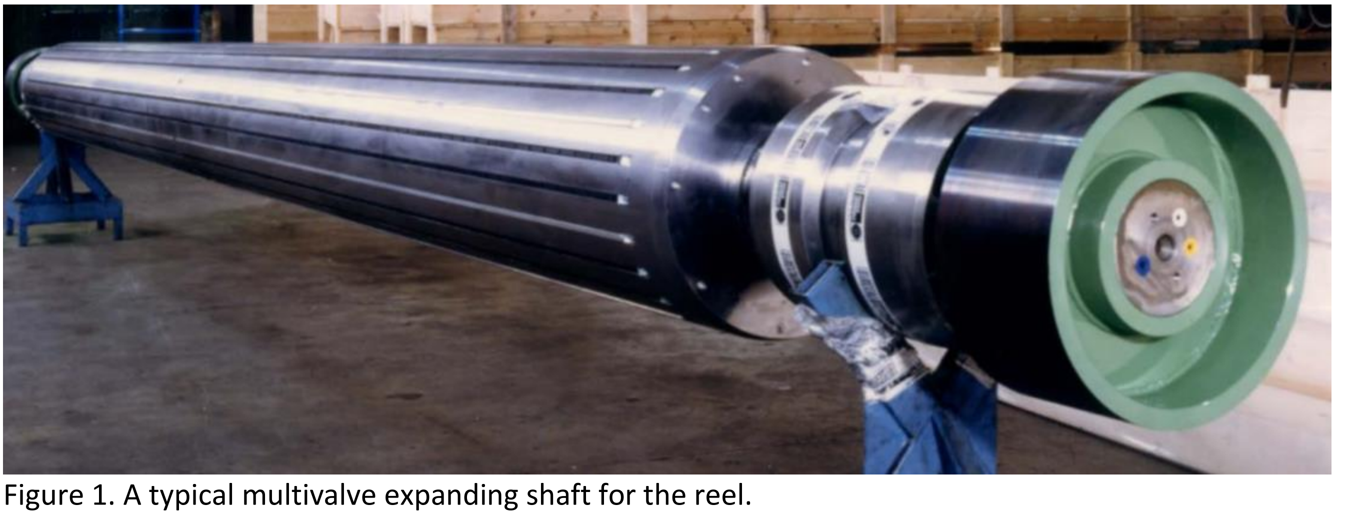

Figure 1. A typical multivalve expanding shaft for the reel.

Independent multiple pneumatic valves do the work
In a typical shaft there are 24 to 28 expanders or more and each one has a valve and a rubber tube that inflates it. To inflate, high-pressure air moves a piston which actuates each single internal valve. This then inflates a rubber bladder which causes the rubber ledge and gripping centering ledges to extend against the core, thus gripping it.

The shaft journal end has three ports for air and over the years the process has become highly automated, with three steps for centering, gripping and releasing the core and the shaft:

1. Inflate the centering ledges
2. Inflate the rubber gripping ledges
3. Deflate all the ledges at once.

The inflating and deflating phases are controlled through pneumatically powered valves and operating time can be adjusted based on need.

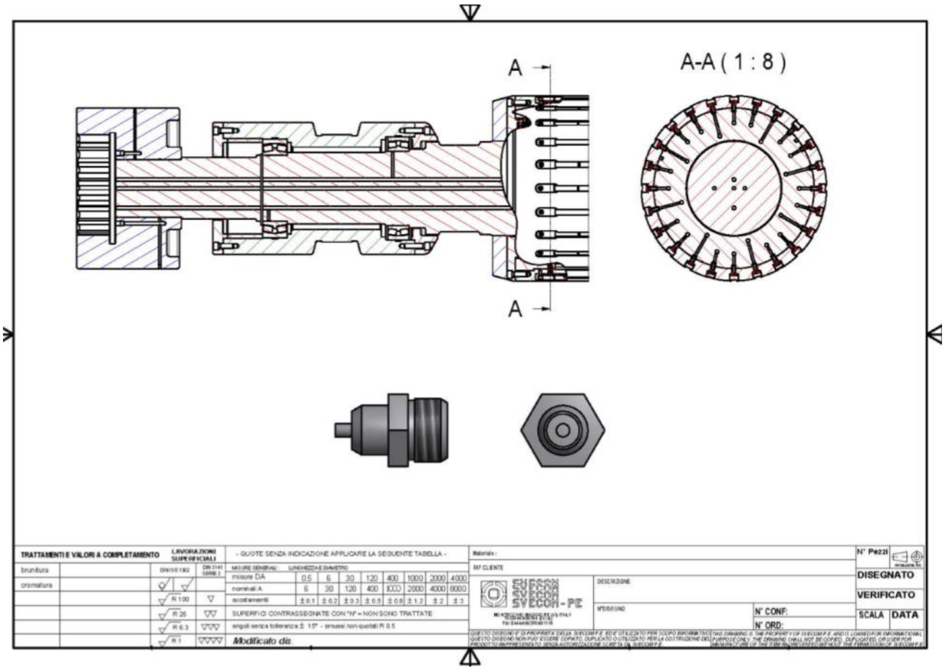

Figure 2. Drawing of the multiple independent valve design.

Pneumatic becomes industry standard

Following its introduction, the independent multiple-valve pneumatic expanding shaft has been widely accepted, both among tissue manufacturers as well as the suppliers of tissue machines. With this solution, each paper machine needs only a minimum of 2, and up to 5, expanding shafts instead of up to 20-40 rubber covered shafts. Cores can be made of paper, plastic or steel and the gentle operation of the expanding shaft reduces damage on the cores.

The pneumatic independent valve design has no speed restrictions, which is a big advantage over the older mechanical design which is speed limited, because the parts can come loose very high rotational speeds.

Mr. Flavio Marin at Svecom says that the shaft design has a higher and safer performance because it is so easy to remove from the paper core, and also because it can be automated with a handling system to deflate and extract the shaft. But the key advantage with the multiple independent valve system is that, if there is one valve failure it is no problem as all the others remain inflated and gripping the core.

"As a result, we are supplying these to both tissue manufacturers, meaning the mills directly, as well as the manufacturers of tissue machines. We have between 90-100% of all the double width machines (5.6-m wide) using this solution today."

Generation change presents challenges

A concern Marin sees in the industry is the generational shift that is taking place in purchasing or engineering departments, where very competent younger people are entering key roles but they don't always have an understanding of the differences in the single-valve or multiple-valve configurations.

"We need to take time to discuss the subtle but significant differences, and the impact that they can have on efficiency and safety in the operations. It basically comes down to reading a drawing and talking with the operations people to get that understanding."

A single-valve shaft, Marin says, costs maybe 5-10% less than the multiple-valves, which can make them attractive, initially. "But that can cause trouble later. We have seen cases where lose one order and then the customer later comes back to the multiple valve system. A multi-valve expanding shaft costs around €30,000, and a cheaper design might be €2-3000 less. But when you add up the trouble, time and lost tonnage that can result with a single-valve solution, the cost is much higher."

Specifications must be exact

Another item that is critically important is getting the sizing specifications right. "We have also worked hard with the purchasing people to ensure that we are very specific about the internal diameters required. Because some people use inches and some use millimeters, there is room for confusion. Since these must be correct to a tolerance of +/-1 mm, it is important that everyone is noting this correctly in the technical specs for the machine. We have definitely made progress on this but still every year some mistake arises, which becomes a problem for all of us."