White Paper: Bladder Inflation Monitoring System for the Converting Industry

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Bladder shafts have been a staple of the converting industry for several decades with predictable, simple performance. The operator supplies air pressure to inflate a bladder, which in turn expands gripping elements that hold a core in place. A properly inflated shaft will do its job without damaging the core; however, if a shaft is not properly inflated, a number of problems related to the material processing and the shaft itself are brought into play. This results in potential unsafe operation of the equipment and costly scrapped rolls. This begs the question: how do you know when the shaft has been properly inflated? Every shaft has an optimal inflation level and achieving this optimal inflation level is critical to the safe operation of the shaft to the correct processing of the material being unwound and wound and to extending the life of the bladder that expands and contracts with each cycle. Most operators believe that a shaft is full when they no longer hear the air passing into the shaft. This is an inaccurate estimate of correct inflation and relying on an audio clue is unrealistic in converting facilities. Air pressure in a shaft can be checked with a gauge, but it is also unrealistic to expect that this is done by every operator on every shift on every shaft inflation.

Problems Related to the Improper Inflation of a Shaft

1.) Core slippage from under-inflation results in problems in the web or quality issues in the finished product such as:

- Web breaks
- Baggy edges
- Loose winds
- Loss of web tension control
- Process defects
- Printing misalignment
- Out of round rolls
- Telescoping rolls
- General web alignment issues
- Decreased repeatability throughout the production process
- Core fires! Unchecked, a slipping core can create enough friction to start a fire

2.) Over-inflation of a bladder can cause the gripping elements (lugs or strips) to apply too much force to the inside of a core, causing premature core tearing and damage that ultimately will result in scrapped material and increased production cost.

3.) Over time, improper inflation will damage the shaft body and its gripping elements. This results in premature shaft maintenance and, in some cases, scrapped shafts that drive up operational costs.

Beyond the challenge of an operator properly inflating the shaft, there is always the risk of catastrophic bladder failure – a "blowout" if you will – that results in shutting down a production line when a bladder fails and the gripping elements cannot expand outward to grip the core. Invariably, these events happen at the worst possible times. Even if you have a spare shaft on hand, re-webbing or threading the machine consumes precious production time. It was once thought these catastrophic bladder failures were entirely random, but the bladder in a shaft has a lot in common with the tire on your car. Unless you hit a pot hole or run something over that causes an immediate failure - a "blowout" - your tire is reliable until fatigue begins to break down the rubber, which is a function of time and miles driven. The repeated inflation and deflation of the shaft in your web process breaks down the rubber bladder material over time in a similar manner. As your tire's life is estimated in miles, your shaft bladder's lifespan is a function of the number of inflation/deflation cycles. Just like your tires, the best practice is to replace your bladder prior to a catastrophic failure shuts down your production line. Unfortunately, bladder shafts don't have a handy mileage gauge to let us know they are coming to the end of their life.

So, how can you tell when it's time to schedule a maintenance review of your shafts? Again, the example of the car tire provides guidance: what is the one way your car tire lets you know you are starting to have a problem? The tire begins to leak. Slowly at first, and if you don't pay attention and fill the tire up with air when this occurs, in a few days you might walk outside in the morning to a completely flat tire. Your bladder shaft reacts the same way – slow leaks precede catastrophic failures. Unlike your tire, you can't see that the shaft is leaking air – it doesn't "look" flat. Additionally, there is most likely a core on the shaft, adding to the difficulty and uncertainty of a visual inspection. When there is a slow leak, the shaft doesn't necessarily act any differently than normal, because it is likely that the cycle times are short enough that the slow leak won't affect the operation of the machine or process.

What causes these slow bladder leaks? They happen over the life of the bladder as it is inflated and deflated by the operator. With every revolution of the shaft, it is being compressed by the weight of the roll of material being processed, so the elastic/rubber/polymer bladder material undergoes tremendous stress and deformation. The strain of this repeated stress and deformation eventually results in initial material failure on a microscopic

scale. You won't know it is there, but the leak has begun. Continued operation under these conditions causes the magnitude of the failure to increase, and the slow leak advances to become a catastrophic failure shutting down your line.

The daily operation of the shaft is not the only reason a bladder will fail. Temperature variations are not conducive to a long life for the most common bladder materials. Operating at either extreme, hot or cold, accelerates the fatigue of the bladder. Heat can come from more than the environment or the material process. If the shaft is underinflated and slips in the core, the resulting friction generates heat, which is transferred through the gripping elements of the shaft directly onto the bladder material. When you clean your shaft with harsh chemicals, the treatment affects the bladder material. If you are using box cutters to slab excess material on shafts with external elements, there is a chance the blade can cut the bladder material.

What happens when a bladder fails? The most common result is a web break. Depending on where this occurs in the process and what type of material is being processed, you can lose hours of productivity and potentially tens of thousands of dollars in materials. In a worst-case scenario, the failed bladder shaft continues to run unattended and generates enough heat to start a core fire. More commonly, rolls wound on poorly performing shafts can telescope, misalign, or lose winding tension. These defects require additional processes to rewind the rolls or the outright scrapping of product. The warning signs that precede catastrophic failure exist, but, there has not been a reliable way to identify these warning signs and subsequently take action to prevent catastrophic failure.

Double E has developed a patented bladder inflation monitoring system called ShaftSafe that gives operators and manufacturing leadership the ability to monitor the operation of an air shaft while in use. It is finally possible to mitigate the risk of a catastrophic bladder failure, to identify, and to perform preventive maintenance cost effectively on your shafts. This system utilizes unique sensing technology to:

- Display air pressure on up to 8 shafts in real-time
- Generate visual and audio alarms when a shaft is operating at an improper air pressure
- Identify a bladder that is experiencing a slow leak
- Record temperature data
- Calculate the amount or time the shaft has been in operation (inflated);
- Count the number of shaft inflation cycles

What this means to your daily operation is readily available, practical data. When the operator inflates the shaft, he/she can view the shaft air pressure on the ShaftSafe screen to ensure it is inflated to the appropriate

level. Guaranteed inflation to the correct level translates to increased uptime and greatly reduces the chance of catastrophic failure. Furthermore, consistent inflation of the bladder shaft to the optimal level improves the repeatability of your web process and the overall long-term health of the shaft.

Arguably the most interesting feature of the system is the detection of a slow leak. Before, there was no practical way to gauge the life expectancy of a bladder in a shaft. Now, the operator or lead person can simply look at one screen and monitor all the shafts in a section of the web process and know they are operating correctly. By continually monitoring the air pressure in the shaft and measuring any changes in pressure over a specific time period, the system can identify a slow leak. Armed with this knowledge, operators and line supervisors can take corrective action to ensure that the under-inflation of the shaft does not affect the web process or cause scrap material. By then taking planned, preventive maintenance, the risk of catastrophic failure is eliminated and operating costs are reduced.

Surprises are never fun in a manufacturing environment. In the web industry, operating problems such as those described above result in defective finished product or a web break. These defects are so routine that they have become status quo. But by leveraging new technology, a plant can remove the element of surprise in their manufacturing process and take positive steps towards reducing operating cost and maximizing machine uptime. By using analytics on something as far upstream in the process as inflating the unwind shaft, production management folks can expect predictable, repeatable results that lead to increased profitability.

Company Info

For over 40 years, Double E has been a trusted source for advanced web handling components for the paper, film and foil web converting and packaging industries. Our product line includes core chucks, core shafts, safety chucks, brakes, web guides, rollers, core cutters, core plugs, reel spools, slitting systems, knife holders, roll stands and slitting modules.

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